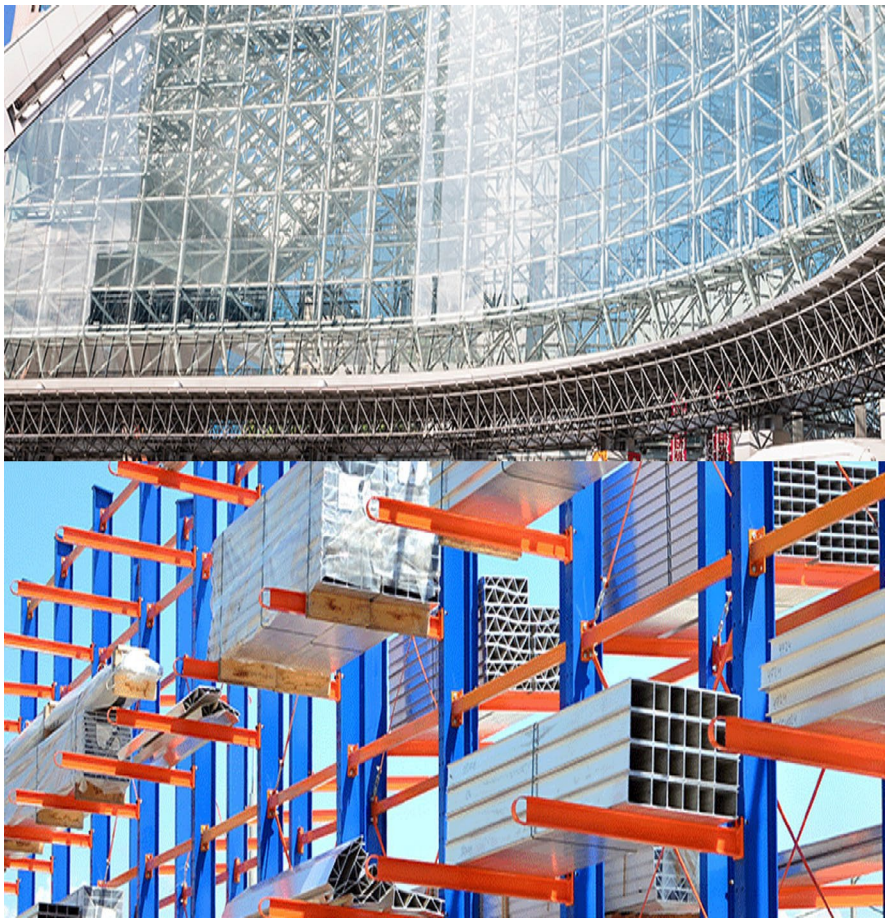
ENVIRONMENTAL PRODUCT DECLARATION

ERW STEEL PIPE

HISTEEL



Histeel's products are crafted in alignment with stringent international standards, offe versatile selection of round, square, and rectangular pipes.

HISTEEL, founded as HANIL IRON & STEEL CO., LTD. in 1957, began manufacturing ERW steel pipes in 1977 through the acquisition of Korea's first steel pipe company. In order to strengthen its competitiveness through intensive development of steel pipe business, Hanil Iron & Steel separated the steel pipe business division in 2003 to create HISTEEL CO., LTD.

The company has developed steadily since then through continuous investment and new product development.

The driving forces of HISTEEL as a globally recognized pipe manufacturing company are loyalty, integrity, which has built trust and satisfaction for our customers. HISTEEL staffs are constantly motivated to offer customer-oriented solutions. HISTEEL is proud to be known as a trusted partner aiming to satisfy customers from all over the world since over half a century.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

HISTEEL

ERW Steel Pipe
Designated Steel Construction Production

According to ISO 14025, ISO21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Solutions 333 Pfingsten Rd, Northbrook IL, 60062 www.ul.com www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v 2.7 2022
MANUFACTURER NAME AND ADDRESS	HISTEEL Co., Ltd. - 139, Namdong-daero, Namdong-gu, Republic of Korea
DECLARATION NUMBER	4791362765.101.2
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	1 metric ton
REFERENCE PCR AND VERSION NUMBER	Part A: Life Cycle Assessment Calculation Rules and Report Requirements, (UL Environment, V4.0 28.03.2022) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 26.08.2020).
DESCRIPTION OF PRODUCT APPLICATION/USE	ERW pipe is used for Represent Square general structures, Ordinary piping, General structures, Machine structures, Special structures, Building structures, and etc.
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	Global
DATE OF ISSUE	September 20th, 2024
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product-specific
RANGE OF DATASET VARIABILITY	N/A
EPD SCOPE	Cradle to gate with options (modules A1-A3, modules C1-C4, and module D)
YEAR(S) OF REPORTED PRIMARY DATA	2023
LCA SOFTWARE & VERSION NUMBER	Sima Pro LCA software (Version 9.6.0.1)
LCI DATABASE(S) & VERSION NUMBER	Ecoinvent Database 3.10
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1, IPCC AR6, EDIP2003, Cumulative Energy Demand (LHV)

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:	Saero Consulting
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Ik-Kim

ENVIRONMENTAL PRODUCT DECLARATION

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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.

HISTEEL

ERW Steel Pipe
Designated Steel Construction Production

According to ISO 14025,
ISO 21930:2017

1. Product Definition and Information

Description of Company/Organization

HISTEEL, founded as HANIL IRON & STEEL CO., LTD. in 1957, began manufacturing ERW steel pipes in 1977 through the acquisition of Korea's first steel pipe company. In order to strengthen its competitiveness through intensive development of steel pipe business, Hanil Iron & Steel separated the steel pipe business division in 2003 to create HISTEEL CO., LTD. The company has developed steadily since then through continuous investment and new product development.

Incheon plant is specialized in the production of essential steel pipes for steel structures such as KS general plumbing, construction, bridges, telephone poles, furniture, and recreational facilities

In particular, our KS and JIS-certified square tubes are exported to over 30 countries around the world and have received positive feedback from customers in terms of quality and delivery. In addition to square tubes, we offer a great product selection with a wide range of rectangular tubes.

The driving forces of HISTEEL as a globally recognized pipe manufacturing company are loyalty, integrity, which has built trust and satisfaction for our customers. HISTEEL staffs are constantly motivated to offer customer-oriented solutions. HISTEEL is proud to be known as a trusted partner aiming to satisfy customers from all over the world since over half a century.

Products name

ERW steel pipe

Product Description

HISTEEL’s a factory that specializes in producing structural steel pipes essential for the production of steel structures such as KS general piping, buildings, bridges, telephone poles, furniture, and play facilities. In particular, each pipe acquires KS and JIS marks and is exported to over 30 countries around the world. In addition to square pipes, we also provide a variety of rectangular square pipes to expand the range of product selection.

HISTEEL

ERW Steel Pipe
Designated Steel Construction Production

According to ISO 14025,
ISO 21930:2017

Product Identification/Specification

Complies with the Korean Industrial Standard (KS D 3507, KS D 3631, KS D 3562, KS D 3517, KS D 3566, KS D 3568, KS D 3632, KS D 3864)

Complies with the Japan Standard (JIS G 3452, JIS G 3454, JIS G 3445, JIS G 3444, JIS G 3466)

Complies with the American Petroleum Institute (API 5L)

Complies with the American Society for Testing Material (ASTM A53, ASTM A513, ASTM A500)

Complies with the United Kingdom Standard (BS 1387, BS 980, BS 1717, BS 1775, BS 980, BS 1139, BS 4848)

Complies with the Australian/New Zealand Standard(AS/NZS 1163)

Complies with the Canada Standard (CSAG40.20-13/G40.21-13Grade50W)

Usage areas and conditions, Application Rules

Represent Square general structures, ordinary piping, general structures, machine structures, special structures, building structures etc.

UNSPSC Code

40171501(Commercial welded carbon steel pipe)

Material Composition

Table 1 KS material

Unit : Max. %

STANDARD	GRADE	C	Si	Mn	P	S	V	N	Nb	Ti	Other
KS D 3507	SPP	0.28	0.35	0.80	0.040	0.040	-	-	-	-	-
KS D 3562	SPPS250	0.30	0.35-	0.30~1.00-	0.040	0.040	-	-	-	-	-
KS D 3566	SGT275	0.25	-	-	0.040	0.040	-	-	-	-	-
	SGT355	0.24	0.40	1.50	0.040	0.040	-	-	-	-	-
	SGT550	0.30	0.40	2.00	0.040	0.040	-	-	-	-	-
KS D 3568	SRT275	0.25	-	-	0.040	0.040	-	-	-	-	-
	SRT355	0.18	0.55	1.50	0.040	0.040	-	-	-	-	-
KS D 3632	SNT275E	0.25	0.35	1.40	0.030	0.015	-	0.006	-	-	-
	SNT355E	0.22	0.55	1.60	0.030	0.015	-	0.006	-	-	-

Table 2 JIS material

Unit : Max. %

STANDARD	GRADE	C	Si	Mn	P	S	V	N	Nb	Ti	Other
JIS G 3444	STK290	-	-	-	0.050	0.050	-	-	-	-	-
	STK400	0.25	-	-	0.040	0.040	-	-	-	-	-
	STK490	0.18	0.55	1.65	0.035	0.035	-	-	-	-	-
	STK500	0.24	0.35	0.30~1.30	0.040	0.040	-	-	-	-	-
	SRK540	0.23	0.55	1.50	0.040	0.040	-	-	-	-	-
JIS G 3452	SGP	-	-	-	0.040	0.040	-	-	-	-	-
JIS G 3454	STPG370	0.25	0.35	0.30~0.90	0.040	0.040	-	-	-	-	-
	STPG410	0.30	0.35	0.30~1.00	0.040	0.040	-	-	-	-	-

JIS G 3466	STKR400	0.25	-	-	0.040	0.040	-	-	-	-	-
	STKR490	0.18	0.55	1.50	0.040	0.040	-	-	-	-	-

Flow Diagram

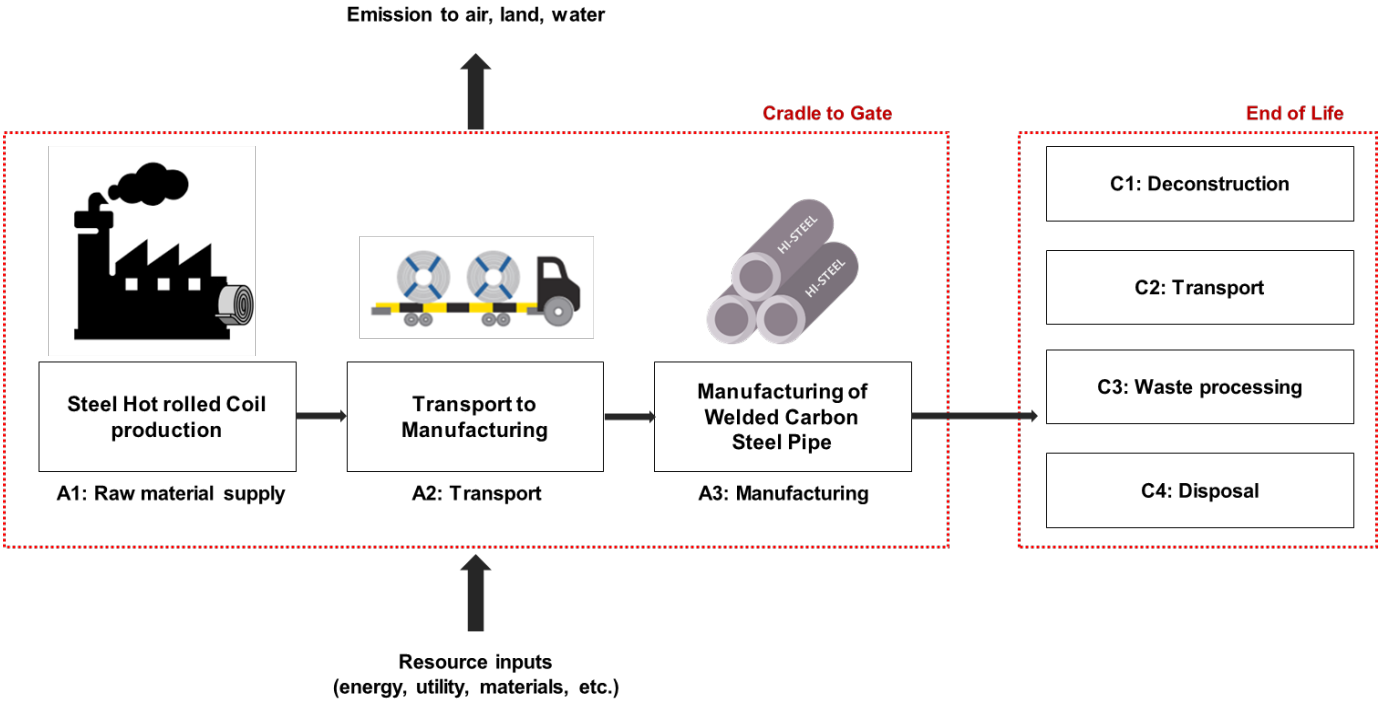

Figure 1 Process Flow Diagram

Production process

Production process consists of 17 steps and is as follows.

Table 3 ERW pipe production Coil Bending Line processes.

No.	Step	Description
1	Hot Coil	Process of inserting skelp into Uncoiler.
2	Levelling	Process to supply coil or skelp to forming process by uncoling the wound
3	Edge Milling	Process that secures the weldability of ERW by milling both longitudinal edges of coil or skelp with square-shape (I type)
4	Forming	Process to transform a flat coil or skelp into a round pipe and to prepare edge alignment for welding
5	Welding	Process of joining both edges of the coil or skelp through high-frequency electric resistance heat and squeeze pressure
6	Bead trimming	Process of removing beads created by ERW to meet specifications
7	Seam Annealing	Process of improving the ductility and toughness of the welded area by reheating the hardened welded area during welding.
8	Air & Waer Cooling	Process of air cooling and water cooling to reduce dimensional deformation after shaping.
9	Sizing	Process to adjust pipe dimension as per customer or specification requirements
10	Cutting	Process to cut the pipe length as per customer or specification requirements
11	End Facing	Process to machine both pipe ends as per customer or specification requirements
12	Straightening	Process to calibrate pipes according to specification requirements
13	Hydrostatic Testing	Process to test pipe hydrostatically with constant pressure and holding time
14	Non-Destructive Test	Process to inspect welds and base metal of pipe by using Non- Destructive method (ultrasonic)
15	Final Test	Process to final inspection of product appearance, function, etc
16	Marking and packing	Process that packages and decides the acceptance/refusal by confirming the dimension of the final product and visual condition
17	Shipment	Product Shipment Process

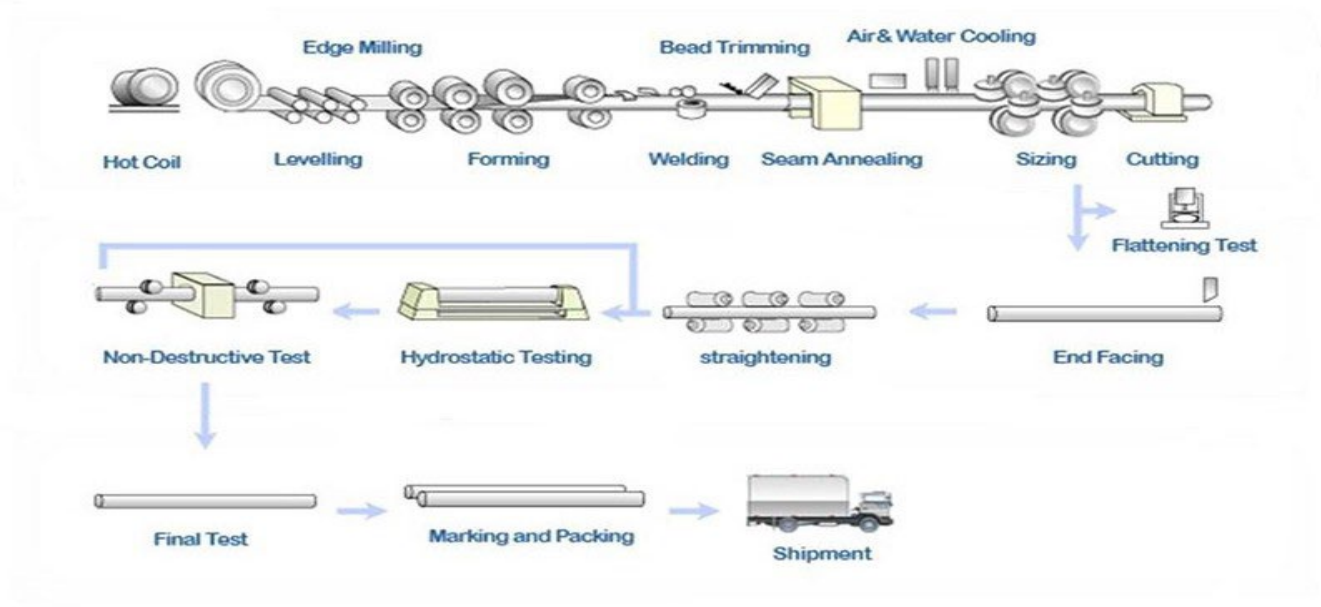

Figure 1 Coil Bending Line Process Flow

2. Life Cycle Assessment Background Information

Goal of the study

This study aims to assess the environmental impact of Electric resistance welded carbon steel pipe(ERW). The purpose is to identify major issues through this.

1) Establish a Life Cycle Inventory database for the target product
2) Derivation of environmental impact assessment results through whole process impact assessment
3) Identification of Major Environmental Issues through the Interpretation of the Whole Process

The results of this study can be used externally to promote corporate environmental management activities by using it as a database that is the basis for obtaining certification. Internally, it can be used as an indicator for improving the environmental of products and as a database for managing the environmental performance of sustainable products.

It discloses quantified information on reducing carbon generation throughout the entire product process, and the certificate obtained by verifying this report can be used as a response document when requesting the results of the entire process evaluation by the partner.

Declared unit

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

NAME	AMOUNT	UNIT
ERW steel pipe	1	Metric ton

Reference service life

Not applicable

System Boundary

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

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

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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

■ **Module A2**: Transport to manufacturer

- Sea transportation of coil and auxiliary materials
- Land transportation of coil and auxiliary materials

■ **Module A3**: Manufacturing of Electric resistance welded carbon steel pipe(ERW).

- Supply of process utilities, including electricity, process water and process gases
- Manufacturing Welded carbon steel pipe at ERW 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

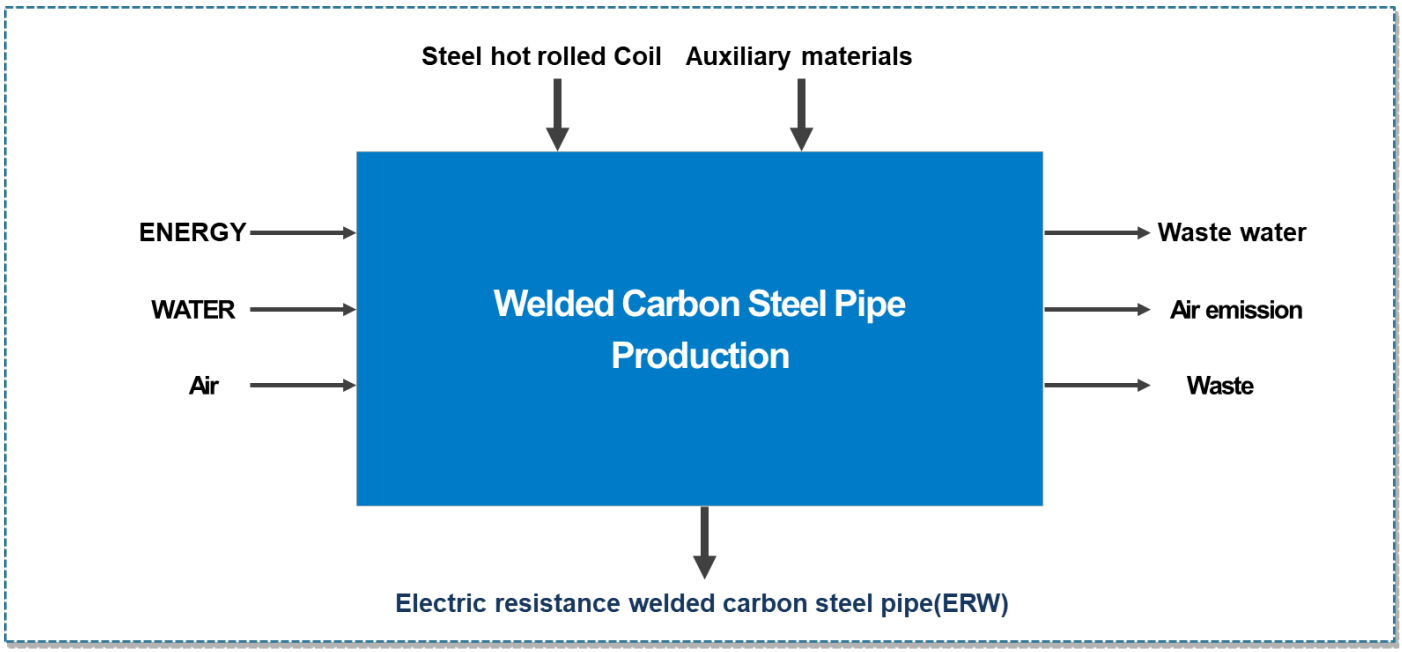

Figure 3 Inputs and outputs into the unit process

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

Allocation procedures for co-products and between product is applied according to Part A PCR. Although clippings occur, there is no economic value, so no allocation was made according to economic value.

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 fiscal year of 2023.
- Geographical coverage: Primary data was collected from Incheon, HISTEEL manufacturer.
- Technology coverage: Primary data current was collected from current ERW process.
- Source of the data: The data used for this Life cycle assessment is ERW steel pipe production data for 2023. Products are produced at the Incheon Factory All input and output data were collected in 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

3. Life Cycle Assessment Scenarios

Data calculation

Information regarding raw materials, raw material transportation, energy use, resource consumption, and emissions was compiled based on an annual average per site.

Raw material extraction and processing (Module A1)
Raw material
- Raw materials collected the amount put into the EPR system-based annual process.

Auxiliary materials
- Auxiliary materials collected the amount put into the annual process based on purchase data.

Manufacturing of sub-merged arc welded carbon steel pipe (ERW) (Module A3)
Utility and energy
- The electricity, LNG and water consumption data were collected using utility bills representing the overall usage for the entire factory.

Waste
- The generated wastes are a scrap associated with the solid waste and scrap metal generated during the cutting process.

Assumptions and limitations

Raw material extraction and processing (Module A1)
- If no DB exactly matches the collected field data, apply conservatively a similar DB with greater environmental impact.
- Assume that all gas used for welding is evaporated.
- If the data collection unit is a quantity, it is applied by checking individual weights and converting them into weight units.
- In the case of data collected by volume, the specific gravity specified in the MSDS is checked and converted into weight and applied.
- For welding rods and weld wires, it is assumed that 99% is included in the product and 1% is generated from waste.

Transport to manufacturer (Module A2)
– The transportation distance for raw materials was optimized by applying the shortest distance between the manufacturing plant and HISTEEL factory.
– For overseas manufacturers, the distance of land and sea transportation to the supplier's region has been calculated and the distance of domestic transport is included.

Manufacturing of Welded carbon steel pipe (ERW) (Module A3)
- In the case of constants, they are used as diluents for lubricating oil. The used constants are all treated as wastewater.
- The transportation distance for waste materials was optimized by applying the shortest distance between the HISTEEL factory and the waste disposal facility.

- Air emissions caused by fuel combustion were used when the company calculated and provided the process direct emissions, and the company stating only the fuel usage calculates the direct emissions according to the usage by applying IPCC and the emission coefficient of the Ministry of Environment.

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 6, are the chosen transportation method.

Waste processing (C3)

- In PCR part A, it is stated that 83.9% of the steel is assumed to be recycled, while 6.1% is assumed to undergo incineration. Please consult Table 4 for disposal assumptions specific to different regions.

Disposal (C4)

- According to PCR part A, it is assumed that 9.4% of the steel is sent to landfills. Please refer to Table 4 for regional product disposal assumptions.

Reuse-Recovery-Recycling-potential (D)

- During the recycling process, 83.9% of the end-of-life product is converted into recycled steel.

Table 4 Product Disposal Assumptions by Region (Source: PCR Part A)

COUNTRY/REGION	MATERIAL	RECYCLING RATE	LANDFILL RATE	INCINERATION RATE
Korea	All	83.9%	9.4%	6.1%

Scenarios (C1~C4, D Module)

Table 5 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	1.00E+03	Kg
Recovery system specified by type Deposition	Re-use	-	Kg
	Recycling	8.39E+02	Kg
	Incineration	6.1E+01	Kg

	Landfill	9.40E+01	Kg
Assumptions	For waste transport	300	Km

Table 6 Benefits and loads beyond the system boundary (D)

NAME	VALUE	UNIT
Recycling rate of product	83.9	%

LCA Software

Sima Pro LCA software (Version 9.6.0.1) 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 3.10

Life Cycle Impact Assessment (LCIA) methodology

The following methodologies were used for LCA.

- TRACI 2.1
- IPCC AR6(IPCC 2021 GWP 100)
- EDIP 2003
- Cumulative Energy Demand (LHV)

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.

4. Life Cycle Assessment Results

Life cycle impact assessment (LCIA) results are declared using TRACI 2.1 methodology, IPCC AR6(IPCC 2021 GWP100) methodology.

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

Table 7 LCA results, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D	TOTAL
GWP 100	kg CO_2 eq	2.46E+03	3.54E+01	3.23E+01	5.40E+00	1.78E+02	1.63E+01	5.88E-01	-1.46E+03	1.27E+03
ODP	kg CFC-11 eq	6.35E-08	5.59E-07	5.75E-07	7.78E-08	2.74E-06	3.60E-07	1.82E-08	3.94E-11	4.39E-06
AP	kg SO2 eq	5.46E+00	1.60E-01	1.08E-01	1.22E-02	3.55E-01	8.00E-02	3.76E-03	-2.87E+00	3.31E+00
EP	kg N eq	2.04E-01	3.74E-02	1.83E-01	1.34E-03	1.84E-01	2.48E-02	7.04E-04	-1.71E-01	4.64E-01
SFP	kg O3 eq	7.48E+01	4.03E+00	2.00E+00	3.32E-01	5.32E+00	2.11E+00	1.00E-01	-3.09E+01	5.78E+01
ADP fossil	MJ, LHV	1.00E+03	6.64E+01	3.39E+01	1.03E+01	3.14E+02	3.83E+01	1.97E+00	-1.83E+00	1.46E+03

Global Warming Potential (GWP 100)
Ozone Depletion Potential (ODP)
Acidification Potential (AP)
Eutrophication Potential (EP)
Smog Formation Potential (SFP)
Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADP fossil)

Resource use indicators used the cumulative energy demand (LHV) methodology

Table 8 Resource use indicators, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D	TOTAL
RPR_E	MJ, LHV	4.70E+02	6.53E+00	2.27E+01	1.55E-01	3.89E+01	3.63E+00	1.30E-01	5.72E+02	1.11E+03
RPR_M	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPR_T	MJ, LHV	4.70E+02	6.53E+00	2.27E+01	1.55E-01	3.89E+01	3.63E+00	1.30E-01	5.72E+02	1.11E+03
$NRPR_E$	MJ, LHV	2.64E+04	5.03E+02	5.74E+02	7.25E+01	2.43E+03	2.87E+02	1.44E+01	-1.45E+04	1.58E+04
$NRPR_M$	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ, LHV	2.64E+04	5.03E+02	5.74E+02	7.25E+01	2.43E+03	2.87E+02	1.44E+01	-1.45E+04	1.58E+04
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.10E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.47E+02	-1.36E+02

Renewable primary resources used as energy carrier (RPR_E)
Renewable primary resources with energy content used as material (RPR_M)
Total use of renewable primary resources with energy content (RPR_T)

Non-renewable primary resources used as an energy carrier ($NRPR_E$)
Non-renewable primary resources with energy content used as material ($NRPR_M$)
Total non-renewable primary resources with energy content ($NRPR_T$)
Secondary materials (SM)
Renewable secondary fuels (RSF)
Non-renewable secondary fuels (NRSF)
Recovered energy (RE)
Use of net freshwater resources (FW)

Output flows and waste category indicators used the EDIP 2003 methodology

Table 9 Output flows and waste category indicators, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D	TOTAL
HWD	kg	1.60E-02	1.32E-02	2.89E-01	5.61E-04	6.26E-02	4.38E+01	2.02E-04	-1.08E-04	4.42E+01
NHWD	kg	1.24E-01	3.00E+01	6.69E+01	1.01E-02	7.31E+01	8.43E+02	9.40E+01	1.75E+02	1.28E+03
HLRW	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ILLRW	kg	3.64E-05	1.06E-04	2.88E-03	3.19E-06	5.77E-04	5.51E-05	2.24E-06	1.59E-03	5.25E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.39E+02	0.00E+00	0.00E+00	8.39E+02
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Hazardous waste disposed (HWD)
Non-hazardous waste disposed (NHWD)
High-level radioactive waste, conditioned, to final repository (HLRW)
Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW)
Components for re-use (CRU)
Materials for recycling (MR)
Materials for energy recovery (MER)
Recovered energy exported from the product system (EE)

Table 10 Carbon emissions and removals, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D	TOTAL
BCRP	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BCEP	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BCRK	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BCEK	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BCEW	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCE	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCR	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNR	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Biogenic Carbon Removal from Product (BCRP)
Biogenic Carbon Emission from Product (BCEP)
Biogenic Carbon Removal from Packaging (BCRK)
Biogenic Carbon Emission from Packaging (BCEK)
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes (BCEW)
Calcination Carbon Emissions (CCE)
Carbonation Carbon Removals (CCR)
Carbon Emissions from Combustion of Waste from NonRenewable Sources used in Production Processes (CWNR)

5. LCA Interpretation

According to the impact assessment results (excluding the D module), Module A1, which raw material supply, including input of materials for product production, was found to have the most significant contribution to the potential environmental impacts of the ERW pipe across all impact categories except for ozone depletion potential (ODP). Module A3, Utilities and waste associated with manufacturing facilities do not make a significant contribution to any impact category except ODP and EP. Additionally, Module A3 within the manufacturing sector and end of life stage (C1-C4) were found not to have a significant contribution to any environmental impact category.

For the production of ERW pipe, a significant portion of the environmental impact across all impact categories except for Ozone Depletion Potential (ODP) can be attributed to the production of hot-rolled coils, which are used as raw materials.

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 information, warranting consideration of uncertainty and comparability. Continuous monitoring and updates may be necessary for a better understanding of changes in the future.

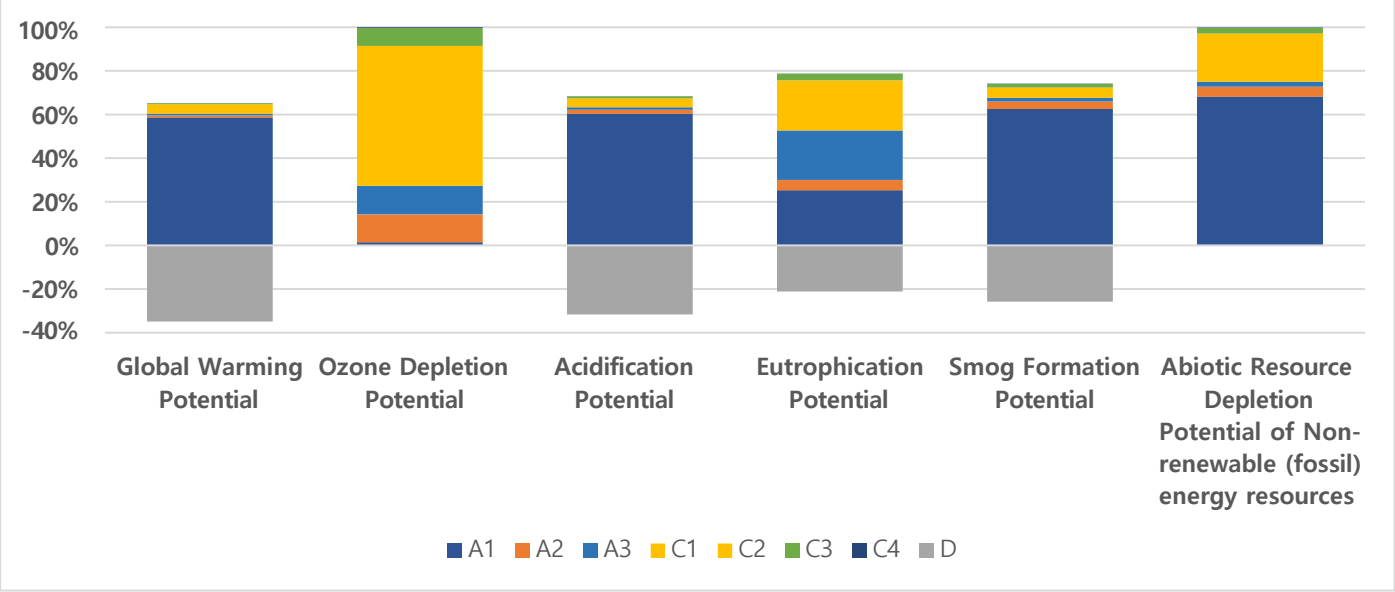

Figure 4 Impact Assessment results

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).

A sensitivity analysis was conducted on electricity used as the main energy source in the production process based on changes in the geography of the database. The database used for this sensitivity analysis is shown in Table 11. Results 1 applied the KR(KOREA) geographic electricity database, and Results 2 utilized the DE(GERMANY) geographic electricity database with a high rate of Renewable Energy. These results are presented in Table 12. Sensitivity percentages indicate the difference between the two LCA results. Result 1 and Result 2 exhibit a variance of 1.00% at the production stage(A1~A3).

Table 11 Electricity DB in the module A3

PARAMETER	GEOGRAPHY COVERAGE	INDICATOR	FACTOR	UNIT
Result 1	KR(KOREA)	KR: market for electricity, low voltage	6.44E-01	kg CO_2 eq
Result 2	DE(GERMANY)	DE: market for electricity, low voltage	3.93E-01	kg CO_2 eq

Table 12 Sensitivity Analysis

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
Result 1 (GWP)	kg CO_2 eq	2.52E+03	5.40E+00	1.78E+02	1.63E+01	5.88E-01	-1.46E+03
Result 2 (GWP)	kg CO_2 eq	2.51E+03	5.40E+00	1.78E+02	1.63E+01	5.88E-01	-1.46E+03
Sensitivity	%	1.00%	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 pipes, environmental impact can be reduced through the use of recycled materials and efficient process management.

6. Additional Environmental Information

Based on ISO 14001: 2015 (Environmental Management System) and OHSAS 18001: 2007 (Health and Safety Management System), HISTEEL continues to strive to build environmentally friendly production and management systems, comply with environmental laws and regulations, and improve the environment.

7. References

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