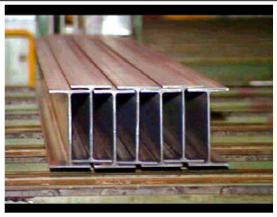
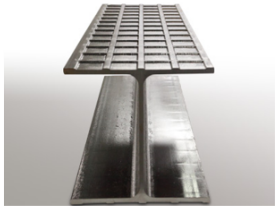
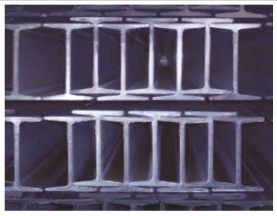
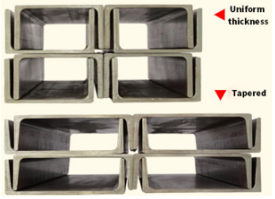
ENVIRONMENTAL PRODUCT DECLARATION

HOT ROLLED STRUCTURAL STEEL SECTIONS

EPD REPORT

Hot rolled structural steel sections	
	
Hot Rolled H-Beam	Checkered H-Beam
	
I-Beam	Channel Beam

TUNG HO STEEL ENTERPRISE CORP.

From its beginnings in “Tung Ho Hang” to today's Tung Ho Steel Enterprise Corporation, the company has always made trustworthiness the company's spiritual essence in its business. The company's core business values and objectives are embodied in the pursuit of exceptional contributions to society. Trustworthiness does not merely represent the company's trustworthiness in relation to outside parties, customers, and society, but also signifies trustworthiness in its employees and in itself.

In response to global warming, in order to effectively mitigate the impacts of climate change, Tung Ho Steel is actively promoting energy conservation and CO_2 reductions, as well as proactively disclosing the carbon footprint information for its products. Through product carbon footprint inventory, it is possible to learn about the greenhouse gas emissions throughout a product’s lifecycle. This enables effective problem identification and implementation of low-carbon and energy-conserving design philosophies to increase service competitiveness.

ENVIRONMENTAL PRODUCT DECLARATION

TUNG HO STEEL ENTERPRISE CORP.

HOT ROLLED STRUCTURAL STEEL SECTIONS

Hot rolled structural steel sections include “Hot Rolled H-Bea
“Checkered H-Beam”, “I-Beam” and “Channel Beam”

According to ISO 14025

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten road Northbrook, Il 60611
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.5 March 2020
MANUFACTURER NAME AND ADDRESS	TUNG HO STEEL ENTERPRISE CORP. Headquater 6F., No.9, Sec. 1, Chang-an E. Rd., Taipei City 10441, Taiwan https://www.tunghosteel.com/EN/HomeEg/Index Site for which this EPD is representative: Kaohsiung Works Address: No.8, Jiaxing St., Xiaogang Dist.,Kaohsiung City 81257, Taiwan Contact person: L. U. Yang k01@tunghosteel.com
Practitioner Name and Address	National Cheng Kung University Industrial Sustainable Development Center No.1, University Road, Tainan City 701, Taiwan (R.O.C) Contact person: Hung Tai Chou rtai88@gmail.com
DECLARATION NUMBER	4789960100.102.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Hot rolled structural steel sections Declared Unit: 1 metric ton of hot rolled structural steel sections
PRODUCT CODE/ STANDARD	HS code 72163300/ AS, CNS, JIS, EN, BS, ASTM
REFERENCE PCR AND VERSION NUMBER	1. Product Category Rules for Building-Related Products and Services Institut Bauen und Umwelt e.V. (IBU) Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019, Version 1.2.2 2. PCR Guidance-Texts for Building-Related Products and Services From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU) Part B: Requirements on the EPD for Structural steels, Version 1.6
DESCRIPTION OF PRODUCT APPLICATION/USE	Hot rolled structural steel sections include “Hot Rolled H-Beam” , “Checkered H-Beam”, “I-Beam” and “Channel Beam”. *Hot Rolled H-Beam is broadly applied in large-scale buildings with major load-bearing capabilities and stable cross-section performance, as well as in bridges, ships, cranes, equipment foundations, support frames, and foundation piles. *Checkered H-Beam is suitable for cover plates involving applications in temporary steel bridges, rapid transit, and other civil engineering projects. *I-Beam is broadly applied in industrial buildings and metal structures such as factories, bridges, ships, agricultural vehicle manufacturing, and power transmission towers. *Channel beam is widely applied in building structure and vehicle production, as well as other industrial structures.
PRODUCT RSL DESCRIPTION (IF APPL.)	--
MARKETS OF APPLICABILITY	Local and international
DATE OF ISSUE	1/21/2022
PERIOD OF VALIDITY	5 Years
EPD TYPE	product-specific
RANGE OF DATASET VARIABILITY	mean
EPD SCOPE	Cradle to gate
YEAR(S) OF REPORTED PRIMARY DATA	2020
LCA SOFTWARE & VERSION NUMBER	SimaPro 9.2.0.2
LCI DATABASE(S) & VERSION NUMBER	Ecoinvent 2.2, Ecoinvent 3, U.S. LCI Database & EF database 2.0

ENVIRONMENTAL PRODUCT DECLARATION

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HOT ROLLED STRUCTURAL STEEL SECTIONS

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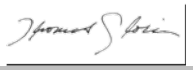
“Checkered H-Beam”, “I-Beam” and “Channel Beam”

According to ISO 14025

LCIA METHODOLOGY & VERSION NUMBER	EN 15804 + A2 Method, EF method 2.0, EDIP2003, AWARE, Cumulated Energy Demand, Recipe 2016 Midpoint
The PCR review was conducted by:	Institut Bauen und Umwelt (IBU) PCR Review Panel info@ibu-epd.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☐ EXTERNAL	 Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Hung Tai Chou, National Cheng Kung University Industrial Sustainable Dvelopment Center
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	 Thomas P. Gloria, Industrial Ecology Consultants

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.

1. Product Definition and Information

1.1. Description of Company/Organization

From its beginnings in“Tung Ho Hang”to today's Tung Ho Steel Enterprise Corporation, the company has always made trustworthiness the company's spiritual essence in its business. The company's core business values and objectives are embodied in the pursuit of exceptional contributions to society.

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1.2. Product Description

Product Identification

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other civil engineering projects.

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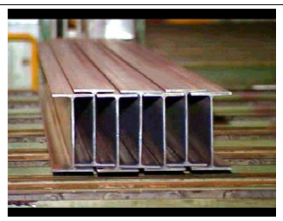
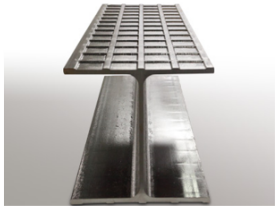
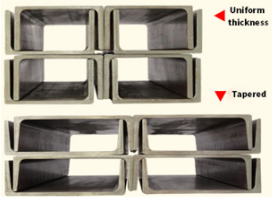
Hot rolled structural steel sections	
	
Hot Rolled H-Beam	Checkered H-Beam
	
I-Beam	Channel Beam

Product Specification

The products own CE MARK for LRV, and can be customized in accordance with Chinese National Standard(CNS), Australian Standard(AS), Japanese Industrial Standard(JIS), European Standard(EN), British Standard(BS) and American Society for Testing and Materials Standard(ASTM). For more details of technical specifications such as: dimensions, properties and steel grade of steel sections, please visit:
https://www.tunghosteel.com/EN/HomeEg/Product/Intro/2

Technical Data

NAME	VALUE	UNIT
Density	7,850	kg/m^3
Modulus of elasticity	2.1	N/mm^2
Coefficient of thermal expansion	11.6	$10^{-6}K^{-1}$
Thermal conductivity	80.2	W/(mK)
Melting point	1,493	℃
Electrical conductivity at 20°C	1,030	$\Omega^{-1}m^{-1}$
Minimum yield strength (für Bleche)	345	N/mm^2

Minimum tensile strength (für Bleche)	450	N/mm^2
Minimum elongation (für Bleche)	≧18	%
Tensile strength	□ 450	N/mm^2

Extraordinary effects for Fire, Water, and Mechanical Destruction

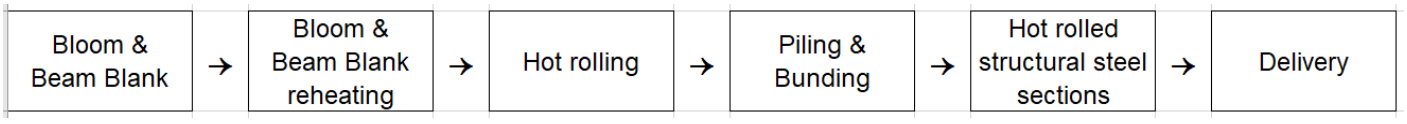
Special Fire Fighting Procedures - Do not use water on molten metal. Do not use Carbon Dioxide (CO_2). Firefighters should not enter confined spaces without wearing NIOSH/MSHA approved positive pressure breathing apparatus (SCBA) with full face mask and full protective equipment.

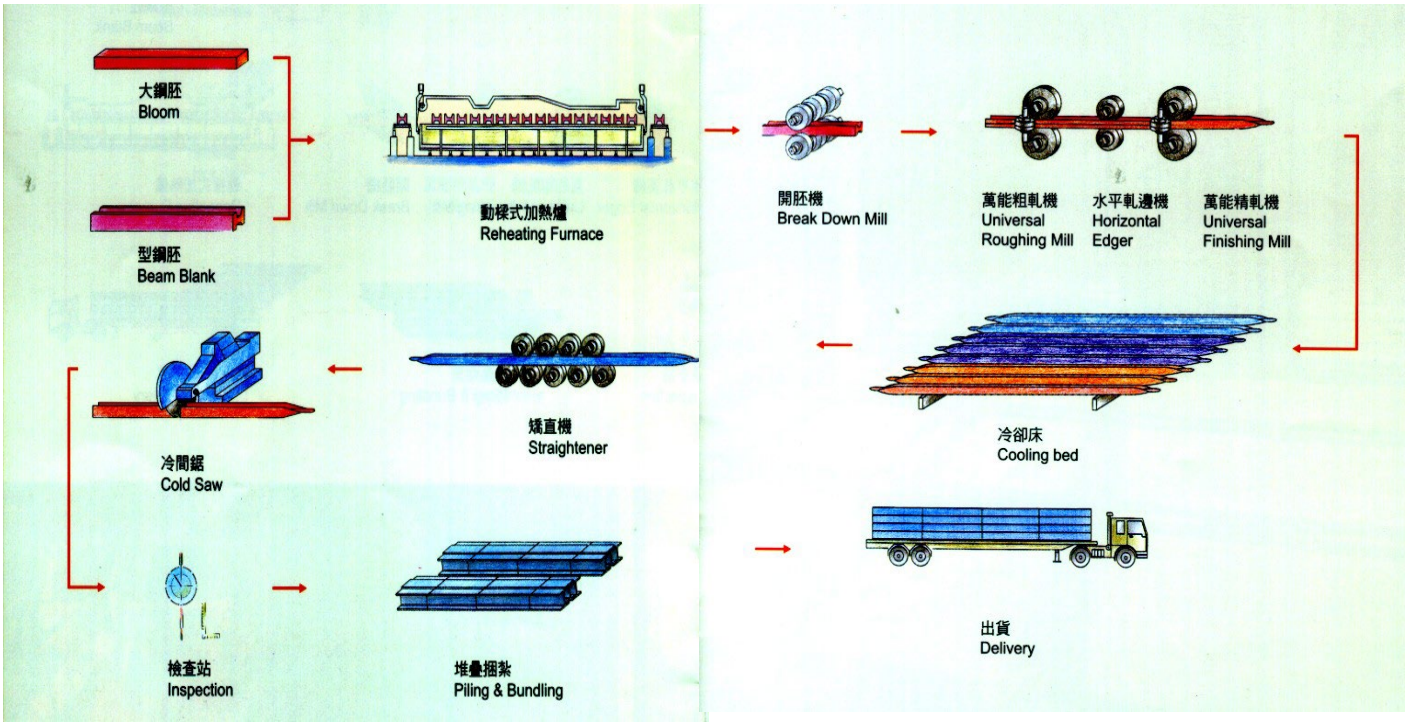
Unusual Fire or Explosion Hazards - Steel products do not present fire or explosion hazards under normal conditions. Any non-oxidized fine metal particles/ dust generated by grinding, sawing, abrasive blasting, or individual customer processes may produce materials that the customer should test for combustibility and other hazards in accordance with applicable regulations. High concentrations of combustible metallic fines in the air may present an explosion hazard.

Manufacturing Process

The manufacturing process includes two major parts, the first is electric arc furnace steelmaking process ,and the second is hot rolling process. The quality management system is ISO 9001. The environmental management system is ISO 14001. The occupational safety management system is ISO 45001.

Flow Diagram





1.3. Application

Hot rolled structural steel sections include “Hot Rolled H-Beam” , “Checkered H-Beam”, “I-Beam” and “Channel Beam”.

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*Channel beam is widely applied in building structure and vehicle production, as well as other industrial structures.

1.4. Reasons for carrying out the study; intended applications of the study; target audiences.

Since more and more clients care about and ask for the environmental impacts of our products, we started the study of life cycle assessment of our products.

1.5. Material Composition

The hot rolled structural steel sections manufactured by Tung Ho is made of 100% low alloyed steel manufactured in electric arc furnace with 90% of recycled material.

The typical composition of the low alloyed is presented in Table 1.

Table 1

ELEMENT	TYPICAL CONTENT
Iron	98.5%
Carbon	0.12%
Manganese	0.18%
Silicon	0.65%
Phosphorus	0.01%
Sulfur	0.01%
Copper	0.02%
Others(Sn, V, Nb, Al, B, Ni, Cr, Mo, Ti)	0.51%
Total	100%

The products do not contain any hazardous substances listed in the "Candidate List of Substances of Very High Concern for Authorisation" (SVHC) exceeding 0.1% of the weight of the product.

1.6. Manufacturing

The hot rolled structural steel sections production flow is: Bloom & Beam Blank → Bloom & Beam Blank reheating → Hot rolling →Piling & Bunding → Hot rolled structural steel sections → Delivery

1.7. Packaging and Delivery Status

The hot rolled structural steel sections are packaged by rod-carbon steel for delivery.

1.8. Disposal/ Re-use/ Recycling

Hot rolled structural steel sections is easy to recycling, but it is not suggested to be re-used as structural elements. The European Waste Index code for hot rolled structural steel sections is ewc-code-17-04-05– iron and steel.

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

Declared Unit: 1 metric ton of Hot rolled structural steel sections

Table 2

NAME	VALUE	UNIT
Declared unit	1	ton
Thickness (des Bleches)	4.3 ~ 24	mm
Density	7,850	kg/m^3
Conversion factor to 1 kg	1,000	kg/ton

2.2. System Boundary

This is a cradle to gate EPD. The following life cycle stages were considered:

A1 – Raw material supply.

A2 – Transport.

A3 – Manufacturing.

*Not including "CONSTRUCTION PROCESS STAGE", "USE STAGE" and "END OF LIFE STAGE".

2.3. Estimates and Assumptions

The life cycle assessment does not include estimates and assumptions.

2.4. Cut-off Criteria

Life Cycle Inventory data for 100% of total inflows (mass and energy) to the upstream and core module have been included. Company infrastructure, employee's transportation and administrative activities were kept out of the scope of this study.

2.5. Data Sources

The material, energy, transportation, waste treatment and air emission data colleted are from the year 2020, and the major data source is from the ERP system of Kaohsiung Works. The LCA software used for this study is SimaPro 9.2.0.2, the LCI databases include Ecoinvent 2.2, Ecoinvent 3 & U.S. LCI Database & EF database 2.0.

2.6. Data Quality

The collected data were checked for plausibility and consistancy. Good data quality can be assumed. Data quality assessment per information module is provided in Tables 3, 4 and 5.

Table 3. Raw material supply module data quality assessment					
Data	Time Related Coverage	Geographical coverage	Technological coverage	Data Source	Measured or estimated
Raw materials consumption	2020	Taiwan	Modern	Tung Ho	M
Distance of Waste transportation to disposal site	2020	Taiwan	Modern	Tung Ho	M
Energy and materials consumption of waste processing in disposal site, as well as waste and generated emissions	2020	Taiwan	Modern	Tung Ho	M&E
Fuels consumption and emissions related to electricity generation and distribution in Taiwan	2020	Taiwan	Modern	Tung Ho	M&E
Energy consumption and generation of emissions related to natural gas production in Taiwan	2020	Taiwan	Modern	Tung Ho	M&E
Energy and materials consumption to raw materials production for tne Manufacturing	2020	Taiwan	Modern	Tung Ho	M&E

Table 4. Transportation module data quality assessment					
Data	Time Related Coverage	Geographical coverage	Technological coverage	Data Source	Measured or estimated
Distance of waste and others raw materials transportation	2020	Taiwan	Not Applicable	Tung Ho	M
Distance of auxiliary items transportation	2020	Taiwan	Not Applicable	Tung Ho	M
Consumption of materials and energy and emissions related to the transport requirements of raw materials and auxiliary inputs	2020	Taiwan	World average	Ecoinvent	M&E

Table 5. Manufacture module data quality assessment					
Data	Time Related Coverage	Geographical coverage	Technological coverage	Data Source	Measured or estimated
Consumption of auxiliary items	2020	Taiwan	Modern	Tung Ho	M&E
Energy and materials consumption of auxiliary items production	2020	Taiwan	Modern	Tung Ho	M&E
Waste generation	2020	Taiwan	Modern	Tung Ho	M
Waste treatment process	2020	Taiwan	Modern	Tung Ho	M&E
Air emissions and waste water generation	2020	Taiwan	Modern	Tung Ho	M&E
Distance of waste transportation	2020	Taiwan	Modern	Tung Ho	M&E

Requirements of waste transportation	2020	Taiwan	Modern	Tung Ho	M&E

2.7. Period under Review

From January 1st to December 31st, 2020.

2.8. Allocation

There are no credits from recycling or energy recovery of packaging materials and production waste. On the other hand, this is a "cradle to gate" study, so there are no credits from recycling or energy recovery from the end of life of the product.

Allocation of Energy and auxiliary materials: 100% used in the production of hot rolled structural steel sections in the Kaohsiung Works.

3. Life Cycle Assessment Results

Table 6. Description of the system boundary modules

	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
EPD Type	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

(X = included in LCA; MND = Module Not Declared).

4.1. Life Cycle Impact Assessment Results

Parameters describing environmental potential impacts were calculated using EN 15804 + A2 Method version 1.01 as implemented in SimaPro 9.2.0.2 for table 7. Table 7 below shows the LCA results per the declared unit and the impact contribution per module.

Information on biogenic carbon content: No biogenic carbon in the product.

Table 7 RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2 (EN 15804 + A2 Method version 1.01): declared unit and product

Impact Category	Unit	A1 - Raw materials supply	A2 - Transportation	A3 - Manufacturing	Total(A1 - A3)	Method
GWP-total(Global warming potential total)	kg CO_2-Eq/ ton	5.62E+02	3.95E+01	1.82E+01	6.19E+02	EN 15804 + A2 Method version 1.01
	%	90.69%	6.38%	2.94%	100.00%	
GWP-fossil(Global warming potential fossil fuels)	kg CO_2-Eq/ ton	5.24E+02	3.94E+01	1.37E+01	5.77E+02	EN 15804 + A2 Method version 1.01
	%	90.79%	6.83%	2.38%	100.00%	
GWP-biogenic(Global warming potential biogenic)	kg CO_2-Eq/ ton	3.74E+01	1.11E-01	4.45E+00	4.20E+01	EN 15804 + A2 Method version 1.01
	%	89.15%	0.26%	10.59%	100.00%	
GWP-luluc(GWP from land use and land use change)	kg CO_2-Eq/ ton	4.99E-01	4.03E-04	1.09E-02	5.10E-01	EN 15804 + A2 Method version 1.01
	%	97.78%	0.08%	2.14%	100.00%	
ODP(Depletion potential of the stratospheric ozone layer)	kg CFC-11Eq/ ton	1.40E-05	7.99E-06	8.30E-07	2.28E-05	EN 15804 + A2 Method version 1.01
	%	61.31%	35.05%	3.64%	100.00%	
AP(Acidification potential, Accumulated Exceedance)	mol H+Eq/ ton	2.20E+00	2.93E-01	9.92E-02	2.59E+00	EN 15804 + A2 Method version 1.01
	%	84.84%	11.33%	3.83%	100.00%	
EP-freshwater(Eutrophication potential, fraction of nutrients reaching freshwater end compartment)	kg PO4-Eq/ ton	8.57E-03	6.00E-04	1.67E-02	2.59E-02	EN 15804 + A2 Method version 1.01
	%	33.11%	2.32%	64.57%	100.00%	
EP-marine(Eutrophication potential, fraction of nutrients reaching freshwater end compartment)	kg N-Eq/ ton	3.68E-01	1.21E-01	3.60E-01	8.49E-01	EN 15804 + A2 Method version 1.01
	%	43.34%	14.27%	42.39%	100.00%	
EP-terrestrial(Eutrophication potential, Accumulated Exceedance)	mol N-Eq/ ton	3.97E+00	1.33E+00	2.60E-01	5.56E+00	EN 15804 + A2 Method version 1.01

	%	71.37%	23.96%	4.68%	100.00%	
POCP(Formation potential of tropospheric ozone)	kg NMVOC-Eq/ ton	2.73E-08	3.78E-01	5.69E-09	3.78E-01	EN 15804 + A2 Method version 1.01
	%	0.00%	100.00%	0.00%	100.00%	
ADP- minerals & metals(Abiotic depletion potential for non-fossil resources)	kg Sb-Eq/ ton	1.66E-04	1.14E-08	1.19E-04	2.84E-04	EN 15804 + A2 Method version 1.01
	%	58.27%	0.00%	41.73%	100.00%	
ADP-fossil(Abiotic depletion potential for fossil resources)	MJ/ ton	3.04E+03	4.56E+00	6.41E+01	3.11E+03	EN 15804 + A2 Method version 1.01
	%	97.79%	0.15%	2.06%	100.00%	
WDP(Water (user) deprivation potential, deprivation- weighted water consumption)	m^3 worldEq deprived/ ton	9.94E+03	1.93E+03	1.05E+02	1.20E+04	EN 15804 + A2 Method version 1.01
	%	83.02%	16.11%	0.88%	100.00%	

4.2. Life Cycle Inventory Results

Parameters describing resource use were evaluated with the Cumulated Energy Demand method version 1.10 (Frischknecht et al. 2007) except for the indicator of use of net fresh water that was evaluated with Recipe 2016 Midpoint (H) version 1.00 (Huijbregts et al. 2017). The detailed description of the use of resources is provided in Table 8.

Table 8 RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: declared unit and product

Parameter	Unit	A1 - Raw materials supply	A2 - Transportation	A3 - Manufacturing	Total(A1 - A3)
PERE(Renewable primary energy as energy carrier)	MJ	4.60E+02	2.93E-01	1.39E+00	4.62E+02
PERM(Renewable primary energy resources as material utilization)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT(Total use of renewable primary energy resources)	MJ	4.60E+02	2.93E-01	1.39E+00	4.62E+02
PENRE(Nonrenewable primary energy as energy carrier)	MJ	7.38E+03	4.60E+00	1.17E+02	7.50E+03
PENRM(Nonrenewable primary energy as material utilization)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT(Total use of nonrenewable primary energy resources)	MJ	7.38E+03	4.60E+00	1.17E+02	7.50E+03
SM(Use of secondary material)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RSF(Use of renewable secondary fuels)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF(Use of nonrenewable secondary fuels)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW(Use of net fresh water)	m^3	2.43E-05	2.32E-01	8.64E-07	2.32E-01

Environmental indicators describing waste generation were obtained from LCI except for background information which has been calculated using EDIP 2003 method version 1.06 (Hauschild and Potting, 2005). Table 9 shows waste and other outputs generated during each information module.

Table 9 RESULTS OF THE LCA –WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: declared unit and product

Parameter	Unit	A1 - Raw materials supply	A2 - Transportation	A3 - Manufacturing	Total(A1 - A3)
HWD(Hazardous waste disposed)	kg	1.85E-03	6.49E-04	2.56E-03	5.05E-03
NHWD(Nonhazardous waste disposed)	kg	5.10E+00	5.10E+00	7.47E+00	1.77E+01
RWD(Radioactive waste disposed)	kg	6.02E-03	4.59E-04	6.11E-04	7.09E-03
CRU(Components for reuse)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR(Materials for recycling)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER(Materials for energy recovery)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE(Exported electrical energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET(Exported thermal energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Environmental indicators describing additional impact categories were obtained from LCI except for background information which has been calculated using EF Method 2.0. Table 10 shows additional impact categories during each information module.

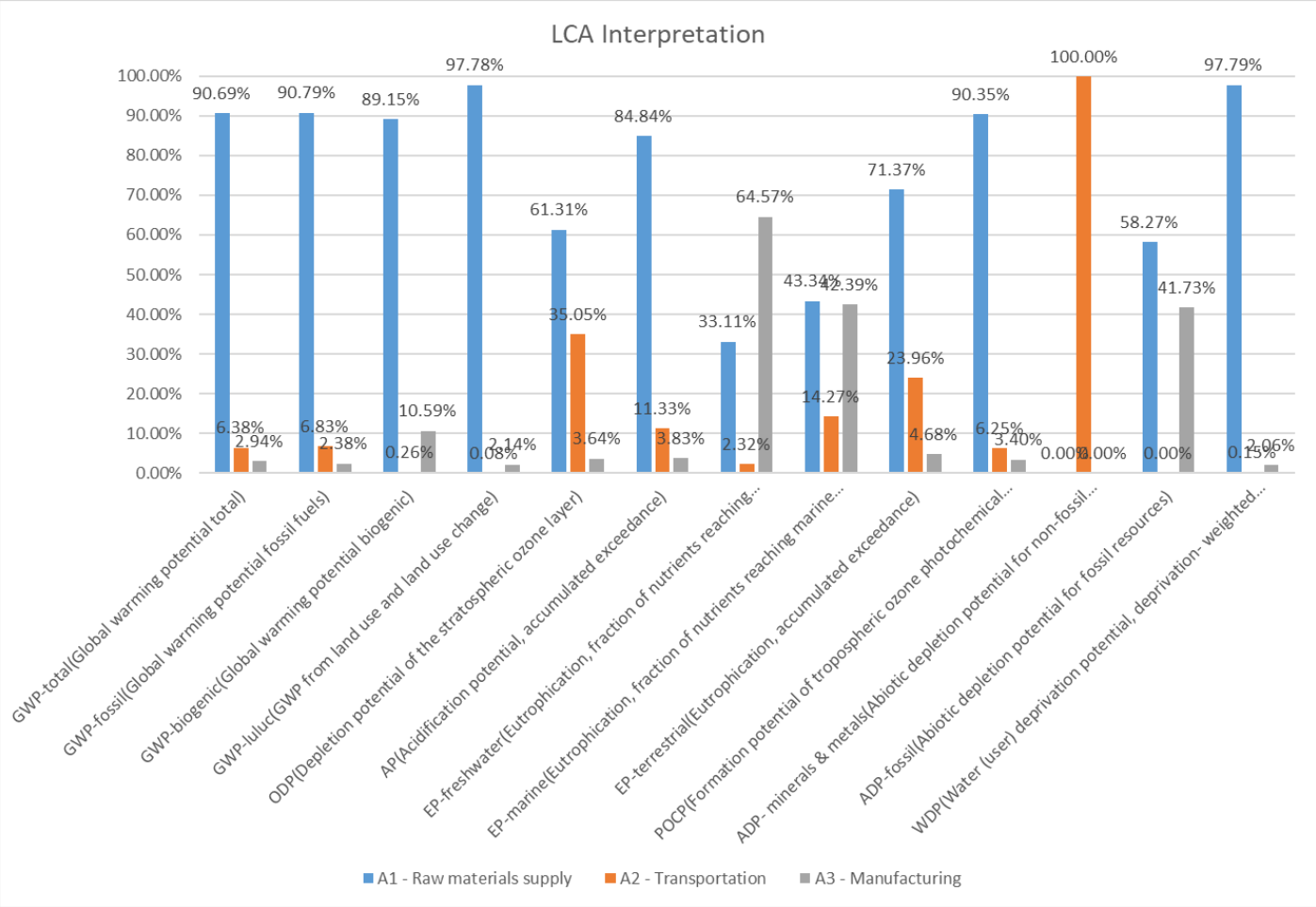
Table 10 RESULTS OF THE LCA –additional impact categories according to EN 15804+A2-optional: declared unit and product

Parameter	Unit	A1 - Raw materials supply	A2 - Transportation	A3 - Manufacturing	Total(A1 - A3)
PM(Potential incidence of disease due to PM emissions)	Disease Incidence	2.43E-05	3.03E-06	8.64E-07	2.82E-05
IR(Potential Human exposure efficiency relative to U235)	kBq U235Eq.	1.17E+02	1.18E+00	8.39E-01	1.19E+02
ETP-fw(Potential comparative toxic unit for ecosystems)	CTUe	1.03E+02	1.26E+01	8.48E+01	2.01E+02
HTP-c(Potential comparative toxic unit for humans cancerogenic)	CTUh	1.33E-06	5.95E-07	2.58E-06	4.50E-06

HTP-nc(Potential comparative toxic unit for humans not cancerogenic)	CTUh	4.36E-05	2.53E-06	3.89E-05	8.50E-05
SQP(Potential soil quality index)	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00

4. LCA Interpretation

The highest proportion of GWP-total(Global warming potential total) impact of the product is module A1(raw material supply), 90.69%. The highest proportion of GWP-fossil(Global warming potential fossil fuels) impact of the product is module A1(raw material supply), 90.79%. The highest proportion of GWP-biogenic(Global warming potential biogenic) impact of the product is module A1(raw material supply), 89.15%. The highest proportion of GWP-luluc(GWP from land use and land use change) impact of the product is module A1(raw material supply), 97.78%. The highest proportion of ODP(Depletion potential of the stratospheric ozone layer) impact of the product is module A1(raw material supply), 61.31%. The highest proportion of AP(Acidification potential of land and water) impact of the product is module A1(raw material supply), 84.84%. The highest proportion of EP-freshwater(Eutrophication, fraction of nutrients reaching freshwater end compartment) impact of the product is module A3 (Manufacturing), 64.57%. The highest proportion of EP-marine(Eutrophication, fraction of nutrients reaching marine end compartment) impact of the product is module A1(raw material supply), 43.34%. The highest proportion of EP-terrestrial(Eutrophication, accumulated exceedance) impact of the product is module A1(raw material supply), 71.37%. The highest proportion of POCP(Formation potential of tropospheric ozone photochemical oxidants) impact of the product is module A1(raw material supply), 90.35%. The highest proportion of ADP- minerals & metals(Abiotic depletion potential for non-fossil resources) of the product is module A2(transportation), 100.00%. The highest proportion of ADP-fossil(Abiotic depletion potential for fossil resources) of the product is module A1(raw material supply), 58.27%. The highest proportion of WDP(Water (user) deprivation potential, deprivation weighted water consumption) impact of the product is module A1(raw material supply), 97.79%.



Sensitivity Check

The study considered sensitivities of most uncertain and significant aspects of the data set, including “Input of Bloom & Beam-blank(Local)”, “Transportation distance of Bloom & Beam-blank(Local)” and “Input of electricity”. After adjusting 20% on each item and check the changes of each LCA result, the results of sensitivity check is as shown on the tables below.

Table 11

Impact Category	Item of Sensitivity Check	The current LCA result	The LCA result after adjusting 20% on input of Bloom & Beam-blank(Local)	Sensitivity(%)
GWP-total(Global warming potential total)	Input of Bloom & Beam-blank(Local)	6.19E+02	7.07E+02	14.20%
GWP-fossil(Global warming potential fossil fuels)	Input of Bloom & Beam-blank(Local)	5.77E+02	6.57E+02	13.96%
GWP-biogenic(Global warming potential biogenic)	Input of Bloom & Beam-blank(Local)	4.20E+01	4.94E+01	17.68%
GWP-luluc(GWP from land use and land use change)	Input of Bloom & Beam-blank(Local)	5.10E-01	5.60E-01	9.71%
ODP(Depletion potential of the stratospheric ozone layer)	Input of Bloom & Beam-blank(Local)	2.28E-05	2.28E-05	0.08%
AP(Acidification potential, accumulated exceedance)	Input of Bloom & Beam-blank(Local)	2.59E+00	2.92E+00	12.95%
EP-freshwater(Eutrophication, fraction of nutrients reaching freshwater end compartment)	Input of Bloom & Beam-blank(Local)	2.59E-02	2.60E-02	0.51%
EP-marine(Eutrophication, fraction of nutrients reaching marine end compartment)	Input of Bloom & Beam-blank(Local)	8.49E-01	9.07E-01	6.80%
EP-terrestrial(Eutrophication, accumulated exceedance)	Input of Bloom & Beam-blank(Local)	5.56E+00	6.18E+00	11.14%
POCP(Formation potential of tropospheric ozone photochemical oxidants)	Input of Bloom & Beam-blank(Local)	3.78E-01	3.78E-01	0.00%
ADP- minerals & metals(Abiotic depletion potential for non-fossil resources)	Input of Bloom & Beam-blank(Local)	2.84E-04	3.05E-04	7.22%
ADP-fossil(Abiotic depletion potential for fossil resources)	Input of Bloom & Beam-blank(Local)	3.11E+03	3.19E+03	2.59%
WDP(Water (user) deprivation potential, deprivationweighted water consumption)	Input of Bloom & Beam-blank(Local)	1.20E+04	1.39E+04	16.44%

Table 12

Impact Category	Item of Sensitivity Check	The current LCA result	The LCA result after adjusting 20% on tansportaion distance of Bloom & Beam-blank(Local)	Sensitivity(%)
GWP-total(Global warming potential total)	Transportation distance of Bloom & Beam-blank(Local)	6.19E+02	6.27E+02	1.26%
GWP-fossil(Global warming potential fossil fuels)	Transportation distance of Bloom & Beam-blank(Local)	5.77E+02	5.85E+02	1.35%
GWP-biogenic(Global warming potential biogenic)	Transportation distance of Bloom & Beam-blank(Local)	4.20E+01	4.20E+01	0.00%
GWP-luluc(GWP from land use and land use change)	Transportation distance of Bloom & Beam-blank(Local)	5.10E-01	5.10E-01	0.02%
ODP(Depletion potential of the stratospheric ozone layer)	Transportation distance of Bloom & Beam-blank(Local)	2.28E-05	2.44E-05	6.99%
AP(Acidification potential, accumulated exceedance)	Transportation distance of Bloom & Beam-blank(Local)	2.59E+00	2.64E+00	2.16%
EP-freshwater(Eutrophication, fraction of nutrients reaching freshwater end compartment)	Transportation distance of Bloom & Beam-blank(Local)	2.59E-02	2.60E-02	0.46%
EP-marine(Eutrophication, fraction of nutrients reaching marine end compartment)	Transportation distance of Bloom & Beam-blank(Local)	8.49E-01	8.73E-01	2.78%
EP-terrestrial(Eutrophication, accumulated exceedance)	Transportation distance of Bloom & Beam-blank(Local)	5.56E+00	5.82E+00	4.67%
POCP(Formation potential of tropospheric ozone photochemical oxidants)	Transportation distance of Bloom & Beam-blank(Local)	3.78E-01	4.51E-01	19.53%
ADP- minerals & metals(Abiotic depletion potential for non-fossil resources)	Transportation distance of Bloom & Beam-blank(Local)	2.84E-04	2.84E-04	0.00%

ADP-fossil(Abiotic depletion potential for fossil resources)	Transportation distance of Bloom & Beam-blank(Local)	3.11E+03	3.11E+03	0.00%
WDP(Water (user) deprivation potential, deprivationweighted water consumption)	Transportation distance of Bloom & Beam-blank(Local)	1.20E+04	1.24E+04	3.22%

Table 13

Impact Category	Item of Sensitivity Check	The current LCA result	The LCA result after adjusting 20% on input of electricity	Sensitivity(%)
GWP-total(Global warming potential total)	Input of electricity	6.19E+02	6.39E+02	3.19%
GWP-fossil(Global warming potential fossil fuels)	Input of electricity	5.77E+02	5.97E+02	3.42%
GWP-biogenic(Global warming potential biogenic)	Input of electricity	4.20E+01	4.20E+01	0.00%
GWP-luluc(GWP from land use and land use change)	Input of electricity	5.10E-01	5.27E-01	3.23%
ODP(Depletion potential of the stratospheric ozone layer)	Input of electricity	2.28E-05	2.36E-05	3.43%
AP(Acidification potential, accumulated exceedance)	Input of electricity	2.59E+00	2.67E+00	3.21%
EP-freshwater(Eutrophication, fraction of nutrients reaching freshwater end compartment)	Input of electricity	2.59E-02	2.74E-02	5.95%
EP-marine(Eutrophication, fraction of nutrients reaching marine end compartment)	Input of electricity	8.49E-01	8.62E-01	1.51%
EP-terrestrial(Eutrophication, accumulated exceedance)	Input of electricity	5.56E+00	5.70E+00	2.55%
POCP(Formation potential of tropospheric ozone photochemical oxidants)	Input of electricity	3.78E-01	3.78E-01	0.00%
ADP- minerals & metals(Abiotic depletion potential for non-fossil resources)	Input of electricity	2.84E-04	2.94E-04	3.47%

ADP-fossil(Abiotic depletion potential for fossil resources)	Input of electricity	3.11E+03	3.36E+03	8.03%
WDP(Water (user) deprivation potential, deprivationweighted water consumption)	Input of electricity	1.20E+04	1.20E+04	0.02%

Table 14 presents disclaimers which shall be declared in the project report and in the EPD with regard to the declaration of relevant core and additional environmental impact indicators according to the following classification.

Table 14: information on disclaimer for environmental indicators

ILCD Classification	Indicator	Disclaimer
ILCD Type 1	Global warming potential (GWP)	none
	Depletion potential of the stratospheric ozone layer (ODP)	none
	Potential incidence of disease due to PM emissions (PM)	none
ILCD Type 2	Acidification potential, Accumulated Exceedance (AP)	none
	Eutrophication potential, Fraction of nutrients reaching freshwater end compartment (EP-freshwater)	none
	Eutrophication potential, Fraction of nutrients reaching marine end compartment (EP-marine)	none
	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	none
	Formation potential of tropospheric ozone (POCP)	none
	Potential Human exposure efficiency relative to U235 (IRP)	1
ILCD Type 3	Abiotic depletion potential for non-fossil resources (ADP-minerals&metals)	2
	Abiotic depletion potential for fossil resources (ADP- fossil)	2
	Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	2
	Potential Comparative Toxic Unit for ecosystems (ETP- fw)	2
	Potential Comparative Toxic Unit for humans (HTP-c)	2
	Potential Comparative Toxic Unit for humans (HTP-nc)	2
	Potential Soil quality index (SQP)	2

Disclaimer 1 – This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to

radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.
Disclaimer 2 – The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

Critical review

The purpose of the project report is not a comparative assertion, but an independent disclosure, so the critical review is not performed.

5. Conclusion and Recommendation

This LCA Report has provided an assessment of the potential environmental impacts associated with the system boundary "cradle to gate" , including module A1(raw material supply) & module A2(transportation) & module A3(manufacturing). The LCA software used for this study is SimaPro 9.2.0.2, the LCI databases include Ecoinvent 2.2, Ecoinvent 3 & U.S. LCI Database, and LCIA methodologies include EN 15804 + A2 Method version 1.01, EF method 2.0, EDIP2003 version 1.06, Cumulated Energy Demand method version 1.10 and Recipe 2016 Midpoint (H) version 1.00.

The specific site of this study is located in Kaohsiung City, Taiwan. However, most of databases we used as environmental impact factors are not local database. In the future, if the local government can develop more databases of environmental impact factors, it will be very helpful for preciser assessment of the potential environmental impacts.

The study is not intended to support comparative assertions intended to be disclosed to the public.

6. References

EN 15804

EN 15804:201204+A1 2013, Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products.

EN 15804

EN 15804:2019+A2 (in press), Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products.

ISO 14025

DIN EN ISO 14025:201110, Environmental labels and declarations — Type III environmental declarations — Principles and procedures.

SimaPro

SimaPro 9.2.0.2, the LCI databases include Ecoinvent 2.2, Ecoinvent 3 & U.S. LCI Database, and LCIA methodologies include EN 15804 + A2 Method version 1.01, EF method 2.0, EDIP2003 version 1.06, Cumulated Energy Demand method version 1.10 and Recipe 2016 Midpoint (H) version 1.00. PRé Sustainability B.V., September 2020.

IBU 2016

Institut Bauen und Umwelt e.V.: General Programme Instructions for the Preparation of EPDs at the Institut Bauen und Umwelt e.V. Version 1., Berlin: Institut Bauen und Umwelt e.V., 2016. www.ibuepd.com

Product Category Rules

Product Category Rules for Building-Related Products and Services
Institut Bauen und Umwelt e.V. (IBU)
Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019, Version 1.1.2
PCR Guidance-Texts for Building-Related Products and Services
From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU)
Part B: Requirements on the EPD for Structural steels, Version 1.6

UL General Program Rules

UL General Program Rules v.2.5, March 2020

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