

Environmental Product Declaration



In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

Steel Sheet Piles (GU[®] Type)

from

ArcelorMittal Europe – Long Products



Programme:	The International EPD [®] System, www.environdec.com
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An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com



General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
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Accountabilities for PCR, LCA and independent, third-party verification

Product Category Rules (PCR)

CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

Product Category Rules (PCR): *PCR 2019:14 Construction products, version 1.3.3 Published on 2023.06.20. Based on CEN standard EN 15804. ISO standard ISO 21930 and CEN standard EN 15804 serves as the core PCR.*

PCR review was conducted by: The Technical Committee of the International EPD®System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.

Life Cycle Assessment (LCA)

LCA accountability: *Luxembourg Institute of Science and Technology (LIST)*

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

EPD verification by individual verifier

Third party verifier: *Matt Fishwick, Fishwick Environmental Ltd*



Approved by: The International EPD® System

Procedure for follow-up of data during EPD validity involves third party verifier:

Yes No

Procedure for follow-up the validity of the EPD is at minimum required once a year with the aim of confirming whether the information in the EPD remains valid or if the EPD needs to be updated during its validity period. The follow-up can be organized entirely by the EPD owner or together with the original verifier via an agreement between the two parties. In both approaches, the EPD owner is responsible for the procedure being carried out. If a change that requires an update is identified, the EPD shall be re-verified by a verifier

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison.

For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD: ArcelorMittal Europe – Long Products.

Contact: sheetpiling@arcelormittal.com, Tel.: +352 5313 3105.

Description of the organisation:

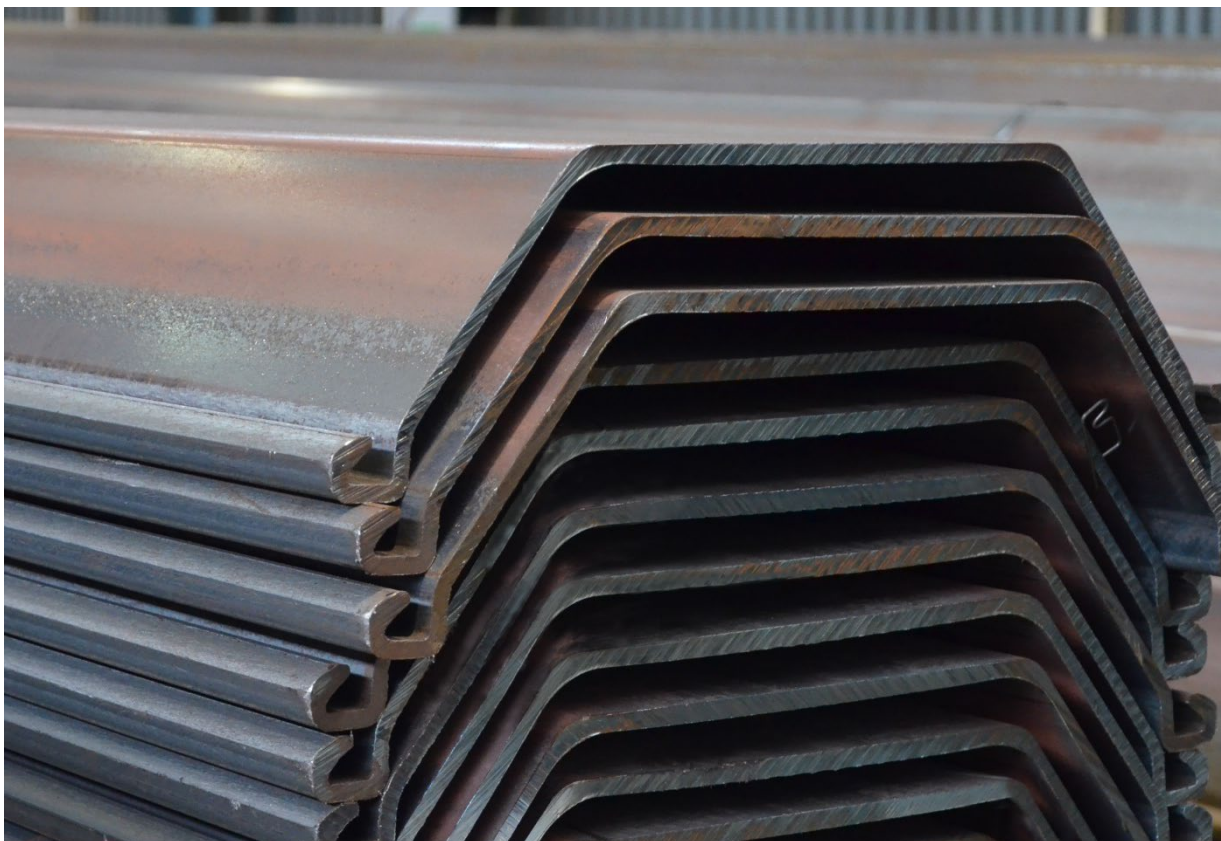
ArcelorMittal Europe – Long Products operates 27 production sites in ten countries and is a leader in the manufacture of sections, sheet piles, rails, quality wire rod, rebars, and bars. ArcelorMittal is the world's largest supplier of cost-effective tailor-made steel foundation solutions, as well as the largest manufacturer of sustainable hot-rolled steel sheet piles. ArcelorMittal Sheet Piling oversees sales, marketing and promotion of hot rolled and cold formed steel sheet piles, HP bearing piles and steel tubes produced in its European mills, as well as accessories used for installation.

Our journey towards becoming carbon neutral by 2050 is well underway. In line with the Paris Climate Goals and the European Green Deal, ArcelorMittal has also committed to reduce CO₂ emissions in our European operations by 35% by 2030.

Product-related or management system-related certifications:

ArcelorMittal's sheet piling mills are covered by ISO 9001, ISO 14001, ISO 45001, ISO 50001, and *Responsible Steel*[™]

Name and location of production site(s): ArcelorMittal Dąbrowa Górnicza, Poland.



Steel sheet piles (GU Type) produced at ArcelorMittal Dąbrowa Górnicza

Product information

Product name: Steel Sheet Piles (GU Type).

Product identification: Hot-rolled steel sheet piles produced according to EN 10248-1:2023.

Product description:

A steel sheet pile can be used in various construction and infrastructure applications. Steel sheet piles are rolled steel profiles with longitudinal clutches at each side. Sheet piles can be connected to each other through these clutches creating a mechanical connection (i.e. interlock) between the profiles allowing continuous walls construction.

Steel sheet piles can be produced in a wide range of shapes and dimensions, lengths, steel grades and specifications. The declaration covers the whole range of steel sheet piles produced in the Polish production site ArcelorMittal Dąbrowa Górnicza: GU-type. GU is the trademark for U-shaped sheet piles produced at ArcelorMittal Dąbrowa Górnicza. It is a final product ready to be installed.

This EPD is valid for GU steel sheet piles of various grades and geometries as covered by following standards:

- European Standards: EN 10248-1, EN 10248-2.
- ASTM International: ASTM A572.

Manufacturing process:

The steel for the production of GU sheet piles at ArcelorMittal Dąbrowa Górnicza originates from the local Blast Furnace / Basic Oxygen route (BF/BOF). Rolling is done in the heavy rolling mill of Dąbrowa.

The production of GU sheet piles goes through following main technological steps:

- Iron- and steelmaking over Blast Furnace / Basic Oxygen route;
- steel refining in Ladle Furnace;
- continuous casting;
- hot rolling;
- cooling and finishing.

Applications:

Hot rolled steel sheet piles are used to build quite impervious retaining walls and cut-off walls, in permanent or temporary applications in the construction and infrastructure field. The main goal is to retain soil and/or water. Typical applications are:

- ports and waterways: quay walls, jetties, breakwaters, riverbanks, embankments, flood protection walls, locks, temporary cofferdams.
- on land: retaining walls, underground car parks, basements, underpasses, bridge abutments, cut-off walls (polluted soils), pit excavations.

In case of mechanical destruction, no risks are expected to occur in terms of environment and human health. The product does not cause any adverse health effects or release of VOCs to indoor air. For the use and application of the product the respective national provisions at the place of use apply, in Germany for example the building codes of the federal states and the corresponding national specifications. At the end of life, they will be recovered and recycled in a new steel product.

UN CPC code: 412 Products of iron or steel.

Geographical scope: Europe.

LCA information

Functional unit / declared unit: 1 metric tonne of GU Steel Sheet Piles.

Reference service life: Not applicable.

Time representativeness: The collection of the foreground data refers to the year 2021.

Database(s) and LCA software used:

The background data has been taken from Sphera Managed LCA Content 2022.2 and the LCA model was created using LCA Sphera for Experts software, version 10.6.2.9.

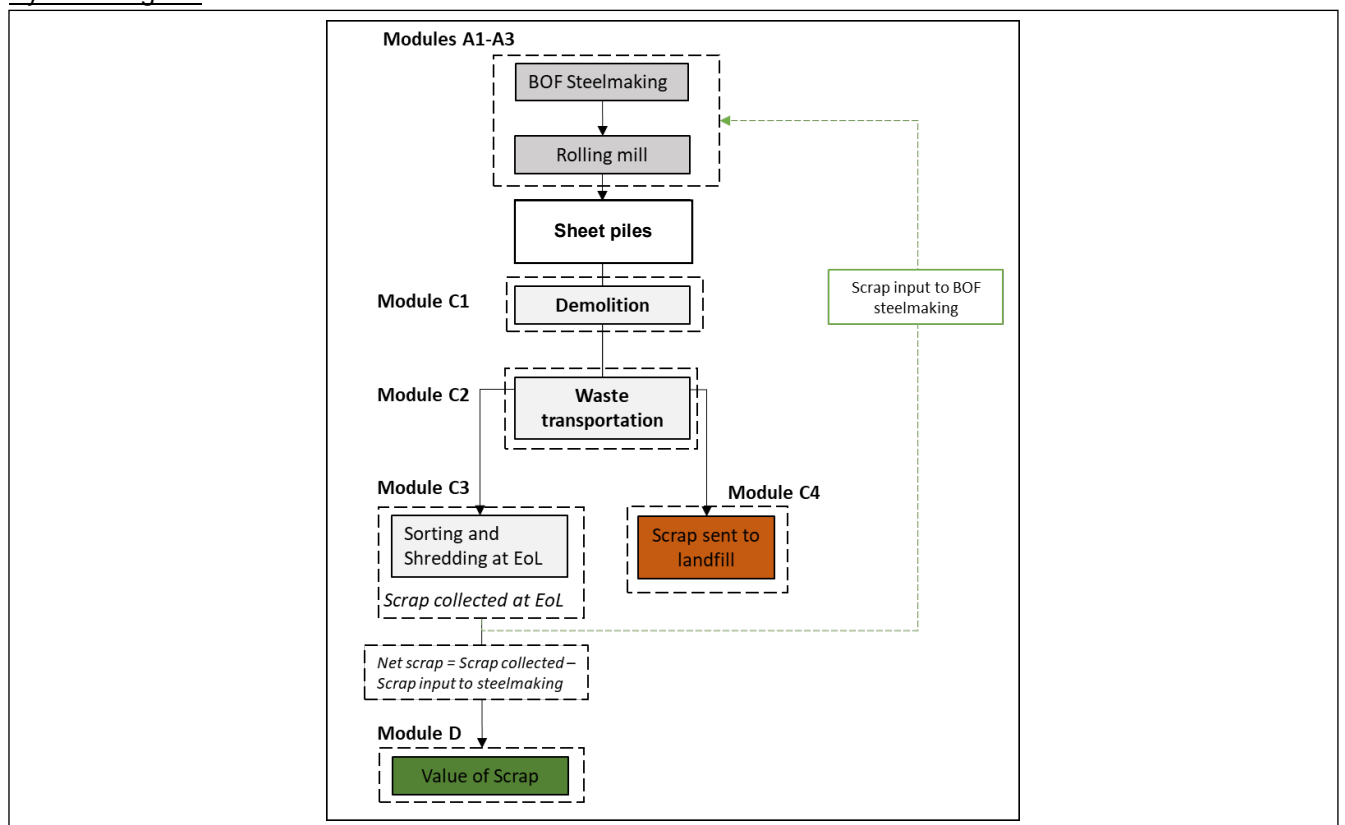
Calculation methods:

Potential environmental impacts are calculated following EN 15804:2012+A2:2019. The characterization models and factors correspond to the latest update of the defaults list (EF 3.1), referred to as Version 2.0.

Description of system boundaries:

The system boundaries are: Cradle-to-gate with options, modules C1–C4, and module D.

System diagram:



- **Module A1 to A3:**

The BF/BOF steelmaking includes processes from coke making to continuous casting and the related input and output flows. The production of structural steel through BOF route is the conventional route for steel production and consists basically in producing pig iron from iron ore and coke reacting in a blast

furnace, then transformed into steel through BOF. Some alloying elements are added to obtain the desired steel grade, and after the continuous casting, steel goes through the hot rolling mill in Dabrowa. No emissions or waste from packaging are considered in modules A1-A3, as all raw materials, semi-products as well as the final products are transported bulk/loose.

The electricity mixes considered for the processing sites are country-specific (national generic background data) and are representative of the average consumption mix for the country. They were chosen according to the plant location.

The resulting weighted average emission factor for the GWP-GHG indicator for the residual mix is 0.881 kgCO₂eq./kWh. The modelling is based on datasets from the 2022.2 Managed LCA Content (Sphera) database.

- *Module C1 to C4:*

Within this EPD, the modules C1-C4 are included. These modules consider the dismantling of the considered product (C1), the transportation of the dismantled components to their End-of-Life (EoL) destination (C2), the waste processing for recovery or recycling (C3) as well as the disposal (C4), if given. At EoL, the steel material leaves the product system in C3 for recycling in Module D. Environmental impacts from grinding, sorting and transportation of steel scrap are neglectable. The considered EoL scenario for the steel material is 60% recycling, 25% reuse, and 15% landfill.

Category	Subcategory	Unit	Quantity
Collection process	Collected separately	kg	1000
	Collected with mixed construction waste	kg	0
Recovery	Reuse	kg	250
	Recycling	kg	600
	Landfill	kg	150
	Incineration	kg	0
	Incineration with energy recovery	kg	0
	Energy conversion efficiency rate	kg	0
Disposal	Material for final disposal	kg	0
Transport	Deconstruction site to scrap processing plant	km	100
	Scrap processing plant to site for end of waste	km	200

- *Module D:*

Module D includes any declared benefits and loads from net flows leaving the product system that have not been allocated as co-products and that have passed the end-of-waste state in the form of reuse, recovery and/or recycling potentials.

Metals are assumed to reach the end of waste status directly at the construction site. The treatment as well as net benefits and loads of reuse or recycling potentials (for the net scrap amount only) are grouped to module D.

Potential environmental benefits are given for the net steel scrap that is produced at the end of a final product's life. This net scrap is determined as follows:

Net scrap = Amount of steel recycled at end-of-life – Scrap input from previous product life cycles.

For the product under study, in case of 60% recycling, 25% reuse, and 15% landfill:

In the production of GU steel sheet piles, 167 kg of external scrap material was utilized. Upon reaching the end of its life cycle, 600 kg of scrap is reclaimed for recycling, and an additional 250 kg is set aside for reuse. The decision to reuse helps prevent the need for manufacturing new steel, thereby saving

42 kg of scrap (calculated as $167/1000*250$). Consequently, the system demonstrates a net flow of 475 kg of scrap (calculated as $600 \text{ kg} + 42 \text{ kg} - 167 \text{ kg}$). This net value is reflected in module D and can be considered as either an environmental credit or burden, depending on the specific impact category.

This EoL scenario represents an average use of the entire sheet pile production of ArcelorMittal. To describe more specific application purposes (e.g.: reuse in temporary applications), further EoL scenarios are provided in the Annex A.

Cut-off criteria:

The environmental impact of the product studied has been assessed by considering all significant processes, materials, and emissions. Excluded flows are assumed to have a negligible impact, contributing less than 5% to the cumulative impact assessment categories. The production of capital equipment, facilities, and infrastructure required for manufacture has not been considered.

More information: <https://sheetpiling.arcelormittal.com/>

Data quality and sources:

Data quality is compliant with ISO 14025:2006. All primary data were collected for 2021. All background data come from the Sphera Managed LCA Content 2022.2 databases and are representative for the years 2018-2023.

Allocation:

Primary data are allocated using the partitioning approach developed by Worldsteel/EUROFER. Steel production generates a number of co-products from the coke oven, the BF, and the BOF. They are reused internally or sold to and used by other industries. The co-products include slags, process gases and organic products from coke making. The processes that produce these co-products cannot be further sub-divided into sub-processes related to each product, inducing some allocations required.

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results)

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	NR	NR	NR	NR	NR	NR	NR	NR	NR	X	X	X	X	X
Geography	EU	EU	EU	-	-	-	-	-	-	-	-	-	GLO	GLO	GLO	GLO	GLO
Specific data used	>95%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

NR- Not reported. MNR- Module not declared.

Content information

Steel Sheet Piles (GU Type)

Product content	Weight, kg	Post-consumer material, weight ¹	Biogenic material, weight
Steel	1000	4.1 %	0% and 0 kg C / kg
Chemical composition			
Iron	> 971.8		
Carbon	< 2.00	-	-
Manganese	< 17.00	-	-
Silicon	< 5.50	-	-
Copper	< 5.50	-	-
Other	< 2.2	-	-

¹According to ISO 14021:2016 average pre- and post-consumer scrap is 7.7% of the total material charged in the BOF. Considering also scrap use of the sinter plant and BF, the percentage of pre- and post-consumer scrap used is 16.7% (ISO 14021:2016).

The products do not contain any of the substances of very high concern (SVHC) regulated by the Regulation (EC) No 1907/2006 (REACH) or the Regulation (EC) No 1272/2008 of European parliament. No packaging is considered in the scenario.

Results of the environmental performance indicators

The environmental performance of the functional unit of one metric tonne of GU Steel Sheet Piles are reported below using the parameters and units as specified in PCR 2019:14 v1.3.3.

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Mandatory impact category indicators according to EN 15804+A2:2019

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO ₂ eq.	2.47E+03	4.35E+01	2.13E+01	1.53E+00	2.18E+00	-1.56E+03
GWP-fossil	kg CO ₂ eq.	2.46E+03	4.32E+01	2.11E+01	1.53E+00	2.24E+00	-1.56E+03
GWP-biogenic	kg CO ₂ eq.	2.76E+00	1.83E-03	1.53E-02	4.83E-03	-6.63E-02	8.36E-01
GWP-luluc	kg CO ₂ eq.	6.05E-01	2.82E-01	1.45E-01	9.15E-04	4.13E-03	-4.06E-01
ODP	kg CFC 11 eq.	6.22E-10	1.33E-11	2.12E-12	1.99E-11	5.26E-12	2.48E-09
AP	mol H ⁺ eq.	5.97E+00	2.46E-01	1.27E-01	3.77E-03	1.59E-02	-4.10E+00
EP-freshwater	kg P eq.	1.40E-03	1.52E-04	7.70E-05	4.47E-06	3.79E-06	-5.19E-04
EP-marine	kg N eq.	1.10E+00	1.19E-01	6.20E-02	1.03E-03	4.06E-03	-8.19E-01
EP-terrestrial	mol N eq.	1.20E+01	1.32E+00	6.87E-01	1.11E-02	4.46E-02	-8.89E+00
POCP	kg NMVOC eq.	4.44E+00	2.31E-01	1.20E-01	2.83E-03	1.23E-02	-2.92E+00
ADP-minerals&metals*	kg Sb eq.	4.09E-04	4.45E-06	2.17E-06	3.85E-07	2.29E-07	-8.13E-05
ADP-fossil*	MJ	2.10E+04	5.82E+02	2.83E+02	2.68E+01	2.93E+01	-1.23E+04
WDP*	m ³	3.89E+01	6.26E-01	2.41E-01	3.12E-01	2.45E-01	1.02E+01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment. EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption						

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator. We discourage the use of the results of modules A1-A3 without considering the results of module C.

Resource use indicators according to EN 15804+A2:2019

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
PERE	MJ	7.40E+02	4.44E+01	1.96E+01	1.39E+01	4.40E+00	8.46E+02
PERM	MJ	3.68E-08	2.10E-10	8.61E-11	-6.77E-10	9.76E-11	8.13E-09
PERT	MJ	7.40E+02	4.44E+01	1.96E+01	1.39E+01	4.40E+00	8.46E+02
PENRE	MJ	2.11E+04	5.85E+02	2.84E+02	2.68E+01	2.94E+01	-1.24E+04
PENRM	MJ	8.65E-02	2.47E-02	1.23E-02	1.98E-03	9.24E-04	2.65E-01
PENRT	MJ	2.11E+04	5.85E+02	2.84E+02	2.68E+01	2.94E+01	-1.24E+04
SM	kg	1.67E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	2.77E-05	0.00E+00	1.89E-07	4.12E-08	4.80E-08	2.86E-06
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m ³	1.91E+00	5.04E-02	2.27E-02	1.32E-02	7.45E-03	-1.09E+00
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water						

Waste indicators according to EN 15804+A2:2019

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
Hazardous waste disposed	kg	8.48E-07	4.07E-09	1.50E-09	1.20E-07	1.51E-09	1.48E-07
Non-hazardous waste disposed	kg	4.81E+00	1.03E-01	4.63E-02	1.88E-02	1.50E+02	-1.47E+01
Radioactive waste disposed	kg	1.30E-01	2.86E-03	5.27E-04	3.95E-03	3.26E-04	8.62E-02

Output flow indicators according to EN 15804+A2:2019

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	2.50E+02	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	6.00E+02	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Other environmental performance indicators according to EN 15804+A2:2019

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
GWP-GHG	kg CO ₂ eq.	2.46E+03	4.35E+01	2.13E+01	1.53E+00	2.24E+00	-1.56E+03
Biogenic carbon content in product	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Biogenic carbon content in packaging	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

References

- General Programme Instructions of the International EPD® System. Version 4.0.
- PCR 2019:14. Construction Products, Version 1.3.3
- Sustainability of construction works - Environmental product declarations - Methodology for selection and use of generic data; CEN/TR 15941:2010
- CPR: Regulation (EU) No 305/2011 of the European parliament and of the council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.
- EN 15804: EN 15804:2012+A2:2019: Sustainability of construction works -Environmental Product Declarations - Core rules for the product category of construction products.
- EN ISO 14025: EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
- EN ISO 14040: EN ISO 14040:2009-11 Environmental management - Life cycle assessment - Principles and framework
- EN ISO 14044: EN ISO 14044:2006-10 Environmental management - Life cycle assessment - Requirements and guidelines.
- LCA FE: LCA FE Software System and Database for Life Cycle Engineering, Sphera Solution GmbH, Leinfelden-Echterdingen, 2022 (<https://www.gabi-software.com/support/gabi>)
- EN 10248-1:2023, Hot-rolled sheet piles of non-alloy steels - Part 1: Technical delivery conditions. CEN, 2023.
- EN 10248-2:1995, Hot rolled sheet piling of non-alloy steels - Part 2: Tolerances on shape and dimensions. CEN, 1995.
- ASTM A572 / A572M-21e1:2021, Standard: Specification for High-Strength Low-Alloy Columbium- Vanadium Structural Steel, ASTM International, West Conshohocken, PA, 2021.
- ISO 9001: 2015, Quality management systems — Requirements
- ISO 45001:2018, Occupational health and safety management systems — Requirements with guidance for use
- ISO 14001:2015, Environmental management systems — Requirements with guidance for use
- ISO 50001: 2018, Energy Management

Annex A – additional environmental information

Additional End-of-Life scenarios according to EN 15804+A2:2019

For additional information and transparency, this annex lists End-of-Life scenarios that could be useful, to precisely describe a project situation.

A1. LCIA results (80% Reuse, 18% recycling, 2% landfill)

Reuse / Rental / Buy back scenario: This scenario describes a typical use of sheet piles in temporary applications: 5x use in total, adapting a conservative approach including some cut-offs after each use, and landfill.

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO ₂ eq.	2.47E+03	4.35E+01	2.13E+01	1.53E+00	2.90E-01	-2.24E+03
GWP-fossil	kg CO ₂ eq.	2.46E+03	4.32E+01	2.11E+01	1.53E+00	2.98E-01	-2.24E+03
GWP-biogenic	kg CO ₂ eq.	2.76E+00	1.83E-03	1.53E-02	4.83E-03	-8.84E-03	-1.73E+00
GWP-luluc	kg CO ₂ eq.	6.05E-01	2.82E-01	1.45E-01	9.15E-04	5.51E-04	-5.62E-01
ODP	kg CFC 11 eq.	6.22E-10	1.33E-11	2.12E-12	1.99E-11	7.01E-13	3.21E-10
AP	mol H ⁺ eq.	5.97E+00	2.46E-01	1.27E-01	3.77E-03	2.12E-03	-5.57E+00
EP-freshwater	kg P eq.	1.40E-03	1.52E-04	7.70E-05	4.47E-06	5.06E-07	-1.17E-03
EP-marine	kg N eq.	1.10E+00	1.19E-01	6.20E-02	1.03E-03	5.41E-04	-1.05E+00
EP-terrestrial	mol N eq.	1.20E+01	1.32E+00	6.87E-01	1.11E-02	5.94E-03	-1.14E+01
POCP	Kg NMVOC	4.44E+00	2.31E-01	1.20E-01	2.83E-03	1.64E-03	-4.10E+00
ADP-minerals&metals*	kg Sb eq.	4.09E-04	4.45E-06	2.17E-06	3.85E-07	3.06E-08	-3.21E-04
ADP-fossil*	MJ	2.10E+04	5.82E+02	2.83E+02	2.68E+01	3.91E+00	-1.89E+04
WDP*	m ³	3.89E+01	6.26E-01	2.41E-01	3.12E-01	3.27E-02	-2.49E+01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment. EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption						

A2. LCIA results (100% recycling)

Recycling scenario: After the service life of a sheet pile, it is generally retrieved and recycled.

Results per one metric tonne of GU steel sheet piles							
Indicator	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO ₂ eq.	2.47E+03	4.35E+01	2.13E+01	1.53E+00	0.00E+00	-1.66E+03
GWP-fossil	kg CO ₂ eq.	2.46E+03	4.32E+01	2.11E+01	1.53E+00	0.00E+00	-1.66E+03
GWP-biogenic	kg CO ₂ eq.	2.76E+00	1.83E-03	1.53E-02	4.83E-03	0.00E+00	2.66E+00
GWP-luluc	kg CO ₂ eq.	6.05E-01	2.82E-01	1.45E-01	9.15E-04	0.00E+00	-4.46E-01
ODP	kg CFC 11 eq.	6.22E-10	1.33E-11	2.12E-12	1.99E-11	0.00E+00	4.61E-09
AP	mol H ⁺ eq.	5.97E+00	2.46E-01	1.27E-01	3.77E-03	0.00E+00	-4.56E+00
EP-freshwater	kg P eq.	1.40E-03	1.52E-04	7.70E-05	4.47E-06	0.00E+00	-2.97E-04
EP-marine	kg N eq.	1.10E+00	1.19E-01	6.20E-02	1.03E-03	0.00E+00	-9.51E-01
EP-terrestrial	mol N eq.	1.20E+01	1.32E+00	6.87E-01	1.11E-02	0.00E+00	-1.03E+01
POCP	Kg NMVOC	4.44E+00	2.31E-01	1.20E-01	2.83E-03	0.00E+00	-3.18E+00
ADP-minerals&metals*	kg Sb eq.	4.09E-04	4.45E-06	2.17E-06	3.85E-07	0.00E+00	3.66E-05
ADP-fossil*	MJ	2.10E+04	5.82E+02	2.83E+02	2.68E+01	0.00E+00	-1.24E+04
WDP*	m ³	3.89E+01	6.26E-01	2.41E-01	3.12E-01	0.00E+00	3.49E+01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment. EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption						

Note: 167 kg scrap is used to manufacture 1.000 kg of GU Steel Sheet Piles. After use, 1000 kg is recycled. Net amount of scrap in the system: -167 + 1000 kg = 833 kg.

