

Owner: Skagen Trådindustri
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Valid to: 15-02-2029

3rd PARTY VERIFIED

EPD

VERIFIED ENVIRONMENTAL PRODUCT DECLARATION | ISO 14025 & EN 15804



Owner of declaration

Skagen Trådindustri
Anker Engelds Vej 4
9200 - Aalborg SV
CVR: 15 76 30 35



Issued:
15-02-2024

Valid to:
15-02-2029

Programme

EPD Danmark
www.epddanmark.dk



- Industry EPD
- Product EPD

Declared product(s)

Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties, with diameters from 1-25 mm.

Number of declared datasets/product variations: 1 product group

Production site

Anker Egelunds Vej 4, 9200 Aalborg SV, Denmark.

Product(s) use

The products are applied in the urban planning and construction industry. This includes, among other thing, masonry ties, ties for concrete elements, reinforcing steel for brick lintels and much more.

Declared/ functional unit

1 kg

Year of production site data (A3)

01.07.2022 – 30.06.2023

EPD version

Version 1.0

Basis of calculation

This EPD is developed in accordance with the European standard EN 15804+A2.

Comparability

EPDs of construction products may not be comparable if they do not comply with the requirements in EN 15804. EPD data may not be comparable if the datasets used are not developed in accordance with EN 15804 and if the background systems are not based on the same database.

Validity

This EPD has been verified in accordance with ISO 14025 and is valid for 5 years from the date of issue.

Use

The intended use of an EPD is to communicate scientifically based environmental information for construction products, for the purpose of assessing the environmental performance of buildings.

EPD type

- Cradle-to-gate with modules C1-C4 and D
- Cradle-to-gate with options, modules C1-C4 and D
- Cradle-to-grave and module D
- Cradle-to-gate
- Cradle-to-gate with options

CEN standard EN 15804 serves as the core PCR
Independent verification of the declaration and data, according to EN ISO 14025
<input type="checkbox"/> internal <input checked="" type="checkbox"/> external
Third party verifier: Guangli Du

Martha Katrike Sørensen
EPD Danmark

Life cycle stages and modules (MND = module not declared)

Product			Construction process		Use								End of life				Beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Re-use, recovery and recycling potential	
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X	

Product information

Product description

This EPD covers Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties, with diameters from 1-25 mm. There are approximately 620 different shapes/product items within the group. The declared unit is 1 kg and is calculated as an average from a mass-based allocation. Since there are many different shapes and sizes of products declared in the product group, the weight per piece of each product type can be found at the manufacturers webpage or by contacting them:

<https://www.skagentraad.dk/produktinformation/>

The main product components are shown in the table below.

Material	Weight-% of declared product
Steel coils	100%
Sum	100%

Product packaging:

The composition of the sales- and transport packaging of the product is shown in the table below.

Material	Weight-% of packaging
EU pallet	89%
Plastic wrap, LLDPE	1%
Cardboard	10%
Sum	100%

Representativity

This declaration, including data collection and the modelled foreground system including results, represents the production of 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties, with diameters from 1-25 mm, from the production site in Aalborg,

Denmark. Product specific data are based on average values collected in the period July 2022 to June 2023. Background data is based on Managed LCA Content (MLC) database from Sphera (version 2023.1) and Ecoinvent database version 3.9.1 and the data is less than 10 years old. Generally, the used background datasets are of high quality, and the majority of the datasets are only a couple of years old.

The geographical scope of this EPD is Denmark.

Hazardous substances

Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties does not contain substances listed on the "Candidate List of Substances of Very High Concern for authorisation".

(<http://echa.europa.eu/candidate-list-table>)

Essential characteristics

The declared products, smooth and ribbed steel rods, brackets and wall ties, from Skagen Trådindustri are produced with steel of different qualities:

- Stainless steel EN 1.4301
- Duplex steel EN 1.4362
- Acid-proof steel EN 1.4401

The products are covered by the standard BS6744.

Further technical information, e.g. declaration of performance (DoP), can be obtained by contacting the manufacturer or on the manufacturers website:

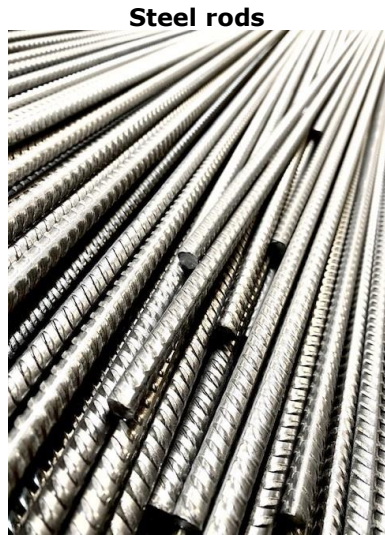
<https://www.skagentraad.dk/produktinformation/>

Reference Service Life (RSL)

Not applicable.

Picture of product(s)

Below are pictures of the three product types included in the declared product group. There are many different shapes within each type of smooth and ribbed steel rods, brackets and wall ties, the pictures are examples.



Steel wall ties



The weight of the different shapes and diameters of smooth and ribbed steel rods, brackets and wall ties from Skagen Trådindustri per piece can be found by contacting the manufacturer or on the manufacturer's webpage: <https://www.skagentraad.dk/>

LCA background

Declared unit

The LCI and LCIA results in this EPD relates to the declared unit of 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties, with diameters from 1-25 mm.

Name	Value	Unit
Declared unit	1	kg
Density	7850	Kg/m ³
Conversion factor to 1 kg.	1	kg/kg

A mass-based allocation factor was used to allocate energy use in production and energy use for utilities at the factory among the different products produced at the factory.

Functional unit

Not defined.

PCR

This EPD is developed according to the core rules for the product category of construction products

in EN 15804:2012+A2:2019, which serves as the core PCR, and NPCR 013 Part B for steel and aluminum construction products (EPD-Norge, 2021) as the c-PCR.

Guarantee of Origin – certificates

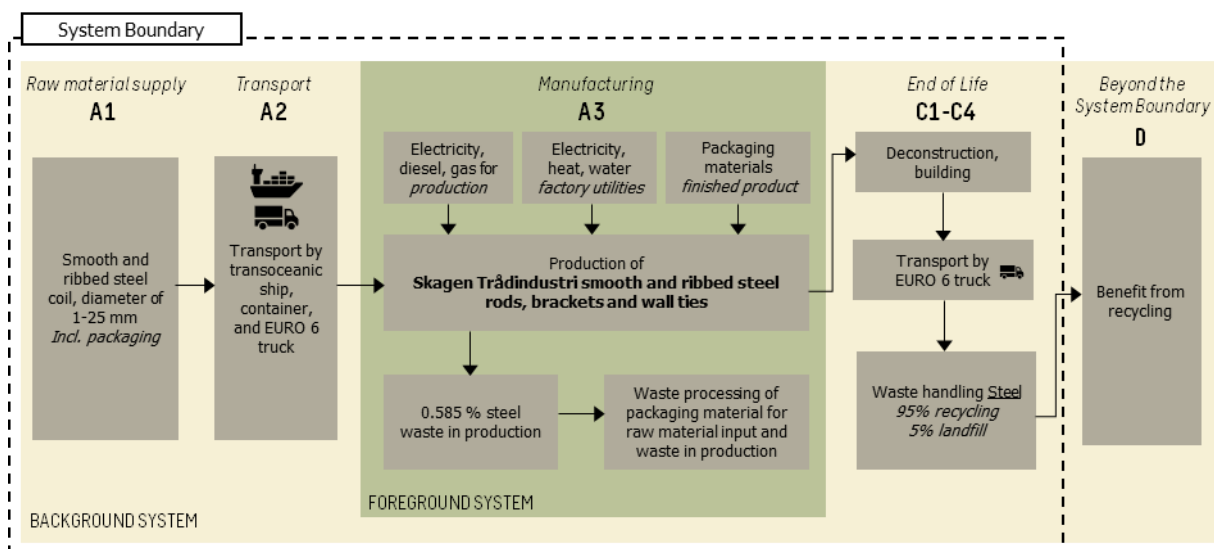
Foreground system:

No use of certified green electricity in the foreground system. The products are produced using electricity modelled as Danish residual electricity mix from 2022 in the production.

Background system:

No use of certified green electricity in the background system. Upstream processes are modelled using national energy mixes. Downstream processes are modelled using national energy mixes.

Flowdiagram



System boundary

This EPD is based on a cradle-to-gate LCA with life cycle modules A1-3, C1-4 and D declared, in which 100 weight-% has been accounted for. In the production of 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties, with diameters from 1-25 mm, a waste of 0.585% occurs from production in module A3.

The general rules for the exclusion of inputs and outputs follows the requirements in EN 15804, 6.3.5, where the total of neglected input flows per module shall be a maximum of 5 % of energy usage and mass and 1 % of energy usage and mass for unit processes. No processes have been excluded from the life cycle inventory.

Product stage (A1-A3) includes:

A1 – Extraction and processing of raw materials

A2 – Transport to the production site

A3 – Manufacturing processes

The product stage includes raw materials as input material, transport to the manufacturer's production site, energy for production and production site, packaging materials for the finished product and waste processing of the raw materials' packaging materials and the materials from waste in the production, up to the "end-of-waste" state or final disposal, according to EN15804+A2 §6.3.5.2. The LCA results for the product stage are declared as an aggregated result for the life cycle modules A1, A2 and A3 in A1-3. In this LCA background report the results for the product stage are also listed separately for A1, A2 and A3 according to the general program instructions for EPD Denmark (EPD Danmark, 2020).

The production of the declared product group of Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties is located at the manufacturer's factory in Aalborg, Denmark.

The raw material in module A1 is cold drawn smooth or ribbed steel coil with a diameter of 1-25 mm. The steel coil is produced in Indonesia and produced with 23% post-consumer steel scrap. The packaging materials for this raw material is plastic wrap, blue plastic foil, cardboard and different steel items.

The transportation of the steel coils is also included in the product stage and consists of transportation by ship from Indonesia to Aalborg port in Denmark, where it is transported by truck to the factory in Aalborg.

The production at the factory in Aalborg consists of different machines, where the steel coils are uncoiled and cut into straight pieces or bended and cut into different shapes to produce the steel rods, brackets and wall ties. The different machines at the factory uses electricity to run. Besides electricity, diesel and gas for trucks at the factory is also included in the production. The factory's utility uses, including electricity, heating and water are also accounted for in the calculation.

Once the steel rods, brackets and wall ties are produced, they are packaged in packaging materials consisting of EU-pallets, plastic wrap and cardboard. All these packaging materials are also included in the production stage. The EU-pallets (wood) are assumed reused 25 times before disposal (EPD Danmark, 2023) (Environment, 2021). Thus, the modelling has been done accordingly with 1/25 virgin material input and 24/25 secondary input material. For the packaging materials in A3 the biogenic carbon content from renewable materials (cardboard and wood), is calculated based on the standard EN16485 as 0.5 kg C/kg dry matter. The cardboard has a moisture content of 7.5% (Mahakalkar, Sambare, & Sunheriya, 2019) and the wood has a moisture content of 15% The biogenic carbon content is calculated from 100% of the material weight input. There is no biogenic carbon content in the declared product leaving the system boundary.

The packaging materials for the raw material input appearing in module A1 and the steel waste in production are treated up to "end-of-waste-state" in module A3. This includes waste treatment of plastic (packaging material for raw material input), waste treatment of cardboard (packaging material for raw material input) and waste treatment of steel (packaging material for raw material input and waste in production). The waste treatment consists of incineration, landfill and recycling. As the waste reaches "end-of-waste-state" in incineration, exported energy (electrical and thermal) is reported from the incineration processes.

As stated in EN15804+A2 §6.3.5.2 the flows leaving the system at the end-of-waste state of the boundary of A1-3 (waste from production and packaging material from raw material inputs) shall be allocated as co-products and loads and benefits from these flows shall not be declared in module D. This rule is applied to handle all waste treatment from A1-3 in module A3 and no potential load and benefits from these waste processes are declared in module D.

End of Life (C1-C4) includes:

C1 – De-construction, demolition

C2 – Transport to waste processing

C3 – Waste processing for reuse, recovery, and/or recycling

C4 – Disposal

Since the declared product groups consists of building materials which are built into the building, C1 is modelled as a deconstruction of a building using an excavator.

In C2, the transport distance scenario is set to 50 km by truck based on a Danish national scenario.

In module C3-C4, 95% of the steel is recycled and 5% is sent to landfill. This waste scenario is based on Danish national waste statistics from 2020 (Miljøministeriet Miljøstyrelsen, 2020) and similar products end of life handling.

The generated waste in module C3-4 is included up to the “end-of-waste” state, including a process for sorting of waste at the waste facility before the steel is recycled.

The potential from the recycling of the steel beyond the system boundary is calculated in module D.

Re-use, recovery and recycling potential (D) includes:

Module D includes reuse, recovery and/or recycling potential, expressed as net impact and benefits, due to reuse,

recycling and incineration of materials with energy recovery in modules C3-C4.

To calculate the amount of net-scrap for credit in module D, the secondary input material in A1 has been deducted from the amount of material for recycling credit in module D. Thus, the 23% post-consumer steel scrap input in module A1 is deducted from the 0,95 kg steel, which is recycled, leaving 0.7315 kg of steel to be credited in module D. The credit is calculated as the difference between production of new primary steel using the blast furnace (BF) route and production of secondary steel from post-consumer scrap using the electric arc furnace (EAF) route. By crediting the difference between these two production routes, the environmental impacts from producing secondary steel from post-consumer steel scrap is subtracted from the environmental impacts from producing primary steel, and an overestimation of the credit in module D has been avoided.

Note

It should be noted that the packaging material, cardboard and EU pallets (wood), has an uptake of biogenic carbon in life cycle module A3. This biogenic carbon is released again in life cycle module A5, but module A5 is not declared in this EPD. However, the uptake of biogenic carbon from the packaging material is very small as related to the total climate change (GWP-total) for life cycle modules A1-3.

The grouping of the different product types in terms of shapes and thicknesses was possible because the difference of the core environmental impact indicators was maximum 6.28%. This is less than +/-10%, in accordance with the General Program Instructions for EPD Denmark.

The cut-off criteria have not been applied in this EPD. Packaging material for the steel coil input is included in the data input and is waste handled in module A3.

LCA results

ENVIRONMENTAL IMPACTS PER 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties										
Parameter	Unit	A1	A2	A3	A1-A3	C1	C2	C3	C4	D
GWP-total	[kg CO ₂ eq.]	2.78E+00	1.87E-01	1.07E-01	3.07E+00	6.09E-04	4.29E-03	6.43E-02	2.31E-03	-1.23E+00
GWP-fossil	[kg CO ₂ eq.]	2.80E+00	1.86E-01	1.20E-01	3.11E+00	6.01E-04	4.24E-03	3.17E-02	2.34E-03	-1.23E+00
GWP-biogenic	[kg CO ₂ eq.]	-2.42E-02	9.43E-05	-1.35E-02	-3.76E-02	2.11E-06	9.72E-06	3.26E-02	-2.89E-05	1.95E-03
GWP-luluc	[kg CO ₂ eq.]	2.28E-03	1.63E-05	5.72E-05	2.36E-03	5.56E-06	3.98E-05	2.27E-05	2.38E-06	-5.18E-04
ODP	[kg CFC 11 eq.]	7.28E-08	1.28E-14	7.93E-11	7.29E-08	7.81E-17	5.59E-16	4.13E-10	3.86E-15	3.66E-12
AP	[mol H ⁺ eq.]	3.40E-02	3.60E-03	2.02E-04	3.78E-02	3.14E-06	6.40E-06	1.46E-04	7.50E-06	-2.81E-03
EP-freshwater	[kg P- eq.]	7.44E-04	4.23E-08	9.41E-07	7.45E-04	2.19E-09	1.57E-08	8.88E-06	2.12E-09	-9.23E-08
EP-marine	[kg N eq.]	3.29E-03	1.53E-03	7.73E-05	4.89E-03	1.47E-06	2.34E-06	6.95E-05	1.88E-06	-6.75E-04
EP-terrestrial	[mol N eq.]	3.48E-02	1.67E-02	7.55E-04	5.23E-02	1.63E-05	2.76E-05	4.61E-04	2.07E-05	-7.30E-03
POCP	[kg NMVOC eq.]	1.12E-02	4.16E-03	2.08E-04	1.56E-02	4.11E-06	5.62E-06	1.48E-04	5.90E-06	-2.25E-03
ADPm ¹	[kg Sb eq.]	6.24E-05	4.36E-09	2.25E-08	6.24E-05	3.98E-11	2.85E-10	4.15E-07	6.40E-11	-1.30E-08
ADPf ¹	[MJ]	2.90E+01	2.32E+00	1.68E+00	3.30E+01	8.18E-03	5.85E-02	3.26E-01	3.49E-02	-9.23E+00
WDP ¹	[m ³]	7.39E+02	5.05E-04	4.75E-03	7.39E+02	7.25E-06	5.19E-05	6.43E-03	-3.18E-05	-1.78E-02
Caption	GWP-total = Global Warming Potential - total; 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 = Ozone Depletion; AP = Acidification; EP-freshwater = Eutrophication – aquatic freshwater; EP-marine = Eutrophication – aquatic marine; EP-terrestrial = Eutrophication – terrestrial; POCP = Photochemical zone formation; ADPm = Abiotic Depletion Potential – minerals and metals; ADPf = Abiotic Depletion Potential – fossil fuels; WDP = water use									
Disclaimer	¹ The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.									

ADDITIONAL ENVIRONMENTAL IMPACTS PER 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties										
Parameter	Unit	A1	A2	A3	A1-A3	C1	C2	C3	C4	D
PM	[Disease incidence]	1.70E-07	9.52E-08	3.29E-09	2.69E-07	3.55E-11	5.30E-11	2.34E-09	8.09E-11	-4.11E-08
IRP ²	[kBq U235 eq.]	1.42E-01	3.12E-04	8.76E-03	1.51E-01	2.29E-06	1.64E-05	2.72E-03	6.01E-05	1.81E-02
ETP-fw ¹	[CTUe]	4.78E+01	1.98E+00	2.66E-01	5.00E+01	5.86E-03	4.19E-02	2.78E-01	1.04E-02	-1.42E+00
HTP-c ¹	[CTUh]	3.17E-08	3.25E-11	1.93E-11	3.17E-08	1.19E-13	8.51E-13	5.23E-11	1.23E-12	-1.92E-09
HTP-nc ¹	[CTUh]	1.43E-08	7.82E-10	4.87E-10	1.56E-08	5.30E-12	3.78E-11	7.54E-10	1.17E-10	1.48E-09
SQP ¹	-	7.98E+00	1.47E-02	2.84E+00	1.08E+01	3.42E-03	2.45E-02	9.47E-01	3.26E-03	8.69E-01
Caption	PM = Particulate Matter emissions; IRP = Ionizing radiation – human health; ETP-fw = Eco toxicity – freshwater; HTP-c = Human toxicity – cancer effects; HTP-nc = Human toxicity – non cancer effects; SQP = Soil Quality (dimensionless)									
Disclaimers	¹ The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.									
	² 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.									

RESOURCE USE PER 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties										
Parameter	Unit	A1	A2	A3	A1-A3	C1	C2	C3	C4	D
PERE	[MJ]	5.24E+00	1.21E-02	9.63E-01	6.21E+00	5.95E-04	4.26E-03	3.02E-02	3.14E-03	1.54E+00
PERM	[MJ]	0.00E+00	0.00E+00	3.48E-03	3.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	5.24E+00	1.21E-02	9.66E-01	6.22E+00	5.95E-04	4.26E-03	3.02E-02	3.14E-03	1.54E+00
PENRE	[MJ]	3.07E+01	2.37E+00	5.44E-01	3.36E+01	8.21E-03	5.87E-02	3.26E-01	3.50E-02	-9.34E+00
PENRM	[MJ]	0.00E+00	0.00E+00	1.13E+00	1.13E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	3.07E+01	2.37E+00	1.68E+00	3.47E+01	8.21E-03	5.87E-02	3.26E-01	3.50E-02	-9.34E+00
SM	[kg]	0.00E+00	0.00E+00	5.87E-02	5.87E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	[MJ]	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]	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	[m ³]	2.51E+01	2.20E-05	3.62E-04	2.51E+01	6.52E-07	4.66E-06	1.50E-04	3.94E-07	-7.97E-04
Caption	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 resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non renewable secondary fuels; FW = Net use of fresh water									

WASTE CATEGORIES AND OUTPUT FLOWS PER 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties										
Parameter	Unit	A1	A2	A3	A1-A3	C1	C2	C3	C4	D
HWD	[kg]	2.54E-03	4.83E-12	2.09E-09	2.54E-03	2.54E-14	1.82E-13	0.00E+00	2.89E-12	-2.35E-11
NHWD	[kg]	1.02E+00	1.45E-04	2.72E-03	1.02E+00	1.25E-06	8.95E-06	0.00E+00	5.01E-02	-1.85E-02
RWD	[kg]	0.00E+00	3.12E-06	7.31E-05	7.62E-05	1.54E-08	1.10E-07	0.00E+00	4.06E-07	1.64E-04
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
MFR	[kg]	0.00E+00	0.00E+00	3.17E-02	3.17E-02	0.00E+00	0.00E+00	9.50E-01	0.00E+00	0.00E+00
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]	0.00E+00	0.00E+00	3.46E-03	3.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Caption	HWD = Hazardous waste disposed; NHWD = Non hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Exported energy									

BIOGENIC CARBON CONTENT PER 1 kg Skagen Trådindustri smooth and ribbed steel rods, brackets and wall ties		
Parameter	Unit	At the factory gate
Biogenic carbon content in product	[kg C]	0,00E+00
Biogenic carbon content in accompanying packaging	[kg C]	2.87E-02
Note	1 kg biogenic carbon is equivalent to 44/12 kg of CO ₂	

Additional information

LCA interpretation

Life cycle modules A1-A3 have the largest contribution to all 13 core environmental impact indicators.

The production stage, life cycle modules A1-A3, is the life cycle stage, which has the largest contribution to the impact category *Climate Change total*, with 97.7% of the total impact.

In the life cycle stage A1-A3, the steel coil input as raw material contributes to 90% of the total impact in the impact category *Climate Change total*. The second largest contribution in A1-A3 is the transportation by ship in module A2, there the steel coil is transported from Indonesia to Denmark by an ocean-going transoceanic ship, in containers. This process contributes with 6% of the total impact in *Climate Change total*. Furthermore, as a single process, the steel coil has the largest contribution to all core environmental impact categories, with a contribution between approximately 60% to 100%.

In the end-of-life stage, life cycle modules C1-C4, it is the process of waste handling at the sorting site for recycling, which has the largest contribution to impact category *Climate Change total* with 89.9% of the total impact. The declared product group has a recycling rate of 95% at EoL, thus the vast majority of the material is handled using this sorting process.

Technical information on scenarios

Reference service life

RSL information		Unit
Reference service Life – not applicable	-	Years

End of life (C1-C4)

Scenario information	Value	Unit
Collected separately	1	kg
Collected with mixed waste	-	kg
For reuse	-	kg
For recycling	0.950	kg
For energy recovery	-	kg
For final disposal	0.050	kg
Assumptions for scenario development	-	As appropriate

Re-use, recovery and recycling potential (D)

Scenario information/Materiel	Value	Unit
Displaced material	0.7315	kg
Energy recovery from waste incineration	-	MJ



Indoor air

The EPD does not give information on release of dangerous substances to indoor air because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.1.

Soil and water

The EPD does not give information on release of dangerous substances to soil and water because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.2.

References

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<p>LCA software / background data</p>	<p>LCA for Experts (LCA FE) version 10.7</p> <p>Generic data are primarily based on life cycle inventory data from Spheras database Managed LCA Content (MLC) version 2023.1 and Ecoinvent database 3.9.1 as well as product specific data on the steel coil.</p>
<p>3rd party verifier</p>	<p>Guangli Du</p> <p>BUILD – Institut for Byggeri, By og Miljø, Aalborg Universitetet København</p>

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