

ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804+A2


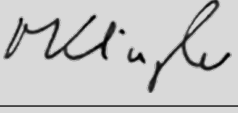
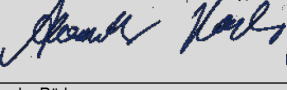
Owner of the Declaration	
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Declaration number	EPD-ZIN-20210263-IBG1-EN
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Valid to	21.03.2027

microZINQ® hot-dip galvanized steel
ZINQ Technologie GmbH

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1. General Information

ZINQ Technologie GmbH Programme holder IBU – Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	microZINQ® hot-dip galvanized steel Owner of the declaration ZINQ Technologie GmbH An den Schleusen 6 45881 Gelsenkirchen Deutschland
Declaration number EPD-ZIN-20210263-IBG1-EN	Declared product / declared unit 1 t of microZINQ® hot-dip galvanized structural steel
This declaration is based on the product category rules: Structural steels, 11.2017 (PCR checked and approved by the SVR)	Scope: This EPD refers to 1t of microZINQ® hot-dip galvanized steel galvanized at the microZINQ® facility of the ZINQ® group in Hagen. Representative foreground data collected by ZINQ Technologie GmbH and background data from the GaBi database was used to conduct the LCA-study.
Issue date 22.03.2022	The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences. The EPD was created according to the specifications of <i>EN 15804+A2</i> . In the following, the standard will be simplified as <i>EN 15804</i> .
Valid to 21.03.2027	Verification The standard <i>EN 15804</i> serves as the core PCR Independent verification of the declaration and data according to <i>ISO 14025:2010</i> <input type="checkbox"/> internally <input checked="" type="checkbox"/> externally
 Dipl. Ing. Hans Peters (chairman of Institut Bauen und Umwelt e.V.)	 Matthias Klingler (Independent verifier)
 Dr. Alexander Röder (Managing Director Institut Bauen und Umwelt e.V.)	

2. Product

2.1 Product description/Product definition

This EPD applies to 1 t (1000 kg) of microZINQ® hot-dip galvanized structural steel which are products of ZINQ Technologie GmbH and applied for the purpose of corrosion protection of said steel components.

Characteristics are:

- Hot-dip zinc coating according to *DIN 50997* consisting of a zinc-aluminium layer as a result of the hot-dip galvanizing process in a zinc- 5 % aluminium alloy
- Applied on steel components, e.g. hot-rolled sections or structures welded from heavy plates; a typical surface of such steel components per ton is 75 - 150 m², the average value resulting from the data is 100 m² per ton of product
- Typical zinc-aluminium coating thickness is 5 – 15 µm, the average value resulting from the data gathered is 12.5 µm

The EPD covers steel products of the grades S235 to S960 rolled out to structural sections, merchant bars

and heavy plates with the aforementioned zinc coating. The steel products are manufactured via Blast Furnace with Basic Oxygen Furnace (BF+BOF) and Electric Arc Furnace (EAF) routes according to the *EPD of Structural steel: Sections and Plates*.

For the placing on the market in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) the following legal provisions apply: *AbZ Z-30.11-60* Mit dem Dünnschicht-Stückverzinkungsverfahren microZINQ® 5 feuerverzinkte Bauteile and the harmonised standard *EN 10025-1: 2005* Hot rolled products of structural steels – Part 1: General technical delivery conditions. The CE-marking takes into account the proof of conformity with the respective harmonized standards based on the legal provisions above. For the application and use the respective national provisions apply.

2.2 Application

Structural steels are intended for bolted, welded or otherwise connected constructions of buildings or other load-bearing (support) structures but also for infrastructure components, commercial vehicle

components and other structures. The zinc coatings applied to steel structures serve in particular the purpose of protecting these against corrosive and/or mechanical loading during the use phase. They thus are applied in steel applications where relevant corrosive loadings occur and appropriate protection against these is required to extend the service life of the steel components and ensure their functionality. Zinc coatings also serve additional purposes, such as optical design and improved fire protection. Examples of hot-dip galvanized steel applications include:

- Single story buildings like industrial and storage halls
- Multi-storey buildings like offices, residential buildings, car parks and shops
- Bridges for different modes of transport like railway or roads
- Sub-structure of solar panels, scaffoldings or shelving systems
- crash barriers, signposts and sign bridges

2.3 Technical Data

This EPD is valid for steel products of varied grades and different forms of delivery according to the *EPD of Structural steel: Sections and Plates*.

Technical Data

Name	Value	Unit
Density	7850	kg/m ³
Modulus of elasticity	210000	N/mm ²
Coefficient of thermal expansion	12	10 ⁻⁶ K ⁻¹
Thermal conductivity	48 - 58	W/(mK)
Melting point depending on the alloy up to	1536	°C

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN 10025*, Hot rolled products of structural steels. Further product standards: *ASTM A36*, *ASTM A283*, *ASTM A514*, *ASTM A572*, *ASTM A573*, *ASTM A588*, *ASTM A633*, *ASTM A709*, *ASTM A913*, *ASTM A992* and *ASTM A1066*.

For the execution of steel structures *EN 1090-2* has to be taken into consideration. For hot-dip galvanizing *DIN 50997*, Zinc-aluminium coatings applied by thin film galvanizing of steel – Requirements and testing has to be taken into consideration. Further relevant standards: *EN ISO 14713-1*, *EN ISO 14713-2*, *ASTM A143*, *ASTM A153*, *ASTM A384*, *ASTM A385*, *ASTM A1072*.

2.4 Delivery status

The dimensions of the products declared in this EPD may vary depending on the intended application.

2.5 Base materials/Ancillary materials

One ton of the hot-dip galvanized structural steels covered in this EPD consist of 991.08 kg of structural steel according to the *EPD of Structural steel: Sections and Plates* and 8.92 kg of protective zinc coating. The masses are based on the declared unit (100 m² surface, 12.5 µm coating thickness).

Materials (zinc & auxiliaries) of the coating process:

- Zinc alloys
- Industrial cleaner
- Corrosion inhibitor
- Wetting agents
- Pickling additives
- Hydrochloric acid
- Hydrogen peroxide
- Ammonium hydroxide
- Flux (based on Zinc chloride and Ammonium plus further metal chlorides, especially alkali and alkaline earth metal chlorides))
- Caustic soda
- Passivation bath
- Sealing bath
- Binding Wire

Hot-dip galvanized steel is not a substance or mixture under the chemical law (*REACH*). Nevertheless, the following declaration are given for microZINQ hot-dip galvanized steel:

- This product/article/at least one partial article contains substances listed in the candidate list (date: 18.12.2019) exceeding 0.1 percentage by mass: no.
- This product/article/at least one partial article contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: no.
- Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): no.

2.6 Manufacture

The manufacturing of structural steel refers to the *EPD of Structural steel: Sections and Plates*.

In hot-dip galvanizing, the fully or semi-fabricated steel components are first cleaned using a wet-chemical pre-treatment and then coated by dipping them into the molten liquid zinc melt. This includes the use of natural gas to fire the molten zinc to ~420°C, ensuring a constant temperature and compensating for thermal losses, as well as the drying furnace. Electrical energy is used for the extraction system at the galvanizing kettle and for the cranes that move the galvanizing material through the process. For this purpose, racks, hooks, chains, wires and traverses are used in addition as auxiliary equipment.

2.7 Environment and health during manufacturing

During production, there are no special requirements for safety, environmental protection and health beyond the legal requirements. Compliance with these requirements is verified in the course of microZINQ® hot-dip galvanizing using management systems (*ISO 14001*, *ISO 45001* and *ISO 50001*). In addition, a complete assessment of all substances used in the process and duroZINQ® product, including an ABC-X

analysis, was carried out as part of the *Cradle-to-Cradle Certification* process (certification has been valid continuously since 2016).

2.8 Product processing/Installation

Processing recommendations:

Planning, processing, implementation and intended use of microZINQ® hot-dip galvanized section and plate constructions have to be carried out depending on the respective applications according to the generally recognized rules of engineering and manufacturer's recommendations. The standards of *EN 1993* and *EN 1994* apply to the design of steel structures and composite steel and concrete structures. They include the requirements regarding serviceability, bearing capacity, durability and fire resistance of steel structures *EN 1993* and composite steel and concrete structures *EN 1994*. *EN 1090-1* and *EN 1090-2* apply to the execution of steel structures and include the requirements for factory production control. In addition, these European Standards will work in connection with national amendments, national instructions, guidelines and publications, as well as legal provisions. Regarding transport and storage of microZINQ® hot-dip galvanized sections and plates, the generally accepted requirements for securing loads have to be observed.

Instruction details of the manufacturer based on verified standards and guidelines e.g. regarding welding, bolting, hot and cold forming or assembly are to be observed in every case.

Occupational safety/Environmental protection:

When processing/using microZINQ® hot-dip galvanized steel sections and plates pursuant to the generally recognized rules of engineering there are no measures to be taken which are going beyond the public occupational health and safety. The processing/using of microZINQ® hot-dip galvanized steel sections and plates pursuant to the generally recognized rules of engineering does not release substantial environmental pollutants. Particular measures to protect the environment are not required.

Residual material:

During microZINQ® hot-dip galvanizing as well as during processing of microZINQ® hot-dip galvanized steel residual pieces as well as turnings are to be separately collected. Zinc-rich waste from the microZINQ® hot-dip galvanizing process is treated and returned to the zinc cycle. microZINQ® hot-dip galvanized scrap steel is entirely recycled by melting and producing new steel products.

2.9 Packaging

No additional packaging is necessary since the microZINQ® coating provides the protecting function of a package.

2.10 Condition of use

microZINQ® hot-dip galvanized steel products are non-/low-alloyed steel products with a protective coating, which results from hot-dip galvanizing in a zinc melt of nominal 95 mass% zinc, the rest being aluminium and minor alloying elements.

During use the zinc coatings undergo permanent reactions with its atmosphere, building a very resistant layer of zinc carbonate (carbonisation), aluminium

compounds and zinc-aluminium compounds. Under ongoing corrosive loading of the zinc coating the zinc corrodes and the layer becomes thinner over time. This process of zinc consumption or zinc loss takes place very slowly at a zinc corrosion rate. For microZINQ the experience has shown a very low zinc corrosion during utilization, which is often characterized by a non-linear behavior over time. The underlying mechanisms were investigated by ZINQ technologies GmbH in cooperation with Fraunhofer Institute IPA. For the present calculation a linear corrosion rate of 0.15 µm per year is assumed, which results from own measurements over five years in C3 atmosphere.

2.11 Environment and health during use

The protective layer of the zinc coating (zinc carbonate, patina) formed naturally under the influence of air and moisture is very stable and not soluble in water (see 2.10) under consideration of today's strongly reduced air pollution (here especially the SO₂ concentration in the air) and proper application (no water drainage permanently provided by the design). The zinc ion runoff significantly depends on the load of "acidic" air pollutants, especially SO₂. As the SO₂ concentration in the air has decreased to one-fifth of previous levels over the past 30 years, there has also been a corresponding decrease in the zinc runoff and thus of the zinc concentration in precipitation water.

The legal limits for the total concentration of zinc in drinking water are undercut. In water systems, only a small portion of the total zinc concentration is available to an organism; this amount is called the biologically available amount. It is related to the physicochemical conditions of the receiving water body. For example, bioavailability is affected by the amount of zinc that is organically or inorganically bound, bound to particles, or competing with other ions.

There are no known adverse effects on health when steel hot-dip galvanized with microZINQ® is used as intended. Like iron, zinc is one of the metals essential for life. Zinc is not accumulated in the body. The zinc intake recommendation of the *German Nutrition Society (DGE)* is 15 mg daily.

2.12 Reference service life

Structural steel products are supposed to serve at least the lifetime of a building which is 50 years according to *EN 15978*. The technical service life of a galvanized steel product is determined by the time the protecting zinc coating stays on the steel to protect it from corrosion. At a rate of 0.15 µm per year (section 2.10) this leads to a technical service life of at least 83 years and therefore exceeds the 50 years lifetime of buildings.

2.13 Extraordinary effects

Fire

The material is class A1, i.e. not flammable per *EN 13501*.

Under fire load, the zinc coating has a positive effect on the steel structure in that it slows down its heating, which ensures the load-bearing capacity of the structure for a longer period of time compared to ungalvanized, unprotected steel.

When heated above 650°C, the thin zinc coating evaporates briefly as zinc oxide (ZnO), producing smoke. The ZnO smoke, inhaled over a longer period

of time, can cause "zinc fever" (diarrhoea, fever, dry throat), which, however, disappears completely some days after inhalation.

Brandschutz

Name	Value
Building material class	A1

Water

Under the influence of water, no negative effects on the functional capability of microZINQ® hot-dip galvanized steel within the intended service life are to be expected - provided that it is used as intended.

Mechanical destruction

Due to the ductility of steel and the high mechanical resistance of the microZINQ® hot-dip zinc coating, microZINQ® hot-dip steel structures react resiliently in the event of unforeseeable mechanical destruction. In case of tensile load, necking will occur before cracking. In case of lasting high compression load, components of microZINQ® hot-dip galvanized steel may buckle or bulge. No splintering or breaking edges shall result.

2.14 Re-use phase

Steel sections and plates made of microZINQ® hot-dip galvanized steels are recyclable to 100 % *EPD of Structural Steel: Sections and Plates*. Re-use takes place for around 11 % of the products while 88 % are recycled in a closed loop. Around 1 % can not be regained due to occurring losses. The zinc coating is carbonized over the lifetime of the steel structure.

2.15 Disposal

Due to its high value as a raw material, hot-dip galvanized steel scrap is not disposed of but recycled in a long-established cycle. Reaction products of the zinc coating with the atmosphere (zinc carbonate resulting from carbonization) are removed from the surface in very low concentrations over the lifespan of the steel product, but without known harm to the environment.

Waste code according to European Waste Catalogue *EW*C:

17 04 05 - iron and steel

2.16 Further information

Further information on microZINQ® products can be obtained from www.zinq.com.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1t (1000 kg) of hot-dip galvanized structural steel. Data from the microZINQ® facility of the ZINQ® group in Hagen as a representative production site has been used to declare a representative product (100 m² surface, 12.5 µm coating thickness).

Declared Unit

Name	Value	Unit
Declared unit	1	t
Conversion factor to 1 kg (mass in kg per declared unit)	1000	-

3.2 System boundary

Type of the EPD: Cradle to gate with options, modules C1–C4, and module D.

Modules A1–A4, B1–B7, C1–C4 and D have been considered.

Module A1–A4 consider the following:

- Production of structural steel according to the *EPD of Structural Steel: Sections and Plates*,
- production of zinc and zinc alloy components,
- transport of the structural steel to the manufacturing sites,
- the galvanizing process, including all auxiliaries and the use of electricity and thermal energy,
- transport from the manufacturing sites to the construction site.

For the electricity consumption of the galvanizing process a renewable energy grid mix has been taken into account. The electricity usage of the production of steel as well as module D refers to the *EPD of*

Structural Steel: Sections and Plates. Electricity credits of energy recovery inside the system boundaries have been accounted for using a German average grid mix. The proportion of green electricity demand for the galvanizing process is 100 %. Therefore, no residual grid mix has been considered.

Module B1–B7 consider the following:

- Carbonisation of the Zinc coating during use of the product. This serves as a carbon dioxide sink. The calculation is based on the stoichiometric ratio lowered by an amount to account for real conditions.
- during intended use over the considered lifetime of hot-dip galvanized structural steels, no maintenance, replacement or refurbishment is needed. The products do not use energy or water.

Module C1–C4 consider the following:

- Deconstruction of structural steel,
- transport to the end-of-life,
- processing and disposal according to the *EPD of Structural Steel: Sections and Plates*.

Due to carbonisation, no remaining zinc must be considered.

Module D considers benefits and loads beyond the system boundary according to the *EPD of Structural Steel: Sections and Plates*.

3.3 Estimates and assumptions

Primary data was used to model all on-site processes of the hot-dip galvanizing process. Data were cross-checked to identify and eliminate data gaps. High-quality secondary data from the *GaBi database* was used to model upstream material and energy flows.

Secondary data was as technologically and geographically representative as possible. Zn/Al master alloys, alloying elements and auxiliaries are considered using their material weights. Instead of primary data collection from suppliers to reflect specific brand products, datasets from the *GaBi database* for standard processing chemicals have been used. For sludges, a solid waste content was assumed. This solid waste content is handled as hazardous waste with the respective treatment. Waste water and water content of the sludges are assumed to be treated in municipal waste water treatment. Other wastes are treated as commercial waste in a municipal waste incineration plant.

3.4 Cut-off criteria

No cut-off criteria are applied in this study. All reported data were incorporated and modelled using the best available LCI data. Data for the sites were cross-checked with one another to identify potential data gaps. No processes, materials or emissions that are known to make a significant contribution to the environmental impact of the products studied have been omitted. On this basis, there is no evidence to suggest that input or outputs contributing more than 1 % to the overall mass or energy of the system or that are environmentally significant have been omitted. It can be assumed, that all excluded flows contribute less than 5 % to the impact assessment categories. Production of capital equipment, facilities and infrastructure required for manufacture are outside the scope of this assessment. Transport of base materials with low shares in the composition are neglected.

3.5 Background data

The LCA model is created using the *GaBi Software* system for life cycle engineering, developed by Sphera Solutions GmbH. The *GaBi database* provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The most recent of the database was 2020.

3.6 Data quality

The foreground data collected by ZINQ Technologie GmbH are based on yearly production amounts in productions plants. All relevant background datasets are taken from the *GaBi database*. The study is based on high quality data.

3.7 Period under review

Allocation for the structural steel is done according to the *EPD of Structural Steel: Sections and plates*. The hot dip galvanizing process does not deliver any co-products. The applied model does not contain any allocation.

3.8 Allocation

The allocations of relevance for calculation (appropriation of expenses across various products) must be indicated, at least:

- Allocation of energy, auxiliary and operating materials used for individual products in a factory;
- Allocation of co-production processes;
- Allocation in the use of recycled and/or secondary raw materials;
- Loads and benefits beyond the system boundary from recycling or energy recovery of packaging materials and production waste;
- Loads and benefits beyond the system boundary from recycling or energy recovery from the end of life of the product.

whereby reference must be made to the modules in which the allocations are performed.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.

The *GaBi database* provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The most recent of the database was 2020.

4. LCA: Scenarios and additional technical information

Characteristic product properties Information on biogenic Carbon

The production of the steel refers to the *EPD of Structural Steel: Sections and Plates*. Information for the scenario used is given in the following tables. Information regarding the service life is given in section 2.12.

Transport to Construction site (A4)

Name	Value	Unit
Transport distance	100	km
Capacity utilisation (including empty runs)	61	%

Name	Value	Unit
Reuse	109	kg
Recycling	872	kg
Energy recovery	0	kg
Landfilling	9.9	kg

Ende des Lebenswegs (C1-C4)

5. LCA: Results

Disclaimer:

EP-freshwater: This indicator has been calculated as "kg P eq" as required in the characterization model (EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe; <http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml>).

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	ND	X	X	X	X	X	X	X	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: declared unit and product

Core Indicator	Unit	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO ₂ -Eq.]	1.21E+3	2.99E+1	1.59E+2	6.03E+0	2.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.11E+1	2.99E+0	1.77E+0	0.00E+0	3.77E+2
GWP-fossil	[kg CO ₂ -Eq.]	1.21E+3	2.97E+1	1.58E+2	5.99E+0	2.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.11E+1	2.97E+0	1.78E+0	0.00E+0	3.76E+2
GWP-biogenic	[kg CO ₂ -Eq.]	1.90E+0	-5.08E-2	8.75E-1	-1.03E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.69E-2	-5.08E-3	-1.38E-2	0.00E+0	-3.68E-1
GWP-luluc	[kg CO ₂ -Eq.]	3.45E-1	2.41E-2	1.47E-2	4.86E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.61E-2	2.41E-3	3.21E-3	0.00E+0	-3.00E-2
ODP	[kg CFC11-Eq.]	-9.15E-8	3.58E-15	3.28E-8	7.21E-16	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.44E-13	3.58E-16	3.30E-14	0.00E+0	2.81E-13
AP	[mol H ⁺ -Eq.]	3.21E+0	3.05E-2	1.03E-1	6.16E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.45E-2	3.05E-3	5.09E-3	0.00E+0	-8.67E-1
EP-freshwater	[kg P-Eq.]	5.28E-4	9.04E-5	2.00E-4	1.82E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.96E-5	9.04E-6	4.53E-6	0.00E+0	-1.92E-4
EP-marine	[kg N-Eq.]	7.48E-1	8.89E-3	2.82E-2	1.79E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.43E-3	8.89E-4	1.36E-3	0.00E+0	-1.73E-1
EP-terrestrial	[mol N-Eq.]	8.16E+0	1.07E-1	3.37E-1	2.16E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.71E-2	1.07E-2	1.46E-2	0.00E+0	1.81E+0
POCP	[kg NMVOC-Eq.]	2.50E+0	2.47E-2	1.58E-1	4.98E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.49E-2	2.47E-3	3.82E-3	0.00E+0	-6.64E-1
ADPE	[kg Sb-Eq.]	4.70E-3	2.13E-6	-1.57E-3	4.30E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.21E-6	2.13E-7	4.53E-7	0.00E+0	-4.04E-3
ADPF	[MJ]	1.29E+4	3.96E+2	2.57E+3	7.99E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.95E+2	3.96E+1	2.99E+1	0.00E+0	3.50E+3
WDP	[m ³ world-Eq deprived]	4.67E+2	2.66E-1	1.17E+2	5.37E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.42E+0	2.66E-2	3.38E-1	0.00E+0	3.35E+1

Caption: GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential

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

Indicator	Unit	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	1310.00	22.30	1160.00	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.40	2.23	11.90	0.00	38.30
PERM	[MJ]	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND	ND	0.00	ND
PERT	[MJ]	1310.00	22.30	1160.00	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.40	2.23	11.90	0.00	38.30
PENRE	[MJ]	12900.00	396.00	2570.00	80.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	195.00	39.60	29.90	0.00	3500.00
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	12900.00	396.00	2570.00	80.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	195.00	39.60	29.90	0.00	3500.00
SM	[kg]	820.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m ³]	11.30	0.03	-2.67	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.01	0.00	-0.82

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 = Use of net fresh water
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RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: declared unit and product

Indicator	Unit	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.28E-4	1.84E-5	2.75E-5	3.72E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	8.07E-8	1.84E-6	1.17E-7	0.00E+0	2.74E-4
NHWD	[kg]	9.64	0.06	3.76	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	9.94	0.00	25.00
RWD	[kg]	5.79E-1	4.91E-4	6.51E-3	9.90E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.96E-2	4.91E-5	3.96E-3	0.00E+0	6.00E-2
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	109.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	872.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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; EEE = Exported electrical energy; EEE = Exported thermal energy
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RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: [declared unit and product]

Indicator	Unit	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	[Disease Incidence]	3.20E-5	1.82E-7	2.78E-7	3.67E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.05E-7	1.82E-8	4.99E-8	0.00E+0	-1.13E-5
IRP	[kBq U235-Eq.]	1.08E+2	7.09E-2	-8.30E-1	1.43E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.85E+0	7.09E-3	6.48E-1	0.00E+0	6.77E+0
ETP-fw	[CTUe]	7.72E+3	2.80E+2	-1.09E+3	5.65E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	8.33E+1	2.80E+1	1.39E+1	0.00E+0	-3.12E+2
HTP-c	[CTUh]	2.67E-7	5.86E-9	-1.55E-8	1.18E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.30E-9	5.86E-10	5.14E-10	0.00E+0	6.61E-8
HTP-nc	[CTUh]	2.42E-5	3.02E-7	-4.36E-8	6.10E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	8.48E-8	3.02E-8	3.17E-8	0.00E+0	-4.32E-6
SQP	[-]	8.26E+2	1.39E+2	6.09E+1	2.80E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.20E+1	1.39E+1	9.30E+0	0.00E+0	-3.30E+1

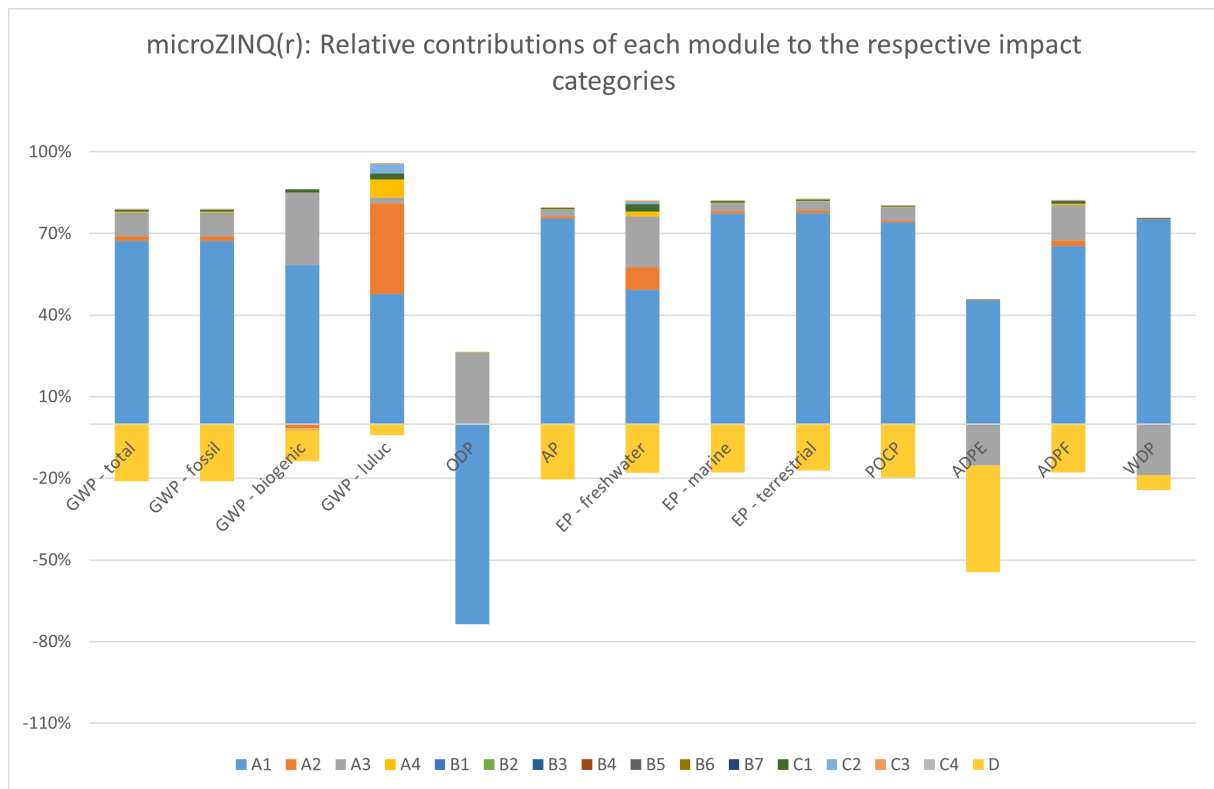
Caption	PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index
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6. LCA: Interpretation

The interpretation of this EPD highlights the contribution of the hot-dip galvanizing process in the environmental impact of 1 t of microZINQ® hot-dip galvanized steel. While the highest share of impacts as for a hot-dip galvanized product is related to the production of the structural steel as part of Module A1, this refers to the *EPD of Structural Steel: Sections and Plates*. The potential benefits in module D are exclusively attributable to the steel. Additionally, the use phase serves as a sink for CO₂ due to carbonization of the zinc coating. The following graph shows the relative contribution of each module for the

different impact categories.

Negative contributions of module A3 (the hot-dip galvanizing process) for ADPE and WDP are linked to the recovery of high-value zinc, a sulphidic ore, using a rotary kiln while the upstream of zinc is part of module A1. This results in a net negative value of module A3 for impact categories linked to the mining of zinc. The results show a similar trend to GWP for most of the impact categories. Module A1 is linked to the highest impacts and module D offers benefits to reuse and recycling of the structural steel.



7. Requisite evidence

7.1 Weathering performance

The corrosion rate of zinc and zinc-aluminium compounds depend on the position of the component and the conditions of the surrounding atmosphere (corrosivity categories for zinc according to *EN ISO 12944-2*). For corrosivity category C3, which according to this standard is characteristic of an urban and

industrial atmosphere with moderate sulfur dioxide load and a coastal atmosphere with low salt load and thus corresponds to the typical corrosive load of steel structures, the corrosion rate is assumed to be 0.15 µm/year.

8. References

Standards

ASTM A36

ASTM A36 / A36M: 2019 Standard Specification for Carbon Structural Steel

ASTM A123

ASTM A123 / A123M: 2017 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A143

ASTM A143 / A143M: 2020 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

ASTM A153

ASTM A153 / A153M: 2016 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A283

ASTM A283 / A283M: 2018 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A384

ASTM A384 / A384M: 2019 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

ASTM A385

ASTM A385 / A385M: 2020 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)

ASTM A514

ASTM A514 / A514M: 2018 Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate

ASTM A572

ASTM A572 / A572M: 2021 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A573

ASTM A573 / A573M: 2020 Standard Specification for Structural Carbon Steel Plates

ASTM A588

ASTM A588 / A588M: 2019 Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance

ASTM A633

ASTM A633 / A633M: 2018 Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates

ASTM A709

ASTM A709 / A709M: 2018 Standard Specification for Structural Steel for Bridges

ASTM A913

ASTM A913 / A913M: 2019 Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST)

ASTM A992

ASTM A992 / A992M: 2020 Standard Specification for Structural Steel Shapes

ASTM A1066

ASTM A1066 / A1066M: 2015 Standard Specification for High-Strength Low-Alloy Structural Steel Plate Produced by Thermo-Mechanical Controlled Process (TMCP)

ASTM A1027

ASTM A1027 / A1027M: 2015 Standard Specification for Zinc-5% Aluminum (Hot-Dip) Coatings on Iron and Steel Products

DIN EN ISO 12944-2

DIN EN ISO 12944-2 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments

DIN 50997

DIN 50997:2020 Zinc-aluminium coatings applied by thin film galvanizing of steel - Requirements and testing

EN 1090-1

EN 1090-1:2012 Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components

EN 1090-2

EN 1090-2:2018 Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures

EN 1993

EN 1993 Eurocode 3 - Design of steel structures

EN 1994

EN 1994 Eurocode 4: Design of composite steel and concrete structures

EN ISO 1461

EN ISO 1461:2009 Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

EN 10025

EN 10025 Hot rolled products of structural steels

EN 10025-1

EN 10025-1: 2005 Hot rolled products of structural steels – Part 1: General technical delivery conditions

EN 13501

EN 13501-1:2018 Fire classification of construction products and building elements Classification using data from reaction to fire tests

EN 14025

DIN EN ISO 14025:2010 Environmental labels and declarations. Type III environmental declarations. Principles and procedures

EN ISO 14713-1

EN ISO 14713-1: 2017 Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance

EN ISO 14713-2

EN ISO 14713-2:2020 Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing

EN 15804

EN 15804+A2 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

EN 15978

DIN EN 15978 Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method

ISO 14001

ISO 14001:2015 Environmental management systems - Requirements with guidance for use

ISO 45001

ISO 45001: 2018 Occupational health and safety management systems - Requirements with guidance for use

ISO 50001

ISO 5001:2018 Energy management systems - Requirements with guidance for use

Further references

AbZ Z30.11-60

Allgemeine bauaufsichtliche Zulassung/Allgemeine Bauartgenehmigung Z-30.11-60 10:2020 Mit dem Dünnschicht-Stückverzinkungsverfahren microZINQ® 5 feuerverzinkte Bauteile

Cradle-to-Cradle Certification

Guidance for the Cradle to Cradle Certified™ Product Standard, Cradle to Cradle Products Innovation Institute www.c2ccertified.com

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Environmental Product Declaration: Structural Steel: Sections and Plates. bauforumstahl e.V., EPD-BFS-20180116-IBG2-EN. Berlin: Institut Bauen und Umwelt e.V. (ed.), 25.10.2018.

EWC

European Waste Catalogue, established by Commission decision 2000/532/EC2

GaBi Database

Sphera Solutions GmbH. (2020). *GaBi LCA Database Documentation*. Retrieved from gabi.sphera.com/international/support/gabi/

GaBi Software

Sphera Solutions GmbH. (2020). *GaBi Software*. For further information see: gabi.sphera.com/international/index/

German Nutrition Society (DGE)

German Nutrition Society / Deutsche Gesellschaft für Ernährung e.V. (DGE), reference values for Nutrient intake, www.dge.de

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General Instructions for the EPD programme of Institut Bauen und Umwelt e.V. Version 2.0, Berlin: Institut

Bauen und Umwelt e.V., 2021. www.ibu-epd.com

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Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2. *Institut Bauen und Umwelt e.V.* (IBU). November 2021. www.ibu-epd.com

PCR Part B

Requirements on the EPD for www.ibu-epd.com Structural steels. *Institut Bauen und Umwelt e.V.* (IBU). November 2021. www.ibu-epd.com

**Publisher**

Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Tel +49 (0)30 3087748- 0
Fax +49 (0)30 3087748- 29
Mail info@ibu-epd.com
Web www.ibu-epd.com

**Programme holder**

Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Tel +49 (0)30 - 3087748- 0
Fax +49 (0)30 - 3087748 - 29
Mail info@ibu-epd.com
Web www.ibu-epd.com

**Author of the Life Cycle Assessment**

Sphera Solutions GmbH
Hauptstraße 111- 113
70771 Leinfelden-Echterdingen
Germany

Tel +49 711 341817-0
Fax +49 711 341817-25
Mail info@sphera.com
Web www.sphera.com

Sphera Solutions GmbH
Hauptstr. 111-113
70771 Leinfelden-Echterdingen
Germany

Tel +49 711 341817-0
Fax +49 711 341817-25
<https://sphera.com/>

ZINQ Technologie GmbH
An den Schleusen 6
45881 Gelsenkirchen
Germany

Tel +49 209 9403400
Fax +49 209 9403444
Mail thomas.pinger@zinq.com
Web www.zinq.com

**Owner of the Declaration**

ZINQ Technologie GmbH
An den Schleusen 6
45881 Gelsenkirchen
Germany

Tel +49 209 9403400
Fax +49 209 9403444
Mail thomas.pinger@zinq.com
Web www.zinq.com