ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A1*

Owner of the Declaration	VM Building Solutions Deutschland GmbH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-VMZ-20180086-IBD1-EN
Issue date	15.11.2018
Valid to	14.11.2024

VMZinc - Preweathered rolled zinc

VM BUILDING SOLUTIONS

Institut Bauen und Umwelt e.V.

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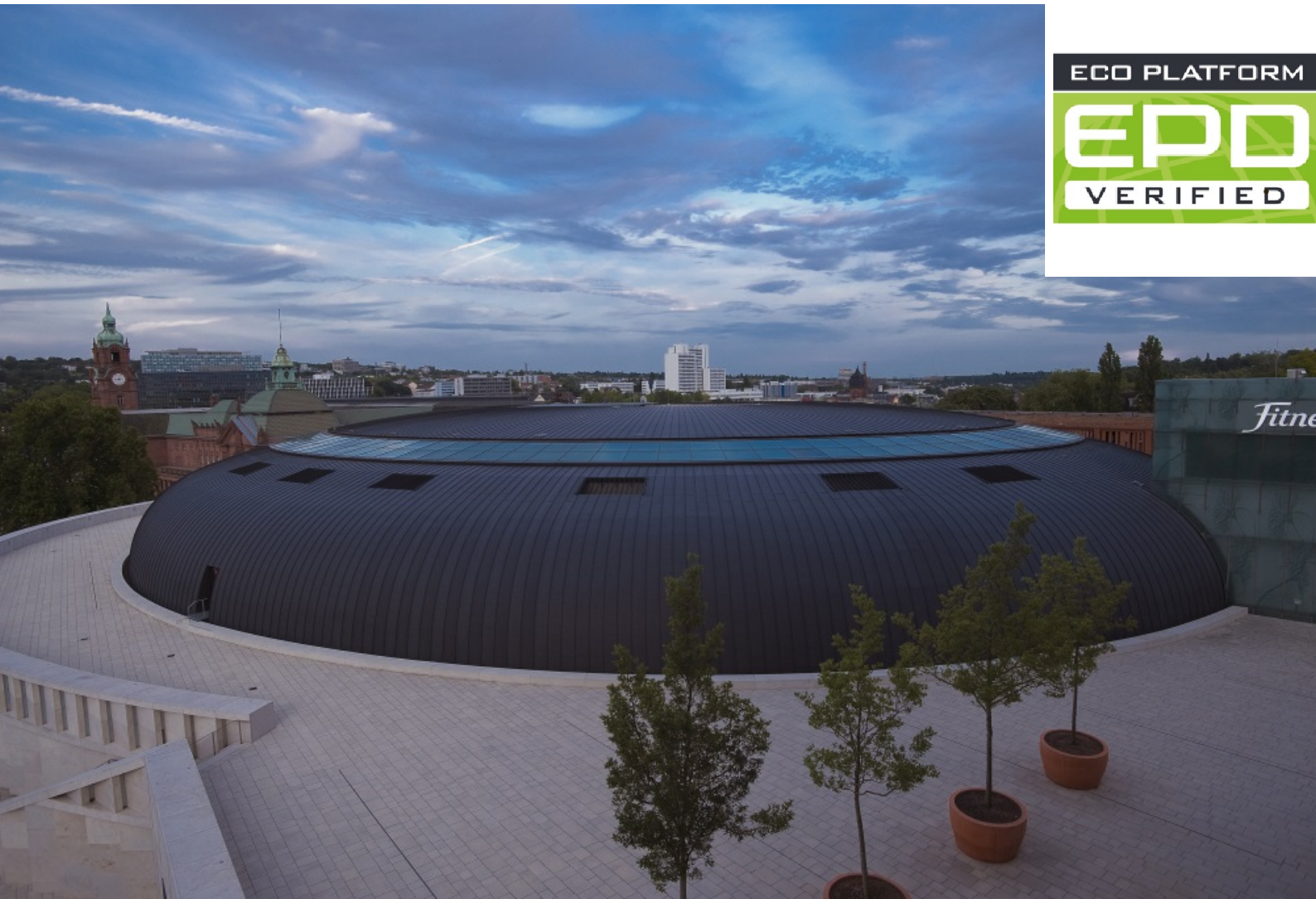


1. General Information

VM BUILDING SOLUTIONS

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-VMZ-20180086-IBD1-EN

This declaration is based on the product category rules:

Building metals, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

15.11.2018

Valid to

14.11.2024

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

VMZinc - Preweathered rolled zinc

Owner of the declaration

VM Building Solutions Deutschland GmbH
Gladbecker StraBe 413
45326 ESSEN
Germany

Declared product / declared unit

1 kg of preweathered rolled zinc – QUARTZ ZINC® and ANTHRA ZINC® from VMZINC

Scope:

This Environmental Product Declaration in accordance with the /EN 15804/ covers the life cycle of 1 kg of preweathered rolled zinc – QUARTZ ZINC® and ANTHRA ZINC® manufactured in the French production plant located in Viviez of the company VM BUILDING SOLUTIONS. The preweathered rolled zinc from VMZINC covered by this EPD can be used in buildings as roof, façade or rainwater systems.
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 EN 15804+A1. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

Dr. Stefan Diederichs,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The product covered by this EPD is 1 kg of preweathered rolled zinc QUARTZ ZINC® and ANTHRA ZINC® in sheets or coils from VMZINC used for building envelope applications (roof, façade or rainwater systems). The preweathered rolled zinc from VMZINC is a copper and titanium zinc alloy in accordance with the /DIN EN 988/, which has received a surface treatment. This alloy contains mainly very high purity zinc in accordance with /DIN EN 1179/ (Grade Z1: 99,995% of purity) with very few alloy components (copper, titanium and aluminium). It has optimal mechanical and physical properties for applications in construction, in particular regarding mechanical resistance and resistance against creep deformation. From an aesthetical point of view, preweathered rolled zinc is less bright and darker than natural rolled zinc.

2.2 Application

The preweathered rolled zinc in sheets and coils is used in numerous building applications:

• Roofing,

• Facade applications,

• Flashings and coverings,

• Roof drainage systems,

• Ornaments under the brand name of "Ateliers d'Art Français'.

2.3 Technical Data

The main constructional data are presented in the following table:

Constructional data

Name	Value	Unit
Coefficient of thermal expansion	22	$10^{-6}K^{-1}$
Tensile strength	152	N/mm^2
Compressive strength	-	N/mm^2
Modulus of elasticity	9000	N/mm^2
Melting point	420	°C
Thermal conductivity	110	W/(mK)
Electrical conductivity at 20°C	17	$\Omega^{-1}m^{-1}$
Density	7200	kg/m^3

Product performance values in line with the /EN 988 Zinc and Zinc Alloys - Requirements of Rolled Flat Products for Use in Construction/.

2.4 Delivery status

Pre-weathered QUARTZ-ZINC® and ANTHRA-ZINC® offer other surface designs than natural rolled zinc. They are produced by immersing the natural rolled zinc by VMZINC® into a solution which changes the metal's crystalline surface structure up to a depth of about 1 µm. This treatment takes place by phosphating and leads to a permanent chemical change of the metal's surface structure.

Right for the start, the QUARTZ ZINC® has a similar look to the natural patina of bright-rolled zinc. ANTHRA ZINC® has a dark grey, anthracite coloured surface.

Ø Dimensions Panels: 1000 x 2000 mm,1000 X 2500 mm, 1000 x 3000 mm;

Ø Coils with following blanks: 200 mm / 250 mm / 280 mm / 333 mm / 400 mm / 500 mm / 600 mm / 670 mm / 1000 mm

Ø Thickness [mm]: 0.5 mm to 1.5 mm

Ø Weight: 3.6 kg/m2 (t=0.65 mm) to 10.8 kg/m2 (t=1.5mm)

2.5 Base materials/Ancillary materials

Name	Value	Unit
Primary zinc (very high purity zinc of 99.995% with limited lead and cadmium contents: grade Z1 according to /DIN EN 1179/)	> 99.835	%
Copper	0.08 to 0.2	%
Titanium	0.07 to 0.12	%
Aluminium	<0.015	%

The composition of preweathered rolled zinc from VMZINC is in accordance with /DIN EN 988/

Consumable materials for the manufacturing of 1 kg of preweathered rolled VMZINC (which does not remain in the composition of the final product):

- 0.86% of acid mixing *

- 0.04% of zinc phosphate

- 0.026% of lubricant

None of the end components included in the final product is included in the candidate list of the /Substances of Very High Concern for authorization/.

**The acid mixing is a mixing composed by nitric, phosphoric and sulphuric acids.*

2.6 Manufacture

The manufacturing of rolled VMZINC takes place in 6 stages:

1. Pre-alloying: An alloy comprising copper, titanium and aluminium is prepared at 650°C in an alloy furnace. This master alloy is put in a second smelting furnace with the refined zinc.

2. Smelting: Refined zinc cathodes and ingots are smelted in the first induction furnace at 500°C and then are put in a second smelting furnace with the master alloy. The finished alloy is fed into the casting furnace. This loads the continuous casting machine at 500°C.

3. Casting and cooling: The molten metal is transferred into a continuous casting machine to harden there into the form of an approx. 12-millimetre-thick and one-metre wide continuous cast strand. The controlled cooling process in the system guarantees a fine, homogenous grain size.

4. Rolling: The cast strand is rolled into the desired thickness in three to five rolling operations. In the course of this process the temperature, rolling speed and degree of reduction are constantly monitored and adapted to achieve the desired mechanical properties and dimensions.

5. Preweathering: Preweathered QUARTZ-ZINC® and ANTHRA-ZINC® are produced from natural rolled VMZINC®

through surface treatment. Preweathering is a continuous, multi-stage surface treatment process consisting of etching, phosphating, rinsing and drying. QUARTZ-ZINC® surface protection is achieved by a film of oil, ANTHRA-ZINC® surface protection is achieved by applying a thin organic coating (transparent).

6. Stretching and cutting: The final stages include stretching and cutting the rolled zinc into sheets and coils into the desired dimensions and weights.

The production plant of Viviez is certified /ISO 9001/ (Quality management).

2.7 Environment and health during manufacturing

The Auby and Viviez production sites are certified in accordance with /ISO 9001/ and /ISO 14001/.

2.8 Product processing/Installation

General principles:

Rolled zinc from VMZINC® must be stored in a dry and ventilated place. This also applies to building site storage as well as for parts stored temporarily at the installation site. Coils are to be stored on pallets, so that moisture cannot penetrate into them (later water stains). Transport may only be carried out by enclosed vehicles. If the surfaces of natural rolled VMZINC are covered with films, make sure that the surfaces are well ventilated. Wet covering films may not come into direct contact with the titanium zinc surfaces to be covered. Rolled zinc from VMZINC which is wet from water may also not be directly covered.

The material is to be processed without tension.

Take into account the expansion coefficient for the installation of the product.

If for compelling reason the rolled zinc from VMZINC work is carried out during the cold time of year, special measures are required with folding which incur additional costs. This must be in accordance with the construction management. With metal temperatures below 10°C and rapid deformation, whole batches have to be warmed up to prevent cracks forming. This particularly applies to connections, for example crimp folds and 180° handling.

Assembly of the rolled zinc from VMZINC with other metals:

Electrolytic corrosion can occur when assembling together with different metals if metal (-part) of the higher potential is arranged above it in the water's flow direction.

With the presence of damp or moisture, damage can occur if the VMZINC system comes into contact with copper or unprotected (no galvanized) steel due to an electrochemical reaction. The direct proximate assembly of copper and rolled zinc from VMZINC components is always to be avoided.

Assembly of rolled zinc from VMZINC with other building materials:

If VMZINC systems are to come into contact with precipitation water from unprotected bituminous roofing, these should be provided with protective coatings, as otherwise you can reckon with so-called "bitumen corrosion".

Detailed processing information as for example types of fixings, deformation and joining techniques can be found in the corresponding information material from VM Building Solutions.

Industrial safety, health and environmental protection measures:

With the processing/installation of VMZINC® products no other health protection measures are required beyond the usual industrial safety measures (like e.g. protective gloves). No significant environmental pollution is triggered by the processing/assembly of the named products. No special measures need to be taken to protect the environment.

Residual materials and packaging:

Any VMZINC® residual materials and packaging on the building site must be collected separately.

Rolled zinc products are 100% recyclable. In Europe there is an extensive network which takes back zinc waste from building sites and recycles this for a huge variety of applications.

2.9 Packaging

The packaging materials used are wooden pallets (transport), cardboard and plastics (films and wires).

All packaging can be recycled if the wastes generated in the building site are well managed.

The /waste keys/ for the main packaging are:

-corrugated board - 15 01 01,

-wood pallets - 15 01 03.

2.10 Condition of use

The behaviour of preweathered rolled zinc exposed to the atmosphere is the same than those of natural rolled zinc: a protective layer called patina occurs naturally. This protective layer ensures absolutely maintenance free of the surfaces of the rolled zinc from VMZINC and is responsible for the rolled zinc from VMZINC's high resistance to corrosion.

In the first stage zinc oxide is formed on the zinc surface. Zinc hydroxide then forms under the influence of moisture (rain). Under the influence of CO_2 from the atmosphere basic zinc carbonate is then formed, which is then the dense, adhesive and water-insoluble protective layer. This very dense and if injured, "self-healing" layer gives lifetime protection and keeps natural wear very low (see section 9.1 Runoff Rates).

2.11 Environment and health during use

Environment

Generally, zinc runoff coming from rolled zinc applications used in building does not create a risk to the environment.

Indeed, zinc is naturally present into the environment and has always been used by living organisms in their growth and development making zinc the third trace elements the most important for human being.

Furthermore, when zinc is released into the environment, a large amount reacts mainly by adsorption with the other components of the environment such as organic matters or oxides (we speak about speciation) leaving a small amount available to living organisms (we speak about bioavailability). Generally, in soil, more than 90% of zinc emitted binds to soil particles, leaving only 10% of the zinc available for living organisms; in water, 70% of zinc emissions are captured into sediments.

This scientific knowledge about zinc behaviour into the environment (speciation and bioavailability) was incorporated into the risk assessment methods used for European regulations.

In all cases, whatever the type of products used in the building, where it is proposed to evacuate rainwater directly into the environment, an environmental impact assessment must be carried out.

Parameters influencing zinc runoff from building products are:

- Sulfur dioxide - SO_2 atmospheric content (the more there is sulfur dioxide the more is zinc runoff rate).

-Chlorides - Cl^{2-} atmospheric content (the more there are chlorides, the more is the runoff rate).

-Slope of the constructive element (the more the slope is high, the less is the zinc runoff rate).

-Surface aspect of rolled zinc.

Zinc concentration into rainwaters, which have passed on building products in rolled zinc:

Corrosion and runoff mechanisms of rolled zinc used in building applications are very well documented. This knowledge allows modelling accurately zinc emissions, which may be obtained as a function of a number of parameters (atmospheric levels of sulfur dioxide and chloride, slop and orientation of the building elements and rolled zinc surface aspect).

Generally speaking, in average after 5 years of exposure under yearly precipitation of rain between 470 and 790 mm/year:

- zinc concentration of rainwater, which has passed on natural rolled zinc roof is around 4 mg/L (2),

- zinc concentration is reduced by 30% with preweathered rolled zinc such as QUARTZ-ZINC® or ANTHRA-ZINC® (2).

The zinc concentration may be even lower if the rainwater has passed on coated rolled zinc such as PIGMENTO®, then zinc concentration is reduced by 95% (3).

Ground seepage:

Due to seepage there can be locally restricted slightly increased zinc concentrations in the ground/ in technical infiltration, like troughs, rigolen systems and absorbing wells. There is no risk of an excess supply of zinc for the soil/plants/animals.

Health

The use stage of the rolled zinc from VMZINC, used in the envelope applications in the building, can't have impacts on the health of the users.

Zinc is an essential element that means it is absolutely necessary for all living organisms.

For human beings, zinc is the 3rd most important.

Oligo-element after magnesium and iron and the WHO recommends zinc daily intakes of 15 mg/day for men and 12 mg/day for women.

2.12 Reference service life

The long experience, which has shown so numerous very old buildings with rolled zinc products still efficient and the deep theoretical knowledge about the behavior of the rolled zinc exposed to the atmosphere lead to announce a service life of 100 years; the standard /ISO 15686/ has not been considered.

2.13 Extraordinary effects

Fire

Fire protection

Name	Value
Building material class	A1

Fire performance:
The VMZINC® products meet the requirements of the building material class A1 "non-flammable" in accordance with the standard /EN 13501-1/.

Water

The effect of floods on zinc coils and sheets does not lead to product change or any other negative consequences for the environment.

Mechanical destruction

None

2.14 Re-use phase

Scrap of 'new' rolled zinc: rolled zinc scrap, from the VMZINC manufacturing process can be fed back completely into the melting in the VMZINC manufacturing process.

Old rolled zinc: the old rolled zinc, dismantled at its end of life during demolition or renovation works in the building site, can be collected to be sold either directly to secondary smelting works or via a scrap metal dealer.

Indeed, due to its high residual value (60 to 75% of the zinc content is remunerated in value) and to a recycling market very well structured, the recycling rate of the rolled zinc products at its end of life is at least 96% in Western Europe.

The old rolled zinc can be recycled to be reused in different applications such as steel galvanizing or zinc oxides manufacturing.

The use of recycled material instead of zinc ore has a positive influence on the sustainability of the natural resources and also on the energy use (significant energy savings from 50 to 90%).

2.15 Disposal

Because of the very high and efficient recycling rate of the rolled zinc products, only 4% of the old rolled zinc from roofing, facade or rainwater systems goes to landfill.

Nevertheless, the /waste key/ for zinc is: 17 04 04.

2.16 Further information

For further information: vmzinc.com

3. LCA: Calculation rules

3.1 Declared Unit

This declaration refers to one kilogramme of preweathered rolled zinc from VMZINC under the trademark QUARTZ-ZINC® and ANTHRA ZINC®.

Declared unit

Name	Value	Unit
Declared unit	1	kg

3.2 System boundary

This declaration is a 'Cradle to Gate' with options. It covers modules A1 to A3, modules C3, C4 and D.

The aggregated module A1-A3 includes:

•The manufacturing and transport of raw materials (Ti, Cu, Zn etc.),

• The manufacturing of the preweathered rolled zinc (QUARTZ ZINC® and ANTHRA ZINC®),

•The manufacturing of the energy resources (electricity, thermal energy, auxiliaries),

• The manufacturing, the transport and the end of life of the packaging (including loads and benefits for electricity and thermal energy),

• The end of life of the process wastes.

Module C3 includes pre-treatment before recycling.

Module C4 corresponds to landfill.

Module D includes re-melting and avoided impacts due to recycling of old rolled zinc.

3.3 Estimates and assumptions

No major estimates or assumptions were necessary for this LCA excepted for recycling rate which has been assumed at 96 % (European recycling rate for rolled zinc).

3.4 Cut-off criteria

All data from the operating data survey, all direct production wastes, all emission measurements available and all transport distances were taken into consideration.

Material and energy flows with a share of less than 1 percent were also taken into consideration.

Only machines, facilities and LPG for engines required at the production plant are neglected.

It can be assumed that the sum of ignored processes may not exceed 5% of the impact categories.

3.5 Background data

The /GaBi 8/ software system on comprehensive analysis developed by PE International GmbH is used for modelling the life cycle for the manufacturing and recycling of the preweathered rolled zinc. All relevant background data records for the manufacturing of zinc are taken from the GaBi 8 software database, specific data related to the production of preweathered rolled zinc were collected in the Viviez VM Building Solutions production plant.

3.6 Data quality

Consistency of the process data and used background data (GaBi) more particularly data related to the production of primary zinc /IZA – SHG LCA/ with the best geographical coverage (worldwide), temporal coverage (2012) and technological (electro-metallurgical and pyro-metallurgical).

3.7 Period under review

The life cycle assessment is based on data collection from Viviez production plants of VM BUILDING SOLUTIONS made in 2012. We considered the data overthe complete year 2012 (nothing has changed since 2012)

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: France

3.9 Allocation

Allocation was avoided as much as possible as required by EN 15804 but allocations had to be done for:

- Production residues and packaging wastes (module A3). Some of the production wastes are fed into incineration processes, landfills or recycling processes. For recycled waste, we chose a conservative approach that does not take into account the benefits and loads.

- Recycling of old rolled zinc at its end of life (module D).

The loads and benefits for the zinc obtained from remelting is calculated on the basis of the data record of primary zinc manufacturing.

3.10 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 data base used involves GaBi data base, version 8.5 and also the IZA 2014 Primary Zinc dataset Thinkstep /IZA – SHG LCA/

4. LCA: Scenarios and additional technical information

Modules A4-A5, B1-B7, and C1-C2 are not considered in this study. The possible loads and benefits given in Module D are based on the recyclability of zinc products. After collection, zinc scrap is re-melted and converted to secondary zinc (third parties). The possible loads and benefits for zinc gained through re-melting is calculated using the dataset of primary zinc production.

Packaging materials for 1 kg of Natural rolled zinc: wood pallets = 0,039kg, kraft paper = 0,006kg, polyethylene film = 0,001kg, polypropylene and steel wire rod = 0,0003kg.

Module A1-A3 have a GWP biogenic carbon = 0,137 kg CO2 eq.

Module A5 (not declared) contains the end of life of the product packaging. The global warming potential is mainly due to the burning of wooden pallets with GWP biogenic carbon = 0,02522 kg CO2 eq. for this step.

The modules C3 includes the mechanical selection of the old

rolled zinc.

The modules C4 includes the landfill of the slight part of the old rolled zinc which is not recovered for being recycled (4%).

After the collection takes place, recycling loads and credits are both addressed in the module D.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE 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	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1 kg Preweathered rolled zinc

Parameter	Unit	A1-A3	C3	C4	D
Global warming potential (GWP)	kg CO_2 eq	2.97E+00	3.74E-03	1.95E-03	-2.25E+00
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	-1.06E-08	2.06E-13	4.71E-15	9.87E-09
Acidification potential of land and water (AP)	kg SO_2 eq	1.67E-02	1.44E-05	5.49E-06	-1.34E-02
Eutrophication potential (EP)	kg PO_4^3 eq	2.64E-03	1.72E-06	6.71E-07	-2.16E-03
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg Ethen eq	9.14E-04	1.17E-06	5.22E-07	-7.04E-04
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	4.42E-04	4.34E-09	1.74E-10	-3.85E-04
Abiotic depletion potential for fossil resources (ADPF)	MJ	2.38E+01	1.01E-01	2.8E-02	-1.56E+01

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1 kg Preweathered rolled zinc

Parameter	Unit	A1-A3	C3	C4	D
Renewable primary energy as energy carrier (PERE)	MJ	1.18E+01	5.38E-02	2.11E-03	-8.94E+00
Renewable primary energy resources as material utilization (PERM)	MJ	0	0	0	0
Total use of renewable primary energy resources (PERT)	MJ	1.18E+01	5.38E-02	2.11E-03	-8.94E+00
Non renewable primary energy as energy carrier (PENRE)	MJ	3.53E+01	4.26E-01	2.91E-02	-2.09E+01
Non renewable primary energy as material utilization (PENRM)	MJ	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	MJ	3.53E+01	4.26E-01	2.91E-02	-2.09E+01
Use of secondary material (SM)	kg	2.56E-03	0	0	9.6E-01
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0
Use of non renewable secondary fuels (NRSF)	MJ	0	0	0	0
Use of net fresh water (FW)	m^3	7.19E-01	1.63E-04	1.23E-07	-6.34E-01

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1 kg Preweathered rolled zinc

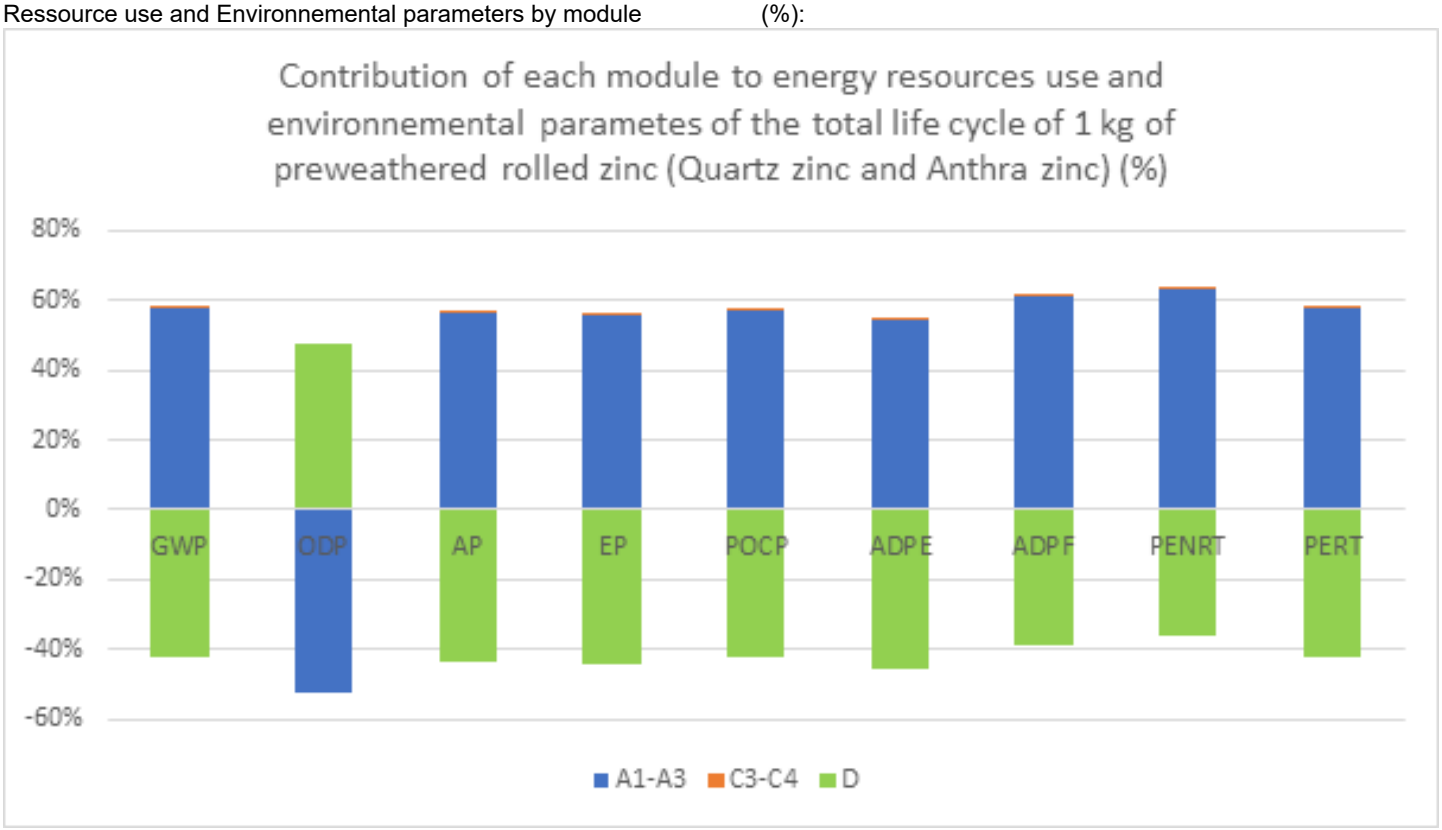
Parameter	Unit	A1-A3	C3	C4	D
Hazardous waste disposed (HWD)	kg	7.59E-04	3.44E-09	3.58E-09	9.72E-03
Non hazardous waste disposed (NHWD)	kg	3.73E-01	9.23E-05	4.02E-02	-1.9E-01
Radioactive waste disposed (RWD)	kg	4.53E-03	1.28E-04	1.28E-04	-2.1E-03
Components for re-use (CRU)	kg	0	0	0	0
Materials for recycling (MFR)	kg	0	9.6E-01	0	0
Materials for energy recovery (MER)	kg	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0

Disclaimer 1 – for the indicator 'Potential Human exposure efficiency relative to U235'. 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 or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators 'abiotic depletion potential for non-fossil resources', 'abiotic depletion potential for fossil resources', 'water (user) deprivation potential, deprivation-weighted water consumption', 'potential comparative toxic unit for ecosystems', 'potential comparative toxic unit for humans – cancerogenic', 'Potential comparative toxic unit for humans - not cancerogenic', 'potential soil quality index'. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

Ressource use and Environnemental parameters by module (%):



Regarding module A1-A3, module A1 itself contributes at 62 % of the total use of non-renewable primary energy resources (**PENRT**) and the module A3 contributes at 37.4 %. For the environmental indicators, module A1contributes between 91 and 99.7% of the environmental indicators.

Regarding the module A1, the production of primary zinc (SHG zinc) contributes between 98% and 99,9% of the energy resources use and the environmental indicators.

Regarding the module A3, the 2 main steps contributing to the environmental indicators are the 'Melting to rolling' step and the 'Preweathering' step.

'Melting to rolling' step is one of the main contributors to environmental indicators due to the module A3 at:

- 30,4 % of the POCP,

- 41.7% of the GWP,

- 52.5% of the EP,

- 42.2% of the AP,

- 37.1 % of the ADPF

The other step contributing more particularly to environmental impacts of module A3 is the 'Preweathering' step; it contributes at:

- 91.2 % of the ADPE,

- 67,9 % of the ODP,

- 41.7 % of the POCP

The negative value of the **ODP** (Ozone depletion potential) is due to the Special high-grade zinc IZA (IZA dataset). In this dataset, the scope of the Life Cycle Inventory of primary zinc production extends to the costs and benefits associated with the generation of co-products such as sulfuric acid and more specifically silver and incineration with energy recovery of certain wastes (in line with the principle of extending the system boundaries). This is why the "ozone depletion" indicator has negative values in the aggregated A1-A3 module.

Regarding the module D, it is interesting to note the significant environmental benefits due to the recycling of the old rolled zinc at its end of life.

7. Requisite evidence

Runoff rate evidences:

Experimental setup**:** Duration 1 year (June 1998 to June 1999), in Stockholm, Sweden, titanium zinc sheet 0.7 mm thick in surface qualities VMZINC® bright-rolled and pre-weathered QUARTZ-ZINC® and ANTHRA-ZINC®, inclination of roof = 45°, roof surface direction south facing.

Measuring agency**:** Royal Institute of Technology, Department of Materials Science and Engineering, Division of Corrosion Science – Stockholm in Sweden

Report of results**:** 'Atmospheric corrosion of zinc-based materials: runoff rates, chemical speciation and ecotoxicity effects' – I.Odenevall Wallinder, C.Leygraf, C.Karlen, D.Heijerick and C.R.Janssen – Corrosion Science n°43 – pp 809-816 - 2001

Result:

As part of this study annual runoff rates were taken from bright-rolled VMZINC® and pre-weathered QUARTZ-ZINC® and ANTHRA-ZINC®(other zinc-based construction materials were part of this study).

The average annual SO_2 concentration at the measuring agency was 3 µg/m^3, the total amount of precipitation during the experiment was 540 mm.

The runoff rates of pre-weathered QUARTZ-ZINC® and ANTHRA-ZINC® is less than: 1.3 g/m2/year.

8. References

/DIN EN ISO 14001/
2009-11, Environmental Management Systems **-** Requirements and Instructions for Application (ISO 14001:2004 + Cor. 1:2009); German and English version EN ISO 14001:2004 + AC:2009

/ISO 9001/
ISO 9001:2015, Quality management

/waste keys/
Regulatory classification of waste Application guide for characterization in danger - 2016 -INERIS

/GaBi 8/
GaBi ts. Software and data basis for Life Cycle Engineering. LBP, University of Stuttgart und PE International, 2017

/**DIN EN ISO 14040**/ 2006-10, Environment Management – Ecological Analysis – Basic Principles and Framework Conditions (ISO 14040:2006); German and English versions EN ISO 14040:2006

/DIN EN ISO 14044/
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