ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	VM Building Solutions
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-VMZ-20240065-IBD1-EN
Issue date	30/01/2025
Valid to	29/01/2030

Natural rolled zinc - VMZINC®

VM BUILDING SOLUTIONS

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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-20240065-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

30/01/2025

Valid to

29/01/2030

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

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

Natural rolled zinc - VMZINC®

Owner of the declaration

VM Building Solutions
place Aimé Césaire 3
93100 Montreuil
France

Declared product / declared unit

1 kg of natural rolled zinc – Natural from VMZINC

Scope:

This Environmental Product Declaration in accordance with *EN 15804* covers the life cycle of 1 kg of natural rolled zinc – Blank-Zinc manufactured on the productions plant of VM BUILDING SOLUTIONS (Auby and Viviez - France) representing the average production for 1 year. This EPD covers the natural rolled zinc from VMZINC only. The natural 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+A2. 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.-Ing. Nikolay Minkov,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The product covered by this EPD is 1 kg of natural rolled zinc in sheets or coils from VMZINC used for building envelope applications (roof, façade or rainwater systems). The natural rolled zinc from VMZINC is a copper and titanium zinc alloy inaccordance with the *EN 988*. This alloy contains mainlyvery high purity zinc in accordance with *EN 1179* (GradeZ1: 99,995% of purity) with very few alloy components (copper,titanium and aluminium). This alloy has optimal mechanical andphysical properties for applications in construction, in particularregarding mechanical resistance and resistance against creep deformation.
For the placing on the market of the product in theEuropean Union/European Free Trade Association (EU/EFTA)(with the exception of Switzerland) Regulation (EU) No.305/2011 (CPR) applies. The product needs a Declaration of Performance taking into consideration *EN 14782:2006*, Selfsupporting metal sheet for roofing, external cladding andinternal lining, or *EN 14783:2013*, Fully supported metal sheetand strip for roofing, external cladding and internal lining, andthe CE-marking.For the application and use the respective national provisionsapply.

2.2 Application

The natural rolled zinc in sheets and coils is used in numerous building applications:
- roof and façade cladding (CE-marked based on *EN14782:2006*, Self-supporting metal sheetfor roofing, external cladding and internal liningor *EN14783:2013*, Fully supported metal sheet andstrip for roofing, external cladding and internal lining)
- interior use
- roof drainage systems (gutters, downpipes andaccessories according to *EN612*)
- Flashings, coverings,
- roof drainage systems (gutters, downpipes andaccessories according to *EN612*)
- Ornaments under the brand name of "Ateliers d'ArtFrançais'.

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
Electrical conductivity at 20°C	17	$\Omega^{-1}m^{-1}$
Compressive strength	-	N/mm^2
Modulus of elasticity	9000	N/mm^2
Melting point	420	°C
Thermal conductivity	110	W/(mK)
Density	7200	kg/m^3

Product performance values in line with the *EN 988*.

Required testing standards are described in *EN 988*. Performance data of the product in accordance withthe declaration of performance with respect to itsessential characteristics according to *EN 14782* and *EN 14783* respectively.

2.4 Delivery status

Natural rolled VMZINC is an untreated zinc alloy with copper and titanium in accordance with *EN 988* without any changesto the surface.When the natural rolled VMZINC leaves therolling mill, it has a metallic shiny surface, whose look changesover time due to atmospheric influences. It forms a natural, mattlight grey patina.

ØDimensions: Panels: 1000 x 2000 mm, 1000 x 2500 mm,1000 x 3000 mm;
ØCoils with following blanks: 200 mm / 250 mm / 280 mm / 333mm / 400 mm / 500 mm / 600 mm / 670 mm / 1000 mm
ØThickness [mm]: 0.5 mm to 1.5 mm
ØWeight: 3.6 kg/m2 (t=0.5 mm) to 10.8 kg/m2 (t=1.5mm)

2.5 Base materials/Ancillary materials

The composition of natural rolled zinc from VMZINC

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	%

VMZINC® is an alloy of zinc with small amounts of copper and titanium. No compound of the alloy >0.1% is listed in the 'Candidate List of Substances of Very High Concern for Authorisation' (SVHC) dated 01/2018. The product does not contain any substances with carcinogenic, mutagenic, reprotoxic (CMR) properties > 0.1%. VMZINC products do not contain biocide properties as defined by the (EU) Ordinance on Biocide Products No. 528/2012).

0.057% of lubricant is used for the manufacturing of 1 kg of Natural rolled VMZINC.

2.6 Manufacture

The manufacturing of rolled VMZINC takes place in 5 stages (same for both site) :

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

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

3.Casting and cooling: The molten metal is transferred into acontinuous casting machine to harden there into the form of anapprox. 12-millimetre-thick and one metre wide continuous caststrand. The controlled cooling process in the systemguarantees a fine, homogenous grain size.

4.Rolling: The cast strand is rolled into the desired thickness inthree to five rolling operations. In the course of this process thetemperature, rolling speed and degree of reduction areconstantly monitored and adapted to achieve the desiredmechanical properties and dimensions.

5. Stretching and cutting: The final stages include stretchingand cutting the rolled zinc into sheets and coils into the desireddimensions and weights.

The two production plants where natural rolled zinc is producedare certified *ISO 9001* (Quality management control).

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:
Natural rolled VMZINC® must be stored in a dry and ventilatedplace. This also applies to building site storage as well as forparts stored temporarily at the installation site. Coils are to bestored on pallets, so that moisture cannot penetrate into them(later water stains). Transport may only be carried out byenclosed vehicles. If the surfaces of natural rolled VMZINC arecovered with films, make sure that the surfaces are wellventilated. Wet covering films may not come into direct contactwith the titanium zinc surfaces to be covered. Natural rolledVMZINC which is wet from water may also not be directlycovered.

The material is to be processed without tension.

Take into account the coefficient expansion during theinstallation.

If for compelling reason the natural rolled VMZINC work iscarried out during the cold time of year, special measures arerequired with folding which incur additional costs. This must bein accordance with the construction management. With metaltemperatures below 10°C and rapid deformation, wholebatches have to be warmed up to prevent cracks forming. Thisparticularly applies to connections, for example crimp folds and 180° handling.

Assembly of the natural rolled VMZINC with other metals:Electrolytic corrosion can occur when assembling together withdifferent metals if the metal (-part) of the higher potential isarranged above it in the water's flow direction.With the presence of damp or moisture, damage can occur ifthe VMZINC system comes into contact with copper orunprotected (no galvanized) steel due to an electrochemicalreaction. The direct proximate assembly of copper and naturalrolled VMZINC components is always to be avoided.

Assembly of natural rolled VMZINC with other buildingmaterials:If VMZINC systems are to come into contact with precipitationwater from unprotected bituminous roofing, these should beprovided with protective coatings, as otherwise you can reckonwith so-called "bitumen corrosion".Detailed processing information as for example types of fixings,deformation and joining techniques can be found in thecorresponding information material from VM Building Solutions.

Safety, health and environment protection measures:With the processing/installation of VMZINC® products no otherhealth protection measures are required beyond the usualindustrial safety measures (like e.g. protective gloves). Nosignificant environmental pollution is triggered by theprocessing/assembly of the named products. No specialmeasures need to be taken to protect the environment.

Residual materials and packaging:
Any VMZINC® residual materials and packaging on thebuilding site must be collected separately.Rolled zinc products are 100% recyclable. In Europe there is anextensive network which takes back zinc waste from buildingsites and recycles this for a huge variety of applications.

Installation includes:
Fastening accessories for the installation of the roofing, façade, or rainwater drainage system (fastening brackets, screws, etc.). In the case of installing gutters , tin-lead or tin/zinc alloy is required for their soldering.
The energy required for the installation of the roofing, façade, or rainwater drainage system (electrical energy for screwing, crimping, etc., and gas energy for heating the soldering iron).

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 thebuilding site are well managed.The waste keys for the main packaging are:
-corrugatedboard - 15 01 01,
-wood pallets - 15 01 03.

2.10 Condition of use

The colour tone of the natural rolled VMZINC is due to the protective layer, which naturally occurs in the atmosphere(patina). This protective layer ensures absolutely maintenancefree of the surfaces of the natural rolled VMZINC and is responsible for the natural rolled VMZINC's high resistance tocorrosion.
In the first stage zinc oxide is formed on the zinc surface. Zinchydroxide then forms under the influence of moisture (rain).Under the influence of CO2 interrelations from the atmospherebasic zinc carbonate is then formed, which is the dense,adhesive and water-insoluble protective layer. The initiallybright silvery outside of the natural rolled zinc changes into amatt, grey-blue patina thanks to this protective layer. This verydense and if injured, "self-healing" layer gives lifetimeprotection and keeps natural wear very low (see section 9.1Runoff Rates).

2.11 Environment and health during use

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

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

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 in 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 the runoff rate).

-Slope of the constructive element (the more the slope is high, the less 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, on average after 5 years of exposure to a 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).

So generally, in all cases, zinc concentration is lower than the drinkable threshold equal to 5 mg/L when this regulatory threshold exists (4) because in numerous countries, there is not drinkable threshold for zinc like at the European level (because zinc is not an issue).

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.

- Sulfur dioxide - SO2 atmospheric content (the more there is sulfur dioxide, the more zinc runoff rate).

-Chlorides - Cl2- atmospheric content (the more there are chlorides, the more the runoff rate).

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

-Surface aspect of rolled zinc.
For human beings, zinc is the 3rd most important
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, on average after 5 years of exposure to a 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).

Generally, in all cases, the zinc concentration is below the 5 mg/L drinking water threshold where such a regulatory limit exists (e.g., in France). However, in many countries, there is no drinking water threshold for zinc, as it is not considered a concern, unlike in Europe where a specific threshold is established.

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 an impact on the health of the users.

During installation, use and disassembly no health safety threshold is crossed.

2.12 Reference service life

Service lifetime according to BBSR (the Federal Office for Building and Regional Planning): > 50 years, The long experience, which has shown numerous very old buildings with rolled zinc products still efficient and the deep theoretical knowledge about the behaviour of rolled zinc exposed to the atmosphere lead to announce a service life of 100 years; the standard *ISO 15686* has not been considered. Description of the influences on the ageing of the product whenapplied in accordance with the rules of technology.

2.13 Extraordinary effects

Fire
The Natural rolled zinc VMZINC® meet the requirements of the building material class A1 "non-flammable" in accordance with the standard *EN 13501-1*.

Fire protection

Name	Value
Building material class	A1

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

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 oxide manufacturing.

The use of recycled material instead of zinc ore has a positive influence on the sustainability of 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 5% 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

The declared unit is 1 kg of natural rolled zinc – Natural from VMZINC

Declared unit

Name	Value	Unit
Declared unit	1	kg

This declaration refers to one kilogramme of natural rolled zinc under the trademark VMZINC.

3.2 System boundary

This declaration is a 'Cradle to Gate' with options. It covers modules A1 to A3, modules C1, C2, C3, C4 and modules D.

The aggregated modules A1-A3 includes:

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

•The manufacturing of the natural rolled 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 C1 corresponds to the De-construction. The dismantling of zinc laminated roofing and facade systems is done manually.

Module C2 corresponds to the transport to module C4.

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 95% (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 (liquefied propane gas) 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 *LCA for Experts* (new version of Gabi) software system on comprehensive analysis developed by Sphera is used for modelling the life cycle for the manufacturing and recycling of natural rolled zinc. All relevant background data records for the manufacturing of zinc are taken from the *LCA for Experts* software database, specific data related to the production of natural rolled zinc were collected in the VM Building Solutions production plants.

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 (2022) and technological. The data set covers all relevant process steps / technologies over the supply chain of the represented cradle to gate inventory with a good overall data quality. The inventory is mainly based on industry data and is completed, where necessary, by secondary data. This data set is based on primary data from internationally adopted production processes, connected with regional precursor chains.

3.7 Period under review

The life cycle assessment is based on data collection from Auby and Viviez production plants of VM BUILDING SOLUTIONS made in 2019. We considered the data overthe complete year 2019 (nothing has changed since 2019).

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:

- Emissions into the water. Emissions into the water are due not only to effluents coming from industrial process of manufacturing of the rolled zinc but also to rainwater coming from the site of soil remediation located near the factory, some allocations have been made for these emissions into the water.

- 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. As a general rule, a comparison or evaluation of EPD data is only possible when all of the data records to be compared have been drawn up in accordance with EN 15804 and the building context and/or product-specific performance characteristics are taken into consideration. The data base used involves GaBi data base, version 10.7.1.28 and also the *IZA 2022 Primary Zinc dataset SPHERA IZA – SHG LCA*

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The total mass of biogenic carbon-containing materials, in this case, cardboard and wooden pallets, is less than 5% of the total mass of the product and accompanying packaging.

Information on describing the biogenic carbon content at factory gate

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	0.086	kg C

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

Modules A4-A5 and B1-B7 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 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.

The C1 module has no declared activity.

Module C2 includes the transport of materials from the demolition/dismantling site to the waste processing site. We assume that 5% of the material is transported to the landfill over a distance of 50 km by truck, and 95% of the material is transported over a distance of 500 km by truck to the recycling center.

The module C3 includes the mechanical selection of the old rolled zinc.

The module C4 includes the landfill of the slight part of the old rolled zinc which is not recovered for being recycled (5%).

After the collection takes place, recycling loads and credits are both addressed in module D.
Service lifetime according to BBSR (the Federal Office for Building and Regional Planning): > 50 years, The long experience, which has shown numerous very old buildings with rolled zinc products still efficient and the deep theoretical knowledge about the behaviour of rolled zinc exposed to the atmosphere lead to announce a service life of 100 years; the standard *ISO 15686* has not been considered.

End of life (C1 - C4)

Name	Value	Unit
Recycling	0.95	kg
Landfilling	0.05	kg

5. LCA: Results

The following Figure shows the relative contribution of the production stages (Module A1-A3), waste treatment (Module C2, C3, C4) and the benefits and loads beyond the product system boundary (Module D) for 1 kg of Natural rolled zinc. The production of the high-grade zinc is the dominating contributor to all indicators of the impact assessment (73%-100%) as main rawmaterial.

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

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg of Natural rolled zinc

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Global Warming Potential total (GWP-total)	kg CO_2 eq	3.8E+00	0	3.86E-02	2.82E-01	2.31E-03	-3.3E+00
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq	3.77E+00	0	3.89E-02	2.83E-01	2.34E-03	-3.3E+00
Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq	2.45E-02	0	-5.81E-04	-9.17E-04	-2.89E-05	-1.16E-03
Global Warming Potential luluc (GWP-luluc)	kg CO_2 eq	1.51E-03	0	3.63E-04	4.28E-05	2.38E-06	-1.23E-03
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	6.12E-11	0	3.43E-15	5.37E-11	3.86E-15	-1.22E-11
Acidification potential of land and water (AP)	mol H^+ eq	2.4E-02	0	3.27E-04	1.23E-03	7.5E-06	-2.17E-02
Eutrophication potential aquatic freshwater (EP-freshwater)	kg P eq	5.11E-06	0	1.43E-07	3.4E-07	2.12E-09	-3.84E-06
Eutrophication potential aquatic marine (EP-marine)	kg N eq	4.5E-03	0	1.63E-04	3.98E-04	1.88E-06	-4.01E-03
Eutrophication potential terrestrial (EP-terrestrial)	mol N eq	4.85E-02	0	1.81E-03	4.3E-03	2.07E-05	-4.32E-02
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC eq	1.23E-02	0	3.06E-04	1.2E-03	5.9E-06	-1.1E-02
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	1.33E-03	0	2.55E-09	2E-08	6.4E-11	-1.23E-03
Abiotic depletion potential for fossil resources (ADPF)	MJ	4.79E+01	0	5.33E-01	4.17E+00	3.49E-02	-3.9E+01
Water use (WDP)	m^3 world eq deprived	1.16E+00	0	4.52E-04	3.15E-02	-3.18E-05	-1.05E+00

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg of Natural rolled zinc

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Renewable primary energy as energy carrier (PERE)	MJ	1.64E+01	0	3.78E-02	3.33E-01	3.14E-03	-1.41E+01
Renewable primary energy resources as material utilization (PERM)	MJ	0	0	0	0	0	0
Total use of renewable primary energy resources (PERT)	MJ	1.64E+01	0	3.78E-02	3.33E-01	3.14E-03	-1.41E+01
Non renewable primary energy as energy carrier (PENRE)	MJ	4.81E+01	0	5.35E-01	4.17E+00	3.5E-02	-3.92E+01
Non renewable primary energy as material utilization (PENRM)	MJ	0	0	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	MJ	4.81E+01	0	5.35E-01	4.17E+00	3.5E-02	-3.92E+01
Use of secondary material (SM)	kg	2.28E-03	0	0	0	0	0
Use of renewable secondary fuels (RSF)	MJ	1.69E-25	0	0	0	0	0
Use of non renewable secondary fuels (NRSF)	MJ	1.99E-24	0	0	0	0	0
Use of net fresh water (FW)	m^3	3.63E-02	0	4.16E-05	8.49E-04	3.94E-07	-3.05E-02

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 kg of Natural rolled zinc

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	1.73E-04	0	1.98E-12	9.62E-03	2.89E-12	1.33E-04
Non hazardous waste disposed (NHWD)	kg	1.86E+00	0	7.71E-05	1.13E-01	5.01E-02	-1.62E+00
Radioactive waste disposed (RWD)	kg	3.36E-03	0	6.92E-07	2.49E-04	4.06E-07	-2.16E-03
Components for re-use (CRU)	kg	0	0	0	0	0	9.65E-01
Materials for recycling (MFR)	kg	1.35E-02	0	0	0	0	0
Materials for energy recovery (MER)	kg	0	0	0	0	0	0
Exported electrical energy (EEE)	MJ	3.11E-02	0	0	0	0	0
Exported thermal energy (EET)	MJ	5.6E-02	0	0	0	0	0

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 kg of Natural rolled zinc

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Incidence of disease due to PM emissions (PM)	Disease incidence	2.99E-07	0	2.14E-09	3.81E-08	8.09E-11	-2.57E-07
Human exposure efficiency relative to U235 (IR)	kBq U235 eq	4.85E-01	0	9.98E-05	1.67E-01	6.01E-05	-2.11E-01

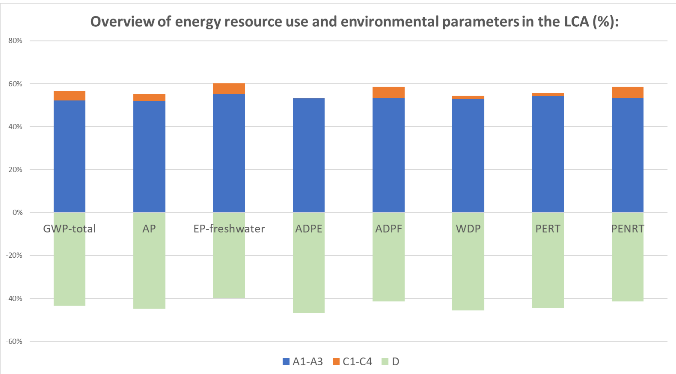
Comparative toxic unit for ecosystems (ETP-fw)	CTUe	5.87E+00	0	3.76E-01	1.13E+00	1.04E-02	-4.64E+00
Comparative toxic unit for humans (carcinogenic) (HTP-c)	CTUh	1.99E-09	0	7.62E-12	1.38E-08	1.23E-12	-1.5E-09
Comparative toxic unit for humans (noncarcinogenic) (HTP-nc)	CTUh	1.59E-07	0	3.35E-10	1.63E-06	1.17E-10	-1.14E-07
Soil quality index (SQP)	SQP	1.44E+01	0	2.23E-01	1.63E-01	3.26E-03	-1.22E+01

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

The following figure shows the relative contribution of the production stages (Module A1-A3), waste treatment (Module, C1, C2, C3 and C4) and the benefits and loads beyond the product system boundary (Module D).



The main module of the aggregated module A1-A3 contributing to the environmental and energy resources use indicator is the module A1 between 88% and 100% depending on the indicators.

Regarding the module A1, the main contributor is the production of primary zinc (SHG zinc) which contributes to 99% of the energy resources uses and 98,4% of the environmental indicators.

Regarding the module A3, the main step contributing to the environmental impacts is the 'Melting to rolling' step, which contributes more than 70% to the **GWP, AP, EP, ADPF** and **ADPE** due to the production of electricity and thermal energy consumed at this step of the process.

Regarding 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 Natural 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 bright-rolled VMZINC® is the following: 2.3 g/m^2/year.

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