ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	KME Germany GmbH & Co. KG
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-KME-20190040-IBA1-EN
Issue date	20.05.2019
Valid to	19.05.2024

TECU® Oxid copper sheets and strips

KME Germany GmbH & Co. KG

Institut Bauen und Umwelt e.V.

www.ibu-epd.com / https://epd-online.com

1. General Information

KME Germany GmbH & Co. KG	TECU® Oxid
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the declaration** KME Germany GmbH & Co. KG Klosterstraße 29 49074 Osnabrück Deutschland
Declaration number EPD-KME-20190040-IBA1-EN	**Declared product / declared unit** Sheets made of copper. The declared functional unit is 1 kg of copper sheets, preoxidized.
This declaration is based on the product category rules: Building metals, 07.2014 (PCR checked and approved by the SVR)	**Scope:** This document refers to TECU® Oxid copper sheets produced by KME Germany GmbH & Co. KG in Osnabrück, Germany. The declared unit is 1 kg copper sheet, preoxidized. The data for the production of the declared product was collected on a plant-specific basis with current annual data from 2017. The declarant is responsible for the underlying data and their verification. 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.
Issue date 20.05.2019	
Valid to 19.05.2024	
	Verification The standard /EN 15804/ serves as the core PCR Independent verification of the declaration and data according to /ISO 14025:2010/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dr. Alexander Röder (Managing Director IBU)	Dr.-Ing. Wolfram Trinius (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

The material TECU® Oxid consists of 100 % by mass of CU-DHP according to /DIN EN 1172/, i.e. oxygen-free Phosphorus-deoxidized copper with limited residual phosphorus content. The material designation is Cu-DHP CW024A.
The inital lustrous, darkly preoxidized copper surface develops through weathering to a dull dark anthracite-brown surface and a green patina, on inclined surfaces.

For the placing on the market of the product in the European Union/European FreeTrade Association (with the exception of Switzerlad) /Regulation (EU) No. 305/2011 Construction Product Regulation (CPR)/ applies. The product needs a declaration of performance taking into consideration /EN 14783:2013/, Fully supported metal sheet and strip for roofing, external cladding and internal lining - Product specification and requirements; and the CE- marking.

2.2 Application

TECU® Oxid sheets and strips are used for roofing, wall cladding and roof drainage systems (roof gutters, pipes and equipment).

2.3 Technical Data

The following technical data and standards apply for TECU® Oxid:
/DIN EN ISO 6507-1:2005/, /DIN EN ISO 6507-2:2005/, /DIN EN ISO 6892-1:2009/, /ISO 1811-2:1988-10/, /ISO 4739-1985-05/.

Constructional data

Name	Value	Unit
Coefficient of thermal expansion	0.017	$10^{-6}K^{-1}$
Tensile strength	240 - 285	N/mm²
Yield strenght	180 - 230	N/mm²
Modulus of elasticity at 20°C	132	N/mm²
Melting point	1083	°C
Thermal conductivity	293 - 364	W/(mK)
Electrical conductivity at 20°C	42 - 52	$\Omega^{-1}m^{-1}$
Density	8930	kg/m³

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to:

/DIN EN 504:2000/ Roofing products from metal sheet - Specification for fully supported roofing products from copper sheet;
/DIN EN 506:2009/ Roofing products of metal sheet - Specification for self-supporting products of copper or zinc sheet;
/DIN EN 612:2005/ Eaves gutters with bead stiffened fronts and rainwater pipes with seamed joints made of metal sheet;
/DIN EN 1172:2012/ Copper and copper alloys - Sheet and strip for building purposes;
/DIN EN 1462:2004/ Brackets for eaves gutters - Requirements and testing;
/DIN EN 1652:1998/ Copper and copper alloys - Plate, sheet, strip and circles for general purposes;
/DIN EN 1976:2013/ Copper and copper alloys - Cast unwrought copper products;
/DIN EN 12166:2016/ Copper and copper alloys - Wire for general purposes; (not part of CE-marking)
/DIN EN 14783:2013/ Fully supported metal sheet and strip for roofing, external cladding and internal lining - Product specification and requirements.

2.4 Delivery status

TECU® Oxid sheets and strips are delivered in the following dimensions:

- Thickness 0.5 – 1.5 mm
- Width 500 – 1250 mm
- Ring - inside -Ø for big coil 500 mm, 600 mm
- Standard sheet length 2000 mm, 3000 mm

2.5 Base materials / Ancillary materials

The material TECU® Oxid consists of 100 % by mass of CU-DHP according to /DIN EN 1172/, i.e. oxygen-free Phosphorus-deoxidized copper with limited residual phosphorus content. The purity is in 99.90 % copper. Only internal and external scrap is used for TECU® Oxid. Copper in cathode form is not used.

Additives:

- Rolling oil-emulsion: 0.544 g/kg Cu highly refined mineral oil, organic esters, polyhydrocarbons, antioxidants which are used for cooling or lubrication during the rolling process. The rolling oil emulsion is biological degradable.
- Benzotriazole: 0.000642 mg/kg Cu is used to temporarily protect the metal. It does not enter the wastewater during production.
- Oxidation: The copper strips are cleansed of rolling oils and emulsion in a de-greasing process. In the subsequent electrochemical process step, a two-stage oxidation process takes place.

2.6 Manufacture

TECU® Oxid manufacturing process consists of 10 steps:

Pouring
The highly pure Cu-DHP is poured into slabs, i.e. extruded blocks.

Warming up
The slabs are heated in a furnace to a hot-roll temperature of approx. 900°C.

Hot-rolling
On a roll stand with a top and bottom rolls (Reversier duo) the slabs are rolled down in several passes i.e. the thickness is reduced by decreasing the gap between the rolls. Afterwards it is wound up into a coil at the end.

Milling
Due to the thermal oxidation and high temperatures during warming up and hot-rolling, a scale layer develops on the surface of the copper, which is removed by milling before further steps. In this process, few tenths of millimetres are removed from each side.

Cold pre-rolling
On a reverse quartet (four-high rolling mill stand), the TECU® copper strips are rolled down with more passes, during which they solidify by forming.

Intermediate annealing
For further processing, a heat treatment is carried out by intermediate annealing, which causes a targeted softening of the copper. This process is carried out in a protected atmosphere to prevent a renewed thermal oxidation of the surface.

Finish rolling
The final thickness of TECU® Oxid is achieved at 0,6 mm - 0,7 mm. The desired strength of R240 semi-hard is achieved in the stability or condition rolling process.

Surface finishing/ Oxidation
In a two-stage electrochemical process, an oxide layer on both sides is not created artificially, but out of the copper.

Stretch straightening
On a stretch straightening unit, the tolerances with regard to straightness and flatness is further reduced.

Packaging
By guillotine shearing, the large coils are splitted into small coils and sheets. Then the TECU® Oxid products are packed.

2.7 Environment and health during manufacturing

Air: Through appropriate emission control measures (filter systems), the process air is cleaned below the limits of /Technische Anleitung zur Reinhaltung der Luft (TA Luft)/.

Water/soil: No additional impact on water or soil occurs. The cooling of the casting process is based on a closed water circuit. The wastewater produced by the pickling plant is cleaned in a neutralisation plant and discharged into the city sewage system, after daily analysis and provision of retention samples.

Noise: Due to adequate acoustical absorption devices, measurements of sound levels have shown that all values inside and outside the production plant are far below the limits required by public law.

Throughout the manufacturing process, additional measures for health safety - exceeding the legal measures for occupational safety for business enterprises - are not required.
At the location of manufacturing the EHQS management system (environment, industrial safety and health protection, energy, quality) is implemented and therefore the following certification exist:

- /ISO 9001/ (quality management)
- /ISO TS 16494/ (additional QM requirement for automotive sectors)
- /ISO 14001:2001/ (environmental protection)
- /OHSAS 18001:2007/ (industrial safety and health protection)
- /ISO 50000:2011/ (energy management)

2.8 Product processing/Installation

During storage and transport protect packages from moisture. Store dry, in original packaging and at room temperature.
If the temperature is below zero, first warm the packages to room temperature before opening. Note the tension-free installation of TECU® Oxid sheets and strips.
During installation and processing, the temperature related changes in length of the material must be taken into account.
Processing limit temperatures: none (recrystallization limit 180 ° C).
Detailed information on working with the material, such as blending and joining techniques, must be observed under instruction information documents of KME Germany GmbH & Co. KG.

2.9 Packaging

KME Germany GmbH & Co. KG uses the following packaging materials:

- taut ribbon: PP/Polyeser
- disposable/ reuseable pallet, wood
- cardboard boxes, cardboard/ paper
- plastic foil (polyethylene foil (LDPE)

Transport, packaging and storage of TECU® Oxid do not exceed the requirements of normal care.
Mechanical damage and scratches to the surface should be avoided. TECU® Oxid sheets and strips must be transported in original packaging units and stored in a dry place. After removal of individual sheets from packaging unit, they must be resealed immediately.
Detailed instructions on transport, packaging and storage should be observed in the KME instruction documents. The wooden pallets can be reused. For disposable packaging materials, there is the possibility of thermal utilization.

2.10 Condition of use

The inital lustrous, darkly preoxidized copper surface develops, depending on the building geometry and the local climate, through weathering to a dull dark anthracite-brown surface and a green patina, on inclined surfaces.

2.11 Environment and health during use

By processing/ installation of the product, no environmental pollution is triggered. Special measures to protect the environment are not necessary.

2.12 Reference service life

TECU® Oxid is UV-resistant and does not rot. It is resistant to defrost water (hot water corrosion), to rust film and to most of the chemical substances used in building construction.
As the rain begins, copper can be washed away in soluble or insoluble form. In the case of TECU® Oxid, the rates of copper elutriation under atmospheric weathering is approx. 0.7 g/m² a and 1,3 g/m² a. This results in a lifespan for copper roof claddings of > 250 years.

Based on the useful lives of building components according to the Sustainable Building Assessment System /BBSR-Table 2017/, Service Lives of components for life cycle assessment according to Assessment System for Sustainable Building (BNB), the reference service life exceeds 50 years.

2.13 Extraordinary effects

Fire

The declared TECU® Oxid sheets and strips correspond to building material class A1, according to /DIN 4102-1/. The fire behavior is: "not flammable / no contribution to the fire."

Fire protection

Name	Value
Building material class	A1
Burning droplets	-
Smoke gas development	-

Water

In addition to the natural geological copper content of the water, diffuse anthropogenic sources provide an additional contribution. The discharge of TECU® Oxid rainwater into flowing waters does not exceed the general water quality requirements.
In waters, copper is stored in sediment. The water of natural waters dissolves only as much copper as is needed by the aquatic organisms, as long as enough copper is present. A natural balance is created. The key factor is the binding form of copper, which determines the bioavailability.

Mechanical destruction

There are no relevant environmental impacts associated with mechanical destruction.

2.14 Re-use phase

Scrap resulting from the production, processing and dismantling of TECU® Oxid are completely returned to the production process.
On the construction site arising remains and old scrap is collected and sent either directly or via the scrap metal trade to secondary smelting companies. The return rate of this construction scrap is almost 100%.
As opposed to many other recycling materials, copper and copper alloy scrap is characterised by its very high value. It can be processed into new construction products with comparatively little effort and energy input. Therefore TECU® Oxid is a sustainable material.

2.15 Disposal

Process and new scrap arising from the production and processing of TECU® Oxid sheets and strips are completely returned into the production process. Waste from copper is recycled in accordance with Annex II of /Directive 75/442/EEC/ on waste according to R 4 Recycling/reclamation of metals and metal compounds.
Due to the highly developed recycling systems, no copper from facade cladding and roofing arise for disposal. Classification according to the Appendix III of the European Waste Shipment Regulation (Green List) /Regulation No 1013/2006/, for deliveries from non-EU countries. The waste code is B1010: Metal and metal-alloy wastes in metallic, non-dispersible form.

The used paper packaging materials/cardboard, polyethylene (PE film), polypropylene (PP film) and steel are recyclable. In case of collection, redemption takes place by INTERSEROH (INTERSEROH No. 25945). The packaging is placed at waste sites with swap bodies in compliance with the statutory provisions. The wooden and steel pallets are returned and refunded (deposit system).

2.16 Further information

On the KME Germany-website processing instructions, product data sheets, safety information and other technical information are available for download in the latest edition:
www.https://www.kme.com/en

3. LCA: Calculation rules

3.1 Declared Unit

The declaration applies to copper alloys. The declared unit is 1 kg copper sheet, preoxidized (TECU® Oxid).

Declared unit

Name	Value	Unit
Declared unit	1	kg
Conversion factor to 1 kg	0.000112	-
Density	8930	kg/m³

3.2 System boundary

The Life Cycle Assessment considers the system boundaries "cradle to gate - with options" and follows the modular construction system described by /EN 15804/. The LCA takes into account the following modules:

- A1-A3: Raw material supply, Transport,Manufacturing
- C2: Transport to waste-processing facility
- C4: Disposal
- D: Potential for reuse, recovery and/or recycling as net flows and benefit

3.3 Estimates and assumptions

Specific data regarding the production process was provided by KME Germany GmbH & Co. KG. Missing data was supplemented by estimates based on comparable substitutes or data used from the secondary literature and the database /GaBi 8:2018/. Missing data was modelled by the Life Cycle Analyst.

3.4 Cut-off criteria

All relevant data, i.e. all applied materials according to the recipe and the energy used originate from the production data acquisition and have been considered within the inventory analysis.
For the considered in- and outputs the actual transport distances were used. Material- and energy flows with a proportion of less than 1 % were collected. Waste of upstream products, which accumulate in small quantities (<1 %) during the manufacturing process, was neglected. It can be assumed, that the sum of the neglected processes does not exceed 5 % of the impact categories.

3.5 Background data

Primary data has been provided by KME Germany Gmbh & Co. KG. All background data required for the Life Cycle Assessment originates form the database of the GaBi-Software /GaBi 8:2018/.

3.6 Data quality

For modelling the Life Cycle of TECU® Oxidproduction, data has been collected by KME Germany GmbH & Co. KG in the manufacturing plant from the production year 2017. All other relevant
background data has been taken from the database of the /GaBi 8:2018/ software. For the Life Cycle Inventory Analysis all input and output flows have been respected. The representativeness and data quality is therefore rated as good.

3.7 Period under review

The amount of raw materials, input energy and the volume of waste relate to the year 2017. Additional data was taken from the database of /GaBi 8:2018/. It corresponds to the best currently available technology and thus is representative for the considered time period. The reference area is Germany.

3.8 Allocation

Co-product allocation does not exist in the manufacturing process. Copper plate residues are fed into the manufacturing process, modelled as closedloop production. After the use stage, the product can be subjected to material recylcing. Modeling the endof-life (EoL), a collection rate of 99% was assumed. There are no material credits for recycling, because the net scrap balance is negative due to the high use of secondary material and the small collection losses. The collection and material losses are compensated in the EoL by a corresponding amount of primary copper, so that in consideration an additional load in the module D becomes effective. The partially contained alloy metals are not subjected in the model of any separate feedstock recycling.

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 background database /GaBi 8:2018/ was used..

4. LCA: Scenarios and additional technical information

The following technical information models the basis for the declared modules or can be used for developing specific scenarios within the context of a building appraisal.

The reference service life according to /ISO 15686-1/ could not have been determined. The declaration of the reference service life underlies the assessment system of the Federal Institute for Research on Building, Urban Affairs and Spatial Development /BBSR/.

Reference service life

Name	Value	Unit
Reference service life (according to /ISO 15686-1, -2, -7 and -8/)	-	a
Life Span (according to /BBSR/)	≥ 50	a
Life Span according to the manufacturer	> 250	a

End of life (C1 - C4)

Name	Value	Unit
Collected separately waste type	1	kg
Recycling	0.99	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Name	Value	Unit
Recycling	0,99	kg
Net scrap as replacement for primary material	0,01	kg

5. LCA: Results

The following table summarizes the results of Life Cycle Assessment. The results of the impact assessment do not provide any information on endpoints of the impact categories, exceedances of thresholds, safety margins or risks. The results refer to 1 kg produced TECU® Oxid copper sheet and strips. The Impact Assessment is based on /CML 2001/ - April 2015.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

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	X	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 kg TECU Classic sheet and strips

Parameter	Unit	A1-A3	C2	C3	D
Global warming potential	[kg CO_2-Eq.]	9.05E-1	7.31E-3	0.00E+0	3.71E-2
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	5.46E-13	1.55E-16	0.00E+0	8.59E-15
Acidification potential of land and water	[kg SO_2-Eq.]	9.72E-4	2.80E-5	0.00E+0	2.60E-4
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	1.76E-4	7.10E-6	0.00E+0	1.56E-5
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	5.29E-5	-1.05E-5	0.00E+0	1.43E-5
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	7.03E-7	7.63E-10	0.00E+0	4.12E-5
Abiotic depletion potential for fossil resources	[MJ]	1.21E+1	9.85E-2	0.00E+0	4.16E-1

RESULTS OF THE LCA - RESOURCE USE: 1 kg TECU Classic sheet and strips

Parameter	Unit	A1-A3	C2	C3	D
Renewable primary energy as energy carrier	[MJ]	2.27E+0	6.66E-3	0.00E+0	7.18E-2
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	2.27E+0	6.66E-3	0.00E+0	7.18E-2
Non-renewable primary energy as energy carrier	[MJ]	1.33E+1	9.88E-2	0.00E+0	4.33E-1
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	1.33E+1	9.88E-2	0.00E+0	4.33E-1
Use of secondary material	[kg]	1.23E+0	0.00E+0	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m^3]	9.21E-3	7.72E-6	0.00E+0	6.08E-4

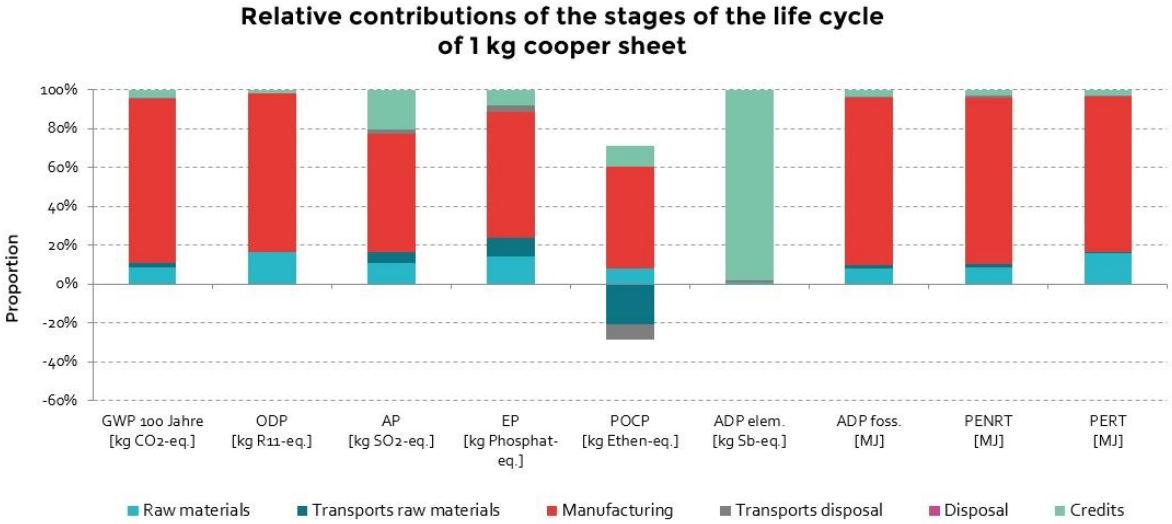
RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 kg TECU Classic sheet and strips

Parameter	Unit	A1-A3	C2	C3	D
Hazardous waste disposed	[kg]	2.44E-8	0.00E+0	0.00E+0	2.79E-9
Non-hazardous waste disposed	[kg]	2.30E+0	5.33E-4	0.00E+0	3.13E+0
Radioactive waste disposed	[kg]	4.75E-4	1.19E-7	0.00E+0	6.73E-6
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	0.00E+0	0.00E+0	-1.00E-2	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0

* MND: Module not declared

6. LCA: Interpretation

The following figure shows the relative contributions of different Life Cycle processes and the primary energy demand in the form of a dominance analysis.



Indicators of the impact assessment

The impact categories of TECU® Oxid within its lifecycle are determined by the energy consumption of the manufacturing process.
Mainly secondary material is used for the production, which is why environmental impacts on raw material supply is relatively low. Due to minor material losses in the recycling, the net scrap balance at the end-of-life is negative and must be compensated by the production of primary copper. Therefore additional environmental burden arise within the lifecycle in module D.

Global warming potential (GWP)
The GWP is determined by the required energy sources electricity (30 %) and natural gas (50 %) in the production stage. Within production (A3), one third of the emission potential is attributed to melting process and one third to subsequent processing. Minor scrap losses in the recycling scenario must be balanced in the LCA by the production of primary copper at the end of life. This leads to additional environmental burden in the module D (credits) with 4 % of the GWP.

Depletion potential of the stratospheric ozone layer (ODP)
The Ozone depletion potential is dominated by the production (ca. 85 %) and the provision of raw material supply (ca. 10 %). The electricity demand accounts for 80 % of the ODP factor during the production stage (A1-A3).

Acidification potential of land and water (AP) and Eutrophication potential (EP)
Half of the Acidification potential and the Eutrophication potential are determined by the supply of electricity and 30 % by the thermal use of natural gas. By compensation for net scrap losses from the production of primary copper at the end-of-life, additional environmental burdens in module D occur.

Potential of tropospheric ozone photochemical oxidants (POCP)
The POCP value is determined in the production stage of ca. 86 % of the electricity and natural gas requirement. By balancing net scrap losses at the end of life, additional primary POCP potential is associated with the production of primary copper along the life cycle of 15 %.

Abiotic depletion potential for non-fossil resources (ADPE)
The ADPE value is predominantly conditioned by the additional extraction of primary copper at the end of life (module D). Since only secondary material is used for the production, the ADPE factor in the production stage (A1-A3) is small in comparison to the extraction of primary copper (module D).

Abiotic depletion potential for fossil resources (ADPF)
Within the production (A1-3), the ADPF value mainly results from the provision of natural gas (ca. 60 %) and electricity (ca. 25 %).

Within the production (A1-3), the total primary energy demand is divided between approx. 85 % non-renewable energy and approx. 15 % renewable energies.

Total use of non-renewable primary energy resources (PENRT)
For the use of primary energy from non-renewable resources, the bulk of energy needs arises from the required energy in the production: natural gas (60 %) and electricity (30%). The supply of raw materials makes only a small contribution in the upstream chain with about 3 %. At the end of life, compensation for net scrap losses from the production of primary copper requires additional energy, which contributes with 5 % to the PENRT factor.

Total use of renewable primary energy resources (PERT)
About 80 % of the renewable primary energy demand results during the entire life cycle from the energy required in the production stage, which can only be attributed to the share of renewable energy sources contained in the electricity mix. A small share of 16 % results from the provision of precursors, such as industrial recovery of nitrogen and hydrogen and deionized water.

7. Requisite evidence

7.1 Weathering

Based on field and laboratory data for the rainwash of copper, a formula has been developed which allows the calculation of the discharge rate in a grid of 50 km² in Europe. The essential parameters of this formula are composed of the SO2-concentration, pH-Value of the rain, rain level and the roof pitch.

Experimental setup: According to /ISO 17752/
Experimental period: 2007 – 2010.
Measuring department: IUTA Institute for Energy and Environment, Mercator University Duisburg.
http://www.corrosionscience.se/runoff/

8. References

DIN 4102-1/
DIN 4102-1:1998-05: Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

/EN 504/
DIN EN 504:2000-01: Roofing products from metal sheet - Specification for fully supported roofing products from copper sheet.

/EN 506/
DIN EN 506:2009-07: Roofing products of metal sheet - Specification for self-supporting products of copper or zinc sheet.

/EN 612/
DIN EN 612:2005-04: Eaves gutters with bead stiffened fronts and rainwater pipes with seamed joints made of metal sheet.

/EN 1172/
DIN EN 1172:2012-02: Copper and copper alloys - Sheet and strip for building purposes.

/EN 1462/
DIN EN 1462:2004-12: Brackets for eaves gutters - Requirements and testing.

/EN 1652/
DIN EN 1652:1998-03: Copper and copper alloys - Plate, sheet, strip and circles for general purposes.

/EN 1976/
DIN EN 1976:2013-01: Copper and copper alloys - Cast unwrought copper products.

/EN 12166/
DIN EN 12166:2016-11: Copper and copper alloys - Wire for general purposes.

/EN 14783/
DIN EN 14783:2013-07: Fully supported metal sheet and strip for roofing, external cladding and internal lining - Product specification and requirements.

/ISO 17752/
ISO 17752:2012-07: Corrosion of metals and alloys - Procedures to determine and estimate runoff rates of metals from materials as a result of atmospheric corrosion.

/ISO 14025/
DIN EN ISO 14025:2011-10: Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006).

/SO 14040/
DIN EN ISO:2009-11: Environmental management - Life cycle assessment - Principles and framework (ISO 14040:2006).

/ISO 14044/
DIN EN ISO:2018-05: Environmental management - Life cycle assessment - Requirements and guidelines (ISO 14044:2006 + Amd 1:2017).

/ISO 15686/
ISO 15686-1:2011-05: Buildings and constructed assets - Service life planning - Part 1: General principles and framework.

/ISO 6507-1/
DIN EN ISO 6507-1:2018-07: Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1:2018).

/ISO 6507-2/
DIN EN ISO 6507-2:2018-07: Metallic materials - Vickers hardness test - Part 2: Verification and calibration of testing machines (ISO 6507-2:2018).

/ISO 6892-1/
DIN EN ISO 6892-1:2017-02: Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2016).

/ISO 9001/
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