Environmental Product Declaration

according to ISO 14025

Rolled lead coils and Rolled lead sheets

**Rolled lead untreated,
VENUSBLEI®,VENUSBLEI-SK®,
bleiCOLOR®, bleiCOLOR-SK®,
bleiPLUS®,
X-READY T120®**

RÖHR + STOLBERG GMBH

Declaration number
EPD-RSG-2011111-E

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Brief version

Environmental Product-Declaration

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Institute Construction and Environment

www.bau-umwelt.com

Program holder

Röhr + Stolberg GmbH
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Declaration holder

EPD-RSG-2011111-E

Declaration number

Rolled lead coils and rolled lead sheets: Rolled lead, VENUSBLEI®, VENUSBLEI-SK®, bleiCOLOR®, bleiCOLOR-SK®, bleiPLUS®, X-READY T120®

This declaration is an environmental product declaration according to /ISO 14025/ and describes the specific environmental impacts of the mentioned construction materials. It is supposed to support the sustainable development of environmental and health friendly construction. All relevant environmental data is contained in this validated declaration.
The declaration is based on the PCR document 'Construction metals,' 2010-09.

Declared building products

This validated declaration entitles the usage of the label of the Institute for Construction and Environment. This exclusively applies to the mentioned products, one year from the date of issue.
The declaration holder is liable for the basic information and verifications.

Validity

The **declaration** is complete and contains in detailed form:
Product definition and information about building physics

- Product definition and information about building physics
- Information about material characteristics and the material's origin
- Description of the product's manufacturing
- Indication of product processing
- Information about the in-use conditions, extraordinary impacts and end-of-use phase
- Life cycle assessment results
- Verifications and tests

Content of the declaration

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14 April 2014

Date of issue

Prof. Dr.-Ing. Horst J. Bossenmayer
(President of the Institute Construction and Environment)

Signatures

This declaration and the rules on which it is based have been verified by the Independent Advisory Board (SVA) according to /ISO 14025/.

Verification of the Declaration

Prof. Dr.-Ing. Hans-Wolf Reinhardt (chairman of the SVA)

Dr. Wolfram Trinius (tester appointed by the SVA)

Signatures

Brief version

Environmental Product Declaration

Product description

The material of the rolled lead products is PB810M, manufactured according to DIN EN 12588. The Declaration refers to rolled lead untreated and rolled lead coils and lead sheets with various surface finishing colours (VENUSBLEI® and bleiCOLOR®) and of tin (bleiPLUS®) as well as single-sided lamination with adhesive tape of resin-modified acrylate adhesive and polyethylene-coated paper coat, siliconised on both sides (X-READY T120®) and single-sided adhesive coating (VENUSBLEI-SK® und bleiCOLOR-SK®).

Area of Application

Rolled lead coils and rolled lead sheets for roofing, facade design, chimney and dormer flashings, for connections and edgings, soundproofing and radiation protection for dry walling.

Scope of the LCA

The LCA is performed according to DIN EN ISO 14040 ff. corresponding to the requirements of the guidelines concerning Type III declarations of the Institute for Construction and Environment. Specific data of the declared products, as well as data from the database "GaBi 4" is used as data basis. The LCA comprises the life cycle stages of the raw material and energy generation and the manufacture with transports.

No primary raw materials are used for the manufacture of the rolled lead coils and sheets. The products consist exclusively of secondary lead, which is 100% recycled from waste lead products. The recycling potential and the resultant credit are already contained in the calculation for the manufacture. The material loss to be expected during and after the utilization phase is estimated at 5% and is listed under End-of-Life (EoL).

Results of the LCA

Rolled lead coils und rolled lead sheets:
Rolled lead untreated, VENUSBLEI®,VENUSBLEI-SK®, bleiCOLOR®, bleiCOLOR-SK®, bleiPLUS®, X-READY T120®

Parameter	Unit per kg	Production	EoL
Primary energy, non-renewable	MJ	19.14	2.40
Primary energy, renewable	MJ	0.33	0.29
Global Warming Potential (GWP)	kg CO2-equiv.	1.164	0.199
Ozone Depletion Potential (ODP)	kg R11-equiv.	9.79E-08	7.39E-09
Acidification Potential (AP)	kg SO2-equiv.	2.31E-03	1.02E-02
Eutrophication Potential (EP)	kg PO4-equiv.	2.02E-04	6.48E-05
Photochemical Ozone Creation Potential (POCP)	kg C2H4-equiv.	1.78E-04	8.15E-04

Prepared by: RÖHR + STOLBERG GMBH, Krefeld in cooperation with PE INTERNATIONAL, Leinfelden-Echterdingen

Verifications and tests

Test and verifications according to PCR, see Chapter 9

Product group, PCR:	Construction metals	Creation date
Declaration holder:	Röhr + Stolberg GmbH	14-04-2011
Declaration number:	EPD-RSG-2011111-E	

Scope of validity

This environmental product declaration covers coated and uncoated lead sheets and coils manufactured by Röhr + Stolberg GmbH in Krefeld, which, depending on their surface finish, are sold under the brand names of VENUSBLEI®, VENUSBLEI-SK®, bleiCOLOR®, bleiCOLOR-SK®, bleiPLUS® and X-READY T120®. Uncoated rolled lead (Rolled lead untreated) is sold either under the brand name of "Saturnblei" (Saturn lead) or without brand according to DIN EN 12588.

1 Product definition

Product definition

The raw rolled lead products for the coated and uncoated rolled lead products from Röhr + Stolberg GmbH are made to 100 % from the material PB810M according to DIN EN 12588, i.e. metallic lead with minimum and maximum limited copper content as alloying element, as well as increased tin content to improve the product resistance to surface corrosion. The considered rolled lead products exhibit different surface finishes:

- Rolled lead untreated according to DIN EN 12588
- VENUSBLEI® - single or double-sided organic surface finish
- VENUSBLEI-SK® - single-sided organic surface finish with self-adhesive bitumen application on the back
- bleiCOLOR® - single or double-sided organic surface finish
- bleiCOLOR-SK® - single-sided organic surface finish with self-adhesive bitumen application on the back
- bleiPLUS® - single or double-sided tin-plated
- X-READY T120® – single-sided organic surface finish, organic surface finish or rolled untreated with laminated acrylate adhesive on the back.

The finishes of the lead coils or sheets with the brand names VENUSBLEI®, VENUSBLEI-SK® and bleiCOLOR® consist of an organic coating on a water base.

Application

Lead sheets and coils for roofing, copings, facade design, connections and edgings in the roof areas such as, e.g. chimneys and dormers, roof lights, solar and PV systems as well as for soundproofing and radiation protection.

Placing on the market /Codes of practice

DIN EN 12588

Quality control

Internal quality control by the manufacturer according to ISO 9001:2008, TÜV Rheinland Cert GmbH Certificate Registration No. 01 100 71035,
Environmental management according to ISO 14001:2004, TÜV Rheinland Cert GmbH Certificate Registration No. 01 104 186448, Certificate for conformance of Röhr + Stolberg – shipping and securing versions of rolled lead pursuant to the applicable guidelines for freight securing pursuant to §§ 22 and 23 StVO (*German Highway Code*), §§ 30 and 31 StVZO (*German Road Traffic Licensing Regulation*), DIN EN 12195-1 and VDI guidelines 2700; DEKRA Automobil GmbH Certificate No. 313 / 16294 YF 1805837549.

Material analyses by the manufacturer by means of FE spectral analysis

Quality assurance of Saturnblei according to the quality and inspection regulations of the Gütegemeinschaft Saturnblei e.V. (*Quality Association Saturn Lead*)

Delivery status, characteristics

Rolled lead untreated:	Rolled coils or sheets Thickness: 0.15 – 3.0 mm Width: 50 – 1300 mm Surface rolled
VENUSBLEI®:	Rolled coils or sheets Thickness: 0.20 – 3.0 mm Width: 50 – 1000 mm Surface with double-sided organic surface finish or organic surface finish / rear side rolled untreated
VENUSBLEI-SK®:	Rolled coils Thickness: Rolled lead 0.5 – 0.8 mm Composite: 1.30 – 1.5 mm (composite thickness) Width: 150 – 450 mm Surface with single-sided organic surface coating / rear side bitumen coated
bleiCOLOR®:	Rolled coils or sheets Thickness 0.20 – 3.0 mm Width: 50 – 1000 mm Surface with double-sided organic surface finish or single-sided organic surface coating /rear side rolled untreated
bleiCOLOR-SK®:	Rolled coils Thickness: Rolled lead 0.5 – 0.8 mm Composite: 1.30 – 1.5 mm (composite thickness) Width: 150 – 450 mm Surface with single-sided organic surface coating / rear side bitumen coated
bleiPLUS®:	Rolled coils or sheets Thickness: 0.18 – 3.0 mm Width: 50 – 1000 mm Surface with double-sided tin-plating or single-sided tin-plating / rear side rolled untreated
X-READY T120®:	Rolled coils or sheets Thickness 0.15 – 3.0 mm Width: 50 – 1300 mm Surface rolled untreated or with organic surface coating / rear side laminated acrylate adhesive

Surface weight with popular thicknesses

Thickness mm	Surface weight kg/m²
0.20	2.27
0.30	3.40
0.50	5.67
0.75	8.50
0.80	9.07
1.0	11.34
1.25	14.18
1.5	17.01
2.0	22.68
2.5	28.35
3.0	34.02

Physical / mechanical properties

Density:	11.336 g/cm³
Melting point:	326 – 327°C
Thermal conductivity at 20°C:	35.01 W/mk
Specific heat capacity:	138 J/kg K
Electr. conductivity at 20°C:	4.82 Ω x m^{-1} x mm^{-2}
Thermal expansion:	0-100°: 0.03 mm/m x °C
Modulus of elasticity at 20°C:	1,700 kg/mm²
Tensile strength:	10.8 – 18.6 N/mm²
Fracture strain:	50 – 70 %
Brinell hardness HBS 1/1/30:	3.3 – 4.7
Vickers hardness 1/30:	3.2 – 4.7

2 Basic materials

Base materials primary products

The stated products are made from nearly 100 % PB810M according to DIN EN 12588, i.e. metallic lead with minimum and maximum limited copper content as alloying element, as well as increased tin content to improve the product resistance to surface corrosion

Auxiliary substances / additives

- Rolling oil emulsion 0.037 g/kg
- Alkaline cleaner 0.380 g/kg
- Organic surface coating 13.986 g/kg
- Bituminous bonding material 8.571 g/kg
- Adhesive 6.584 g/kg

Material explanation

Rolling oil emulsion: The oils are highly refined mineral oils with additives. The mixture of water with 0.5 – 0.8 % of this oil results in the rolling oil emulsion. The rolling oil emulsion serves as coolant and lubricant during the rolling process.

Alkaline cleaner: Mixture of the following substances: 2.5 – 10 % nitrilotriacetate (NTA), 2.5 – 10 % ethylhexyl hydrogen sulphate, < 2.5 % sodium hydroxide. The alkaline cleaner is used as degreasing medium prior to the organic surface coating for the products bleiCOLOR®, bleiCOLOR-SK®, VENUSBLEI®, VENUSBLEI-SK® and X-READY T120®.

Organic surface coating: Organic surface coating on the basis of water as mixture for the following substances:
1.01 – 2.50 % N-methyl-2-pyrrolidone, 2.51 – 10.00 % propane-2-ol, 1.01 – 2.50 % xylene, as well as 1.01 – 10.00 % dipropylene glycol methyl ether, isomer mixture.
This is used for coating the products bleiCOLOR®, bleiCOLOR-SK®, VENUSBLEI®, VENUSBLEI-SK® and X-READY T120®.

Bituminous bonding material: Bonding material on the basis of bitumen. The bitumen serves as self-adhesive layer for fitting the products bleiCOLOR-SK® and VENUSBLEI-SK®.

Adhesive: Transfer adhesive tape of resin modified acrylate adhesive with polyethylene-coated paper coat, siliconised on both sides. The transfer adhesive tape serves as self-adhesive layer for fitting the product X-READY T120®.

Raw material extraction and origin

When lead is recycled after its initial use one speaks of secondary lead. The rolled lead products considered in this declaration are manufactured from 100% recycled waste lead products (secondary lead).
Primary lead is won from lead ores. The worldwide most significant mining countries for lead ore are the People's Republic of China, Australia and the USA. In Europe, Ireland, Sweden and Poland can be quoted as the largest lead producers.

Regional and general availability of raw materials

Lead is a raw material which, after it has been used, is collected as scrap and is recycled for a new application. Lead can be recycled to nearly 100 % and is therefore not lost from the recovered substance cycle. Recycled, resp. secondary lead has the same material properties as new, resp. primary lead. The ratio of recycled lead from the European Lead Sheet Industry Association (ELSIA) is currently about 95% of the total lead employed. Therefore, a shortage of the material lead is not to be expected now or in the future.

3 Product manufacturing

Manufacturing the product

- **Smelting:** The lead ingots supplied by the secondary smelters are liquefied in the melting pot together with production scraps in batches of up to 30 tons and at temperatures of 450 – 500°C. The desired alloy composition can be set during this process. Stirring units ensure a homogenous mixing of the raw material.
- **Slab casting:** From the melting pots, the liquid lead is cast into block moulds. In these moulds, the lead cools down to below the melting point and solidifies. The solid lead block (slab) can now be de-moulded by tipping and is brought to the rolling mill.
- **Rolling:** On a rolling stand with upper and lower roll (reserve duo) the lead slab is rolled to a coil in several passes. For thicknesses of <1 mm the lead coil is further processed on a trio roll; a thickness of 0.15 mm can be achieved here.
- **Conversion:** During conversion, the lead coil is processed with the help of rolling knives into rolls or sheets of various dimensions. These are then weighed and labelled.

- **Organic coating bleiCOLOR® resp. VENUSBLEI®:** The products bleiCOLOR®, bleiCOLOR-SK® resp. VENUSBLEI® and VENUSBLEI-SK® are organically coated in addition. As preparation, the lead coil is cleaned of grease and oils with an alkaline cleaner.
- **Bituminous bonding material for bleiCOLOR-SK® resp. VENUSBLEI-SK®:** These products receive a bitumen coating on one side.
- **Laminating X-READY T120®:** This product is laminated with an additional adhesive foil on one side.
- **Packaging:** The rolled lead coils and sheets are fixed on a Euro palette with the help of triangular fillets and timber battens and then shrink-wrapped with a shrink hood. The products VENUSBLEI-SK® and bleiCOLOR-SK® are also first packed in a cardboard box.

Health protection production

During the complete manufacturing process there is no need for health protection measures which go above and beyond the usual occupational health and safety measures for manufacturing firms.

Environmental protection production

- **Air:** The total resulting process air is filtered in corresponding filtration systems.
- **Water/Ground:** The cooling water circulates in a closed water circuit. Sewage, which may not be introduced into the sewer, is disposed of by authorised specialized enterprises. Other sewage introduced into the sewer is analysed regularly.
- **Noise:** Sound level measurements have shown that all values determined inside and outside of the production site, are well below the legal and normative limit values, due to the introduced sound proofing measures.

4 Product processing

Processing recommendations

The technical rules for lead in the construction and building industry, of the Gütegemeinschaft Saturnblei e.V. (*Quality Association Saturnblei*) must be complied with for the declared products.

Attention must be paid that the palettes are transported and stored in dry conditions. Non-coated lead sheets should be laid in dry weather conditions and subsequently treated with patinating oil. This prevents the formation of white lead in rainy weather.

Coated rolled lead can be laid in any weather conditions because one need not fear the formation of white lead even in moist conditions. Patinating the coated sheets is therefore not necessary.

Potential assembly with other materials

	Aluminium (Al)	Copper (Cu)	Titanium zinc (Zn)	Stainless steel (S.S.)	Galvanized steel (GSt)
Lead (Pb)	+*	+	-	+	+

+ permissible, - non-permissible

* Assembly of lead surfaces with underlying aluminium connections in marine atmospheres should be avoided since it may lead to corrosion phenomena. Assembly with plaster (calcium sulphate) is usually not a problem. Contact with lime, cement and sealing materials on an ethanoic acid base should be avoided, as corrosion phenomena with white colouration occur on the lead.

Tools for processing lead sheets

The tools for processing lead sheets are dibble, mallet – asymmetric - made of wood, mallet made of plastic, banana made of plastic, mallet – symmetric - made of plastic, rubber mallet, rubber mallet with rounded head and diverse sheet shears.

Occupational safety

According to Annex I of the new Ordinance on Hazardous Substances, metallic lead in compact form or as alloys does not present a health hazard for persons through inhaling, swallowing or skin contact. Hygiene should be observed when handling lead, e.g. regular washing of hands. During work, where lead particles, such as e.g. dust may be released (demolition work or cutting) personal protective equipment (e.g. dust mask) should be worn while working.

See also

- *TRGS 505 - Lead*
- *BGI 843 – Hazards when handling lead and its inorganic compounds*

Environmental protection

Special measures to protect the environment do not need to be undertaken (The Netherlands Organisation for Applied Scientific Research – TNO Report R2005/306).

Residual materials

Any lead residue and packaging accruing on the building site must be collected separately. The provisions of the local waste disposal authorities, as well as the references specified under Point 6 must be taken into consideration for the utilization.

Packaging

Packaging materials used:

- Tensioning strap: Steel and plastic straps (polypropylene PP)
- Wood (triangular fillets/ timber battens)
- Fibreboard
- Non-returnable / reusable palettes
- Cartons, paper / cardboard (corrugated cardboard)
- Plastic film, foam film, shrink hoods (polyethylene PE)

The packaging materials made of paper, cardboard, polypropylene and polyethylene can be recycled.

5 Condition when in use

Constituent parts

The product represents an alloy of lead and copper with different surface coating. The constituent parts correspond with the basic materials stated in Point 1.

Rolled lead untreated: In the course of the chemical processes of applying a protective coating, lead oxide is initially formed with atmospheric oxygen. Lead hydroxide is then formed through the influence of water (precipitation) which is converted to a dense, bonded and water-insoluble cover layer of alkaline lead carbonate (patina) because of the reaction with the carbon dioxide in the air. The patina, as vert antique, takes on a protective function for the metal, which becomes more effective as years go by.

Coated products: The organic surface coatings applied either on one or both sides of the products bleiCOLOR®, bleiCOLOR-SK®, VENUSBLEI®, VENUSBLEI-SK® and X-READY T120®, resp. the tin plating rolled on with bleiPLUS® protects the lead from atmospheric influences. The coating prevents the creation of white lead.

Bituminous bonding material: The bonding material applied to the surface of one side of the products bleiCOLOR-SK® and VENUSBLEI-SK® on the basis of bitumen serves as a fastening and sealing help.

Effect relationships

Health aspects:

Environment - Health

An impairment to health is not to be expected when the lead products are used according to their intended purpose.

Environmental aspects:

Lead can be classified as a substance non-hazardous to water because this substance shows a water solubility of less than 100 mg/l at 20°C (Administrative provision for substances hazardous to water - VwVwS). The lead concentration in rain water runoff is minor and shows no effects on public health and the environment (The Netherlands Organisation for Applied Scientific Research – TNO Report R2005/306, Schulze-Rettmer, 1995; 2002). In addition, lead remains almost immobile in the upper soil horizon (Schulze-Rettmer, 1995; 2002).

Utilization period

Rolled lead has a good corrosion resistance against many media occurring in today's atmosphere through a naturally forming protective layer made of nearly insoluble lead carbonate or sulphate (patina), e.g. against sulphurous acids from the flue gas in the chimney area. It is UV-resistant, rot-proof, break-proof and recyclable.
The wash-down rate with atmospheric weathering is approximately 1g lead per m² and year; theoretical service life for lead roofing is >250 years.

6 Extraordinary impacts

Fire

The products stated in this declaration fulfil the requirements of the building material class A1 "incombustible" according to DIN 4102, Part 1.

Development of flue gas / smoke density:

With the products rolled lead untreated as well as bleiPLUS® there is a minimal development of smoke. With the products bleiCOLOR®, bleiCOLOR-SK®, VENUSBLEI®, VENUSBLEI-SK® and X-READY T120® there is dense black smoke in the case of fire, due to the organic components of the coating.

Toxicity of the fumes:

Lead oxide smoke, resp. lead steam is toxic. Generation of breathable or swallowable smoke and dust with PbO and other toxic metal oxides or those hazardous to health. Breathing in of hazardous products of decomposition when the organic coatings burn can cause serious health damage.

Changing the aggregate state (burning dripping/dropping off):

The melting point is around + 326 - 327 °C.

Water

Effects of water:

Compare the information provided in Point 5 "Condition when in use" as well as in Point 9 "Proof".

7 End of Life phase

General

The process and new scrap accruing during the manufacture and processing of the products in the application scope of this EPD are returned in full to the production process.

Reuse / reutilisation

All rolled lead products can be recorded according to variety without any problems in the case of conversion or termination of the utilization phase of a building

Recycling

The process and new scrap accruing during the manufacture and processing of the products are returned in full to the production process. The mono-material cutting scraps accruing on building sites as well as capital scrap is collected and is sold, either directly or through scrap metal traders to secondary metal shops or the manufacturer. The return rate of these building scraps is more than 95 %. The lead scraps can be recycled to new building products with little effort and use of energy. The energy input for recycling lead scraps and the manufacture of new products is clearly lower than with other building products due to the low melting point of 326 – 327 °C for lead.

Disposal

As a result of the modern recycling systems, there is a very low amount of lead from the sector of building products, which is actually disposed of / used as landfill. The ratio of recycled lead from the European Lead Sheet Industry Association (ELSIA) is currently about 95% of the total lead employed. Therefore, a shortage of the material lead is not to be expected now or in the future. According to the European Waste Catalogue, the code for lead is 170403.

The employed packaging materials of paper / cardboard, polyethylene (PE foil), polypropylene (PP foil) and steel can be recycled. In the case of mono-material collection, it will be taken back via INTERSEROH (INTERSEROH certificate Contract No. 27860); the packaging is collected from the source of waste generation, which is equipped with exchangeable containers, under compliance with the legal provision. The reusable wooden pallets are taken back and refunded (deposit system).

8 Life cycle assessment

8.1 Information on system definition and modelling of the life cycle

Declared unit

This declaration refers to 1 kilogram rolled lead coil / rolled lead sheet

System boundaries

The declared product mix is representative for the product range from Röhr + Stolberg GmbH. The system boundaries include all process steps for the manufacture of rolled lead coils and rolled lead sheets, their packaging, transport and product installation, as well as the End-of-Life phase.

Assumptions and estimations

The disposal / End-of-Life scenario earmarks a collection of 95% of the used product as well as 1% losses and 4% disposal.

Cut-off criterion

Data from the operating data elicitation, i.e. all employed source materials, the energy consumed, the internal consumption of operating materials, production waste, as well as the results of the available emission measurements have been taken into consideration in the balancing.

The following rule was applied as cut-off criterion: all processes whose total contribution to the end result according to mass and energy is greater than 1% in the categories have been taken into consideration.

The sum of the neglected processes is smaller than 5% of the results of the individual categories and the requirements of the IBU (Industrial Association Metal-forming Sector) have been fulfilled.

The database /GaBi 2009/ was used to calculate the material and energy production. Corresponding system boundaries (cut-off criteria) are documented in /GaBi 2009/.

Transports

Transports of raw, auxiliary and operating materials during the manufacturing phase of the rolled lead sheets and coils have been included. An average transport distance for the distribution chain (factory to building site) has also been taken into consideration. It is 300 km.

Period under consideration

The LCA is based on production data from the business year 2009. The background data refers to the years 2002 to 2009 /GaBi 2009/.

Background data

The software system for Life Cycle Engineering "GaBi 4" was used to model the life cycle of the rolled lead sheets and rolled lead coils /GaBi 2009/. All background datasets relevant for the manufacture of the considered products have been taken from the software GaBi 4 database /GaBi 2009/.

Data quality

On principle, the LCI data contains information on materials, energy, auxiliary materials, as well as water consumption and waste (primary data). This primary data was transmitted by Röhr + Stolberg GmbH for the declared products. Furthermore, LCA datasets (cradle to gate) for raw materials, energies and other auxiliary materials, which are relevant for the various life cycle steps, are included (background data). Background data will be supplied by PE INTERNATIONAL.

The age of the data employed is less than 6 years. Therefore one may proceed from a good representative nature of the data.

Allocation

The metals from socialised ores are allocated according to market value.

Selection of End-of-life scenarios

The End-of-Life Scenario (EoL) comprises recycling of the rolled lead sheets and coils. The collection rate for the End-of-Life phase is assumed at 95% (TNO 2006). This means that after use, 95% of the products are available for recycling. The residual 5% are distributed into 1% losses as well as 4% landfill / disposal.

Credits / charges

Production of the rolled lead sheets and rolled lead coils is carried out to 100% via the secondary route. Here, this results in a net consumption of lead scrap across the total life cycle, i.e. more lead scrap is used up in production than will be supplied at the End-of-Life for the next life cycle. The resultant charges are represented via the primary production of lead.

8.2 Representation of the assessment results and analysis

Life Cycle Inventory (LCI)

The following sections show the LCA results with regard to material and energy flows during manufacture and the End-of-Life of the declared products.

Primary energy

Table 1 illustrates the use of primary energy (renewable and non-renewable) of 1 kg rolled lead sheet / rolled lead coil.

Table 1: Primary energy consumption of 1 kg rolled lead sheet/rolled lead coil

	Unit	Production	EoL	Total
Primary energy consumption From non-renewable resources	**Mj**	**19,14**	**2,40**	**21,53**
Primary energy from brown coals	Mj	0,60	0,26	0,85
Primary energy from natural gas	Mj	7,58	-0,19	7,40
Primary energy from crude oil	Mj	4,00	-0,10	3,91
Primary energy from coal	Mj	3,54	2,16	5,70
Primary energy from uranium	Mj	3,41	0,26	3,68
Primary energy consumption From re-newable resources	**Mj**	**0,33**	**0,29**	**0,62**
Primary energy from hydropower	Mj	0,142	0,249	0,39
Primary energy from wind power	Mj	0,127	0,012	0,14
Primary energy from solar power	Mj	0,053	0,031	0,08
Primary energy from other Renewable resources	Mj	0,004	$3,87^{E}$-05	0,004

The use of primary energy in production is, first and foremost, defined via the production of the secondary lead (87%). Furthermore, the provision of power and thermal energy contributes with more than 10%.

Figure 1 represents the acquisition type of the non-renewable primary energy in production. During the production phase, the non-renewable primary energy resource natural gas shows the highest contribution with nearly 40%. This is followed by crude oil (20.9%) and coal (18.5%). The energy resource uranium (17.8%) is used for power production in nuclear plants.

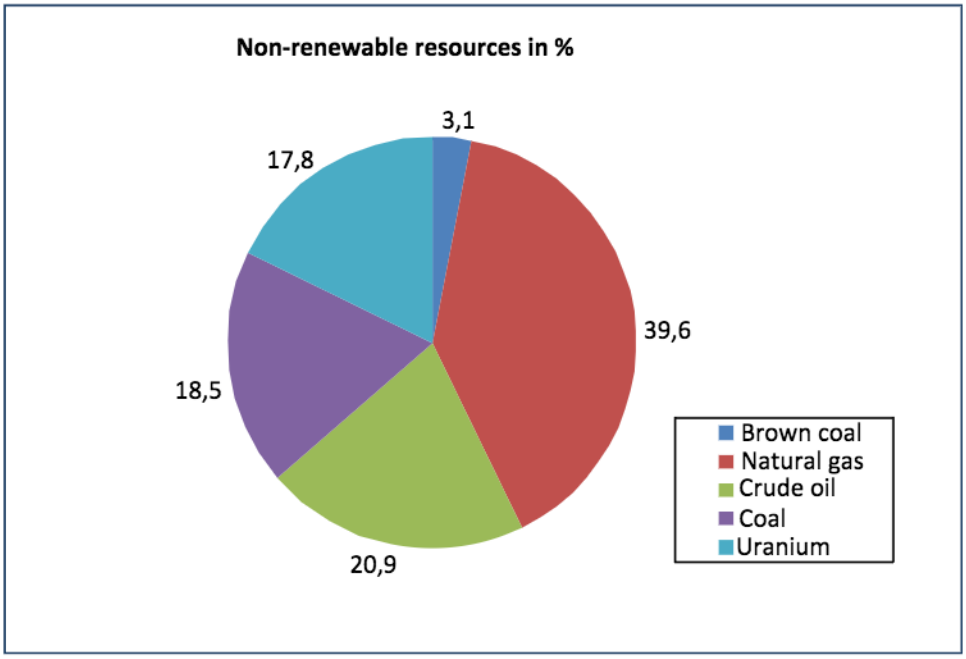

Figure 1: Acquisition type of the non-renewable primary energy in the production phase

The use of primary energy from renewable resources (Figure 2) is mainly determined via hydropower, (43.6%), wind power (38.9%) as well as solar power (16.4%).

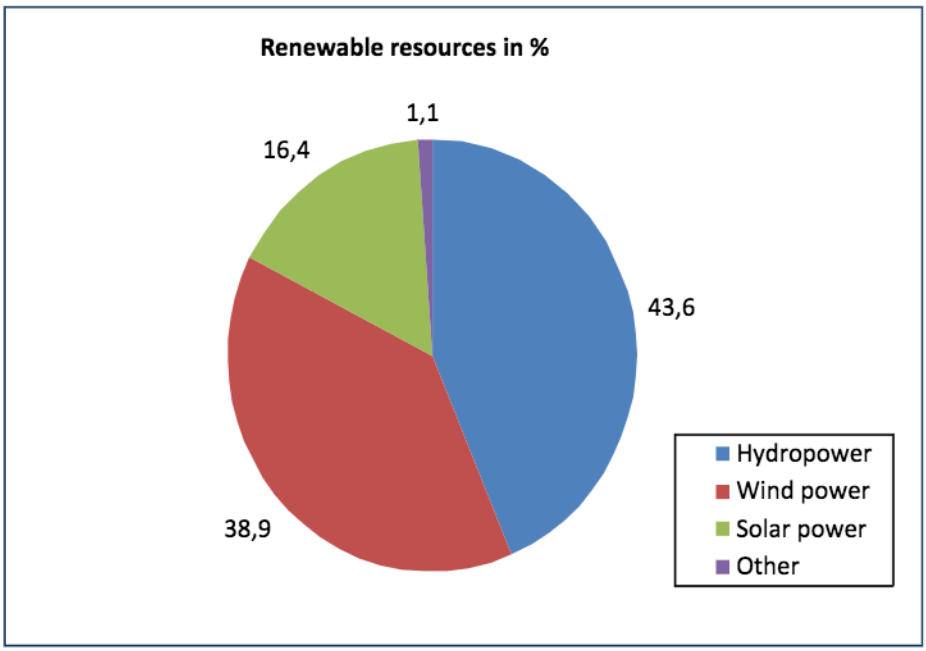

Figure 2: Acquisition type of the renewable primary energy in the production phase

Water utilisation

Table 2 shows the water consumption of 1 kg rolled lead sheet / rolled lead coil. The water consumption for production per kg of the product is around 1.06 kg. The consumption across the total life cycle is 3.12 kg per kg product.

Table 2: Water consumption of 1 kg rolled lead sheet / rolled lead coil

	Unit	Production	EoL	Total
Water	kg	1.06	2.07	**3.12**

Waste

Table 3 shows the amount of waste for 1 kg rolled lead sheet / rolled lead coil.

Table 3: Waste from 1 kg rolled lead sheet / rolled lead coil

Wast	Unit	Production	EoL	Total
Waste / dump goods	kg	2.23	2.44	4.67
Consumer waste	kg	0.086	-0.022	0.064
Dangerous waste	kg	0.023	-5.71E-03	0.018
Radioactive waste	kg	1.23E-03	8.32E-05	1.31E-03
Hazardous waste	kg	0.022	-5.79E-03	0.016

The analysis of the amount of waste is separated into the contingents waste / dump goods (including residues from ore preparation) consumer waste and dangerous waste.

The contingent waste / dump goods represents the largest amount in production. This contingent is mainly created in the provision chain (energy / auxiliary materials) of the secondary lead production. Dangerous waste is mainly waste from upstream stages, as well as the upstream stages of power production. The radioactive waste is exclusively due to the demand (nuclear power).

Impact assessment

For the evaluation of the potential environmental impact of rolled lead sheets and rolled lead coils the CML-methodology (CML = Center voor Milieukunde at Leiden) with the characterization factors of November 2009 is applied.

- Global Warming Potential (GWP)
- Ozone Layer Depletion Potential (ODP)
- Acidification Potential (AP)
- Eutrophication Potential (EP)
- Photochemical Ozone Creation Potential (POCP)
- Abiotic Resource Depletion (ADP[1])

[1] This covers ADP (elements) [kg Sb-eq.]

The following Table 4 represents the impact assessment of 1 kg rolled lead sheet / rolled lead coil.

Table 4: Impact assessment of 1 kg rolled lead sheet/rolled lead coil

Impact category	Unit	Production	EoL	Total
Global Warming Potential (GWP)	kg CO2-Equiv.	1.164	0.199	1.363
Ozone Depletion Potential (ODP)	kg R11-Equiv.	9.787E-08	7.385E-09	1.1E-07
Acidification Potential (AP)	kg SO2-Equiv.	2.31E-03	0.010	0.012
Eutrophication Potential (EP)	kg PO4-Equiv.	2.0E-04	6.5E-05	2.7E-04
Photochemical Ozone Creation	kg Ethene-Equiv.	1.8E-04	8.1E-04	9.9E-04
Potential (POCP) Abiotis Resourc Potential (ADP)	kg Sb-Equiv.	5.9E-06	5.4E-04	5.5E-04

In the production phase the Global Warming Potential is dominated by the carbon dioxide emissions (approx. 96%). Methane contributes to the GWP in production with about 4%.

The Acidification Potential (AP) in production is determined in particular by the sulphur dioxide and nitric oxide emissions in the air.

Nitric oxides in air with about 87% mainly contribute to the Eutrophication Potential (EP) from production.

The Photochemical Ozone Creation Potential (POCP) is caused, first and foremost, by carbon monoxide (approx. 41%), sulphur dioxide (approx. 46%) as well as nitric oxide emissions (approx. 5%) in air.

The Ozone Depletion Potential (ODP) in the production phase is created by diverse organic emissions in air containing halogen.

Environmental burdens in the End-of-Life result from the net consumption of lead scrap across the total life cycle of the considered products.

In the EoL phase Global Warming Potential (GWP) is mainly created by carbon dioxide emissions in air (approx. 95%). The ratio of methane emissions is around 5%.

The Acidification Potential (AP) in this phase is mainly caused by sulphur dioxide emissions (approx. 98 %).

Air emissions contribute with approx. 97.5% (mainly nitric oxides) to the Eutrophication Potential (EP) in the End-of-Life phase as do emissions in fresh water with approx. 3% (mainly COD).

In the EoL phase, the Photochemical Ozone Creation Potential (POCP), with about 99%, is caused by inorganic emissions in air: carbon monoxide (approx 48%), sulphur dioxide (approx. 49%) and nitric oxides (approx.1.5%).

In the End-of-Life phase the Ozone Depletion Potential (ODP) is created by organic emissions in air containing halogen (trichlorofluoromethane, dichlorotetrafluoroethane, dichlorodifluoromethane and chlorodifluoromethane).

9 Proof

There is no concrete proof available. The environmental relevance is documented by the following research reports:

- **Institute of Occupational Medicine:**

Research Report TM/06/04: Assessment of dermal exposure to inorganic lead caused by direct skin contact with lead sheet and moulded PVC profiles.

- **The Netherlands Organisation for Applied Scientific Research (TNO)**

TNO Report R2005/306: The use of lead sheet in the building industry: an environmental profile.

- **The Netherlands Organisation for Applied Scientific Research (TNO)**

TNO Report 2006-A-R0232/B: Environmental performance of lead sheet and alternative weatherproofing products.

- **The Netherlands Organisation for Applied Scientific Research (TNO)**

TNO Report CA05.8041: Experimental study of new lead alloys for atmospheric application

- **Enviros Aspinwall**

Enviros Aspinwall Report LE0280002a. Lead in construction and demolition waste: qualitative study.

10 PCR Document and verification

This Declaration is based on the PCR Document “Construction metals”, 2010-09.

Review of the PCR documents by the Independent Advisory Board (SVA) Chairman of the SVA: Prof. Dr.-Ing. Hans-Wolf Reinhardt (UniversityStuttgart, IWB)
Independent verification of the Declaration according to /ISO 14025/: ☐ internal ☒ external
Validation of declaration: Dr. Wolfram Trinius

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