COPPER CONCENTRATE

ZINC CONCENTRATE

LEAD CONCENTRATE

ENVIRONMENTAL PRODUCT DECLARATION

In accordance with UNE-EN ISO 14025:2010 and UNE-EN 15804: EN 15804:2012 + A2:2019/AC:2021 standards

Zinc, Lead and Copper Mineral Concentrates

From Rudnik and flotation Rudnik DOO.

Programme:	The International EPD® System, www.environdec.com
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This EPD must provide current information and may be updated if conditions change. Therefore, the indicated validity is subject to subsequent registration and publication on www.environdec.com. This EPD is a multiple product (includes zinc, lead, copper concentrates) and the results presented are based on the worst scenario.

Información del programa

Programme:	The International EPD® System
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Product category rules (PCR):	**PCR 2019:14 Construction products version 1.3.4 (EN 15804+A2)**

PCR review was conducted by: The Technical Committee of the International EPD System. See www.environdec.com for a list of members.
Review chair: Claudia A. Peña, University of Concepción, Chile.

The review panel may be contacted via the Secretariat www.environdec.com/contact.

Independent third-party verification of the EPD and data, according to ISO 14025:2006:

☐ EPD process certification ☒ EPD verification

Third Party Verifier: Verifier approved by the International EPD® System.

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The procedure for tracking data during the validity of the EPD involves a third-party verifier:

☐ Yes ☒ No

Manufacturer information:

Owner of the EPD: RUDNIK AND FLOTATION RUDNIK DOO

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Development of the EPD: SGS TECNOS S.A.U

The EPD owner is the sole owner, responsible for and bound by the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully aligned PCRs or PCR versions; cover products with identical functions, technical performance and use (e.g. identical declared/functional units); have equivalent system boundaries and data descriptions; apply equivalent data quality requirements, data collection methods and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For more information on comparability, see EN 15804 and ISO 14025.

General information

Manufacturer: RUDNIK AND FLOTATION RUDNIK DOO
Miše Mihajlovića 2,
32313 Rudnik,
Republic of Serbia

Copper concentrate

Zinc concentrate

Lead concentrate

Company Overview:

The company Rudnik and flotation Rudnik doo is located in Rudnik, in the municipality of Gornji Milanovac, in the Moravica district. The mine is engaged in the exploitation and processing of copper, zinc, lead and silver ores. The company Rudnik was privatized in 2004 when it was bought by the company "Contango" as the majority owner with 70% of the shares of the share capital. In 2012, the company Rudnik became a limited liability company, and the company "Contango" bought the rest of the shares and became a 100% owner of the company Rudnik.
Rudnik is committed to meeting customer-specified requirements and legal, regulatory and other requirements and to continuously improve its Integrated Management System (ISO 9001, ISO 14001, ISO 45001) (ISO 9001:2015 certificate number: Q03-2207RU, ISO 14001:2015 certificate number: E02-2207RU, ISO 45001:2018 certificate number: O03-2207RU). In 2018, the requirements of the international standard ISO 26000 – Guidelines on Social Responsibility were met, and in 2019 it obtained the certification of the Social Responsibility Management System (IQNet SR 10).

It should be noted that environmental management is one of the essential elements of the operations of company Rudnik and Fotation Rudnik on their path towards sustainable development. Guided by the Environmental Protection Policy, the company respects and implements national laws and the requirements of the ISO 14001:2015 standard (certificate number: E02-2207RU) in its daily work.

This EPD is a multiple product (includes zinc, lead, copper concentrates) and the results presented are based on the worst scenario.

The objective of this report and of the EPD is to become a Useful tool for people interested in the construction sector who are increasingly demanding more information about the environmental impact of buildings and works.

Product Life Cycle Analysis (LCA) also allows for better understanding of manufacturing processes and his Environmental impact.

Product Category Rule (PCR): **PCR 2019:14 Construction products version 1.3.4 (EN 15804+A2)**

Product information

Name of the product or family of products covered by this EPD: This Environmental Product Declaration (EPD) describes the environmental impacts corresponding to 1 tonne of concentrated mineral.

There are three concentrates: zinc, lead, copper concentrates, but the results presented are based on the worst scenario.

Description of the product and its use:

Lead concentrate (Pb): Lead concentrate is obtained by the process of flotation concentration. The process includes basic flotation (rough and control) with two-stage purification. After flotation, the lead concentrate contains 20% solid phase (80% H_2O). Due to the high-water content, drainage takes place in two stages:

- Thickening: It is carried out in a radial thickener with a central rake drive, where a thickened product with approximately 60% solid phase (40% H_2O) is obtained.
- Filtration: The thickened material is transported by mud pumps to the disk filter. Drying takes place with the application of vacuum, and disk filters enable continuous operation. After filtering, the moisture in the concentrate drops to 6.5–7.5% H_2O.

The lead concentrate has a blue-gray color. Lead concentrate, in addition to the main element lead (70-75%), also contains the chargeable element silver, whose content is on average 1100 to 1500 ppm (0.11-0.15%). Elements that negatively affect the quality of the concentrate are arsenic with an average content of around 0.1-0.15%, bismuth with an average content of 0.40-0.50% and selenium with an average content of around 0.11%. Other elements with a significant content but without impact on the concentrate are copper about 0.25%, zinc 0.40% and iron about 4.5%. The lead concentrate also contains about 14% sulfur.

Copper concentrate (Cu): Copper concentrate is produced by flotation concentration, which includes basic flotation (rough and control) with one-stage purification. After flotation, the copper concentrate contains 20 % solid phase (80 % H_2O). The dewatering process is carried out in two stages:

- Thickening: It is carried out in a radial thickener with a central rake drive, where a thickened product with approximately 60% solid phase (40% H_2O) is obtained.
- Filtration: The thickened material is transported by mud pumps to the disk filter. Drying takes place with the application of vacuum, and disk filters enable continuous operation. After filtering, the moisture in the concentrate drops to 8.5–9.5% H_2O.

The copper concentrate has a yellow-green color. Copper concentrate, in addition to the main element copper (20-25%), also contains the chargeable element silver with a content of about 0.04-0.06%. The accompanying elements with a negative impact in the copper concentrate are lead 3-5.5%, zinc 3-6%, cadmium 0.03-0.06% and arsenic 0.05-0.10%. Elements with increased content that do not affect the concentrate are iron with about 30-35% and bismuth 0.5-1%. Copper concentrate also contains sulfur about 24.4%.

Zinc concentrate (Zn): Zinc concentrate is produced by flotation concentration. The process includes basic flotation (rough and control) with two-stage purification. After flotation, the zinc concentrate contains 20% solid phase (80% H2O). The dewatering process is carried out in two stages:

- Thickening: It is carried out in a radial thickener with a central rake drive, where a thickened product with approximately 60% solid phase (40% H2O) is obtained.
- Filtration: The thickened material is transported by mud pumps to the disk filter. Drying takes place with the application of vacuum, and disk filters enable continuous operation. After filtering, the moisture in the concentrate drops to 7.5-8.5% H2O.

Zinc concentrate has a dark brown color. Zinc concentrate has the only significant element zinc with a content of about 46-48.5%. Elements with a negative impact are iron with a content of about 13.5-14.5% and cadmium 0.35-0.45%. All other elements have no influence on the concentrate, such as lead around 0.4% and copper 1%. Zinc concentrate also contains sulfur in a concentration of about 29.5%.

The moisture content of all concentrates is determined when the concentrate is shipped. Samples are taken for each truck separately. The moisture content of the samples is determined by an accredited instrumental method for moisture determination.

Copper concentrate | *Zinc concentrate* | *Lead concentrate*

Figure 1: Photographs of mineral products

Chemical data and physical properties:

Appearance	Solid, powder, dark grey
Odour	Weak organic odor from entrained xanthates
Melting point/ (%)	Not applicable
Relative Density	2 - 2,6 g/cm^3
Solubility(ies)	Insoluble in water.
Explosive properties	No explosive material.
Reactivity	Reaction with acids releases toxic hydrogen sulphide
Chemical stability	In a dry clean environment protected from air humidity.
Possibility of hazardous reactions	In contact with acid release a toxic gas.
Incompatible materials	Acid, peroxide, (zinc, cadmium, magnesium) chlorate
Hazardous decomposition products	Many sulfides react violently with strong oxidizing agents to form large amounts of irritating and toxic sulfur dioxid. Operations at high temperatures (cutting with acetylene, etc.) can produce metal fume. Also, this material contains up to 0.05% arsenic under reducing conditions may release highly toxic arsine.

Description of system components:

This EPD is a multiple product (includes zinc, lead, copper concentrates) and the results presented are based on the worst scenario.

The product covered by this LCA is copper concentrate that includes the components described in tables 2 and 3 distributed from the production plant to the customer jointly. The declared Unit is defined according to weight.

Table 1: Composition table of the copper concentrate corresponding to the concentrate in the worst scenario.

Main component	Product Components	Weight (t/wmt)	Post-consumer recycled material, weight %	Biogenic material, kg C/kg
Ore concentrates	Virgen	0,9686	0,00	0,00
COPPER CONCENTRATE	DOWFROTH - 200 FLOATATION FOAMER (Dow D 200)	0,0008	0,00	0,00
	Potassium amyl xanthate	0,0015	0,00	0,00
	Sodium cyanide	0,0011	0,00	0,00
	Ferrous sulphate heptahydrate	0,0035	0,00	0,00
	Potassium dichromate	0,0003	0,00	0,00
	Zinc sulphate	0,0025	0,00	0,00
	Copper (II) sulphate	0,0021	0,00	0,00
	Hydrate lime	0,0162	0,00	0,00
	Hydrochloric acid	0,0035	0,00	0,00
TOTAL		**1,00**	**0,00**	**0,00**
Packaging material		Weight (t/wmt)	Weight % (on the product)	Biogenic material, kg C/kg
RUDNIK AND FLOTATION RUDNIK		0,00	0,00	0,00
TOTAL		**0,00**	**0,00**	**0,00**

In terms of packaging, RUDNIK does not generate packaging waste because everything is transported in bulk.

During the product life cycle, no hazardous substances included in the "Substances Candidate List (SVHC)" have been used in a percentage greater than 0.1% of the product weight. All quantities specified in the system component description table refer to mineral concentrates, unifying all stages of the life cycle.

Table 2: Amount of biogenic carbon in the product.

Results per declared unit		
BIOGENIC CARBON CONTENT	**UNIT**	**AMOUNT**
Biogenic carbon contained in the product	kg C	0
Biogenic carbon contained in the packaging	kg C	0

LCA Information

DECLARED UNITY	1 ton of concentrated product
SYSTEM LIMITS	From "Cradle to gate" with options, C1-C4 module, D module and optional modules (Specific A4).
REFERENCE SHELF LIFE (RSL)	No aplplicable.
CUTTING RULES	Energy consumption for manufacturing facilities is considered to be at least 99% 99% of raw material is considered in bulk. The following processes have been excluded: - Manufacturing of equipment used in production, buildings or any other capital goods - Transportation of personnel to the plant - Transportation of personnel within the plant - Research and development activities - Long-term emissions.
ASSIGNMENTS	Wherever possible, allocations have been avoided. For cases where this has not been possible, a physical allocation based on mass is made. The data referring to the composition of the system have been obtained directly and have been analysed following the principles of modularity and the polluter pays. The allocations of the composition declared in this EPD have been made for the weighted average of the raw materials according to manufacturing data for each of the references.
GEOGRAPHICAL COVERAGE	Global
PERIOD	2022
LCA SOFTWARE USED FOR CALCULATION	Ecoinvent 3.1 (allocation, cut-off by classification) with the Simapro 9.6.0.1 database used for LCS calculations. The LCA methods used are in accordance with the UNE-EN 15804:2012 + A2:2019/AC:2021 standard.

Data quality

The data collected regarding components and energy correspond to the year 2022 and include data on raw materials consumed and energy consumption. The plausibility and consistency of the data collected has been verified. Therefore, the data quality can be considered good.

The calculation of the LCA of the system has not considered the flows related to the construction of production plants, application machines or employee transport and the methodology indicated in the UNE-EN 15804:2012 + A2:2019/AC:2021 standard has been followed.

Other information:

This LCA has been carried out by **SGS TECNOS S.A.U.** The invoices for materials and energy consumption have been collected and verified. The study covers at least 95% of the materials and energy per module and at least 99% of the total materials and energy use of each unit process.

Life cycle and compliance:

This EPD includes the stages shown in Table 3. This declaration is of the cradle-to-gate with options, C1-C4 module, D module and optional modules (Specific A4).

This declaration may not be comparable with those developed in other programs or according to different reference documents; in particular, it may not be comparable with Declarations not prepared according to Standard UNE-EN 15804:2012 + A2:2019/AC:2021. Similarly, environmental declarations may not be comparable if the origin of the data is different, the same information modules are not included, or they are not based on the same scenarios.

	PRODUCT STAGE			STAGE OF THE CONSTRUCTION PROCESS		USE STAGE							END-OF-LIFE STAGE				RESOURCE RECOVERY STAGE
	Supply of materials Premiums	Transport	Manufacturing	Transport	Installation of construction	Use	Maintenance	Repair	Replacement	Restoration	Operational Energy Use	Operational use of water	Deconstruction, demolition	Transport	Waste treatment	Disposal	Reuse-Recovery-Recycling-Potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Declared Modules	X	X	X	X	-	-	-	-	-	-	-	-	X	X	X	X	X
Geography	GLO	GLO	RS	RS	ND	ND	ND	ND	ND	ND	ND	ND	RS	RS	RS	RS	RS
Specific data used	<8% GWP-GHG			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	76,56%			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation: Sites	0%			-		-	-	-	-	-	-	-	-	-	-	-	-

Table 1: System boundaries. X: Declared module; RS: Serbia, GLO: Global, EU: Europe.

Table 2. Total share of primary data, of GWP-GHG results for A1-A3 for concentrate COPPER which represent the worst case

Process	Source type	Source	Reference year	Data category	Share of primary data, of GWP GHG results for A1-A3
Manufacturing of product	Collected data	EPD owner	2022	Primary data	0,00%
Generation of electricity used in manufacturing of product	Database	Ecoinvent v3.1	2022	Secondary data	7,07%
Transport of raw materials	Database	Ecoinvent v3.1	2022	Primary data	0,05%
Production of packaging	Collected data	EPD owner	2022	Primary data	0,00%
Other processes	Database	Ecoinvent v3.1	2022	Primary data	0,01%
Total share of primary data, of GWP-GHG results for A1-A3					**07,13%**

Stages of the life cycle

Description of system limits: "Cradle to gate" with Options module C1-C4, module D and Optional Modules (A4)

Figure 2: Stages of the life cycle of a product according to the analysis from "Cradle to gate" with options, module C1-C4, module D and optional modules.

Product Stage A1 - A3

Stage description:

The product stage of the zinc, lead and copper concentrate range is subdivided into A1 modules for the supply of raw materials, A2 for transport to the manufacturer and A3 for manufacturing. The grouping of these three modules is mandatory contemplated by the UNE-EN 15804:2012 + A2:2019 standard/AC:2021 which is applied in this EPD.

A1 Supply of raw materials

This module refers to the extraction and pre-processing of raw materials and energy sources used in the manufacture of the products that make up the system. This module begins with the extraction of the ore, starting with specialized heavy equipment and machinery, such as wheel loaders, haul trucks, and dump trucks, which transport the ore to the facility for processing.

A2 Transportation to the manufacturing site

This module includes the transport of raw materials to the manufacturing plant. For this module, a Euro VI truck is used as transport.

A3 Manufacturing

This module mainly covers energy consumption during product manufacturing as well as product manufacturing. Stage A3, corresponding to manufacturing. Mineral processing starts with:

1. **Crushing and sieving**

The first stage of crushing is primary crushing. The excavated ore is delivered to the bunker of the primary crusher by truck. From the bunker, the ore is delivered into the primary crusher with a steel articulated feeder. The primary crusher is a jaw crusher marked DCJ 1100x800, from the Czech manufacturer PSP Engineering.
Primarily crushed ore is transported by rubber conveyor belt to secondary crushing. The secondary crusher is a cone crusher marked KDC 22, from the Czech manufacturer PSP Engineering.
Secondary crushed ore is delivered by a rubber conveyor belt to the sieve where the crushed ore is sifted. The sieve is marked SVS 4x1.5 / 2 by STROJNI INŽENIRING, Ljubljana, Slovenia.
Insufficiently crushed ore (sieve oversize product) is drained to the tertiary crushing with a rubber conveyor belt. Tertiary crushing takes place in a cone crusher marked KDC 33, Czech manufacturer PSP Engineering. The product of tertiary crushing is delivered to the sieve with the same conveyor belt as the product of secondary crushing.
Sufficiently crushed ore (sieve sub-sieve product) is sent to the mill with a rubber conveyor belt. From the mill bunker, the ore is dosed to the ball mill by a system of conveyor belts.

2. **Ore grinding and grading**

The ball mill is made in Russia, with a mark of 3.2x3.1. After grinding, the pulp (mixture of ore and water) was obtained. The pulp is taken to a mechanical two-spiral classifier in which the grading is performed.

Insufficiently ground product is returned to the mill for re-grinding and sufficiently ground product is transported by sludge pump to the second level of classification, in the hydrocyclone.
Hydrocyclone sand (insufficiently crushed ore) is returned to the mill replenishment and the overflow (sufficiently crushed ore) goes to the lead conditioner.

3. **Flotation concentration**

After conditioning (preparation), the pulp is gravitationally discharged into flotation machines in the lead section. The machine has a total of 22. The lead concentrate is transported to the lead thickener by a sludge pump. The lead flotation island is also transported to the copper conditioner by a sludge pump. After conditioning, the pulp is drained to flotation machines in the copper section, a total of 22. Copper concentrate is discharged to the copper thickener with a sludge pump and the swelling is discharged to the zinc conditioner. After conditioning, the pulp is taken to flotation machines in the zinc section. A total of 32 machines. The product (zinc concentrate) is discharged by a sludge pump to the zinc thickener and the island represents the definitive tailings of the process and is gravitationally discharged to the tailings pumping station.
From the tailings pumping station, tailings are transported by sludge pumps and piping system to the hydrocyclone on the tailings. In the hydrocyclone, tailings are classified. Sand (large fraction) is installed in the tailings dam and the overflow (small fraction) is taken to the tailing's accumulation.

4. **Dewatering of concentration products**

Definitive concentrates (final products) are pumped to thickeners. In thickeners, the first stage of concentrate dewatering is carried out. The thickened material settles at the bottom of the thickener and the clarified water remains in the upper part of the thickener. Clarified water is drained through a system of channels and pipes into collecting pools, where another level of mechanical water purification is performed. Thickened material, lead concentrate, as well as copper and zinc concentrates, with 50% solids, is pumped to a disk vacuum filter. In them, the second stage of concentrate dewatering takes place. Each filter is equipped with a receiver, dripper, compressed air blower and vacuum pump. After filtering lead concentrate with 7% moisture, copper concentrate with 10-11% moisture and zinc concentrate with 8 - 9% moisture falls into special concentrate warehouses from where it is loaded into trucks with a loader and sent further for metallurgical processing.

5. **Disposal of flotation tailings**

Definitive flotation tailings are transported by gravity from the plant to the tailings pumping station. From there, the tailings are transported to the hydrocyclone at the dam with a tailings pump. The sand of the hydrocyclone (coarse fraction) is used to upgrade the dam of the flotation landfill, and the overflow of the hydrocyclone (light fraction) goes into the sedimentation lake of the landfill. In the sedimentation lake, the finest particles are deposited, and the purified water is used as technical water in the flotation process.
Wastewater from operations: crushing, grinding, flotation, dewatering, preparation and dissolution of reagents, as well as secondary activities are transported and drained into the tailings pond.

All activities take place in two different locations (mine shaft and flotation), 3 km apart. The main office with annexes (logistics, workers' accommodation, canteen, etc.) is located in Rudnik, Republic of Serbia.

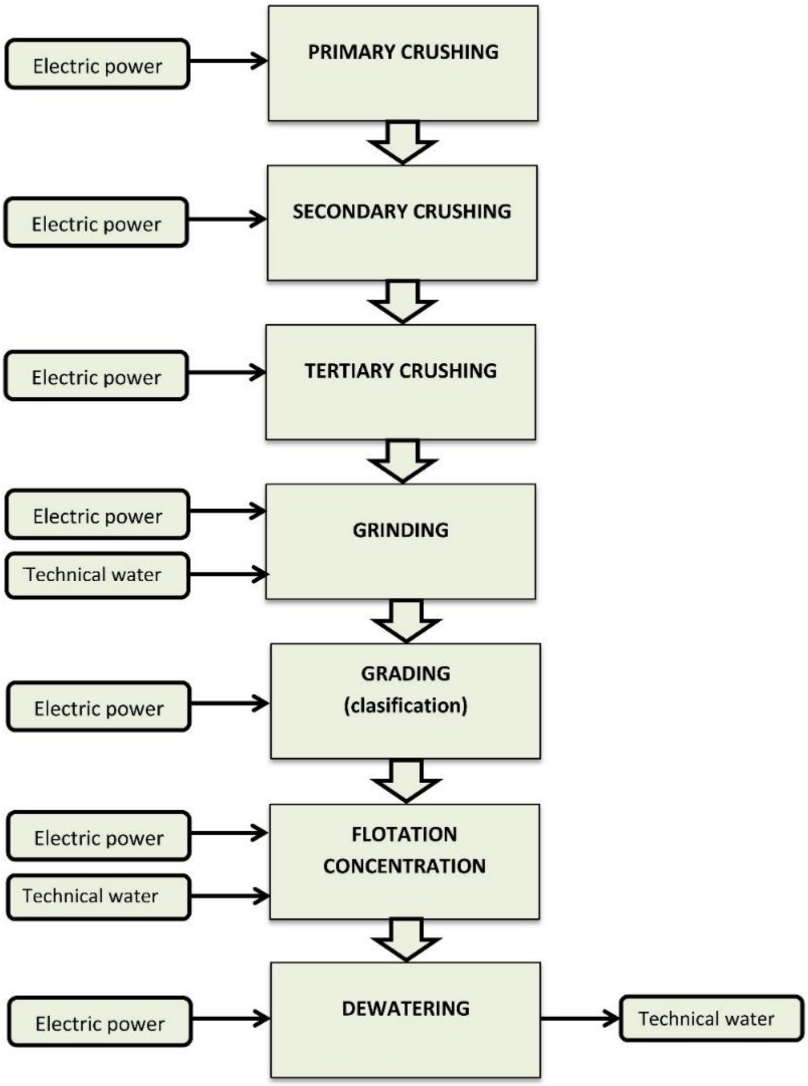

Figure 2: Mineral Extraction Plan Diagram

The origin of the energy used in the manufacturing plant is defined in the plant's electricity bills. The electricity production model considered is that corresponding to the country where the plant is located, Serbia (0,972 kgCO2eq/kWh), according to dataset of Ecoinvent.. It should be noted that Serbia has only one electricity supply company, which is capable of supplying large industrial complexes such as Rudnik.

In addition, this module considers the waste and waste produced during the production process, but packaging is not taken into account for the transport of the product since it is not used, the scope is Serbia. At this stage, manufacturing, no recirculation of materials is carried out. For the case of water discharges, the data at the mine exit is not used; the mine is outside the scope (no data available).

Construction process stage A4 - A5

Stage description:

The zinc, lead and copper concentrate construction process stage are subdivided into modules A4 transport to site and A5 installation.

A4 Transport to construction site

This module covers the transport of the system components from the production site to the application site, including the possibility of intermediate storage. This module considers the distance to the final destination of the product (only Serbia is considered in A4), the quantity of product transported, and the type of transport used, as shown in Figure 4.

Transport is calculated on the basis of a scenario whose characteristic parameters are described in the following table.

PARAMETER	VALUE (expressed per declared Unit)
Fuel consumption of the vehicle or means of transport used	Truck with an average load of 16-32 t (euro 6) for land transport.
Weighted average total distance	133 km by land
Bulk density of the transported product	N.A.
Load capacity utilization (in volume, including return of unladen transport)	% assumed in the Ecoinvent database
Load capacity utilization factor, in volume	1 (default)

Figure4: Stage A4.

A5 Installation

This module covers the application of the product on site. As the product applications depend on the type of use and manufacture of the components, and this is not under the control of RUDNIK, this module has not been included in the life cycle.

Stage of Use (excluding possible savings) B1 - B7

Stage description:

This stage refers to the operation of the building, including emissions into the environment caused by the use of the product (module B1) or by subsequent technical operations: maintenance (B2), repair (B3), replacement (B4) or rehabilitation (B5).

- B1: There are not emissions of volatile organic compounds into the environment of the applied product.
- B2-B5: The performance of the product under consideration allows us to conclude that its useful life is equal to or greater than the useful life of the building. Once applied, the components of the system do not require technical actions or operations until the end-of-life stage, so the product is considered to generate no environmental loads at this stage.

The use stage also includes the use of energy in service (module B6) and the use of water in service (module B7).

- B6, B7: The product does not use water or electricity during its useful life. The use stage does not include the use of energy in service (module B6) or the use of water in service (module B7).

End of life stage, C1 - C4

Stage description:

This phase is made up of the modules related to the end of life, C1 to C4, which are detailed below:

- C1 Deconstruction, demolition: Since the demolition and/or dismantling of the product is part of the demolition of the building itself, the environmental impact is assumed to be extremely low and can therefore be dispensed with.
- C2, transport: Includes the transfer of construction waste from the site to the waste treatment point, estimated at a distance of 50 km.
- C3 Waste treatment: Includes the reuse, recovery and/or recycling of waste. According to DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2008/98/EC on waste (hereinafter, Directive (EU) 2018/851), it is assumed that waste destined for preparation for reuse, recycling, and other material recovery at a treatment facility reaches 70%.
- C4, waste disposal: 30% of waste is supposed to be disposed of in a landfill according to Directive 2018/250 and an average distance of 50 km is considered.

PARAMETER	VALUE (expressed per unit declared)	
Collection process (mixed with the rest of the CDW)	Zinc	1 tonne
	Lead	1 tonne
	Copper	1 tonne
Recovery System	Recovery (70%) – 0.7t	
Disposal (in landfill)	Landfill (30%) – 0.3 t	
Transport assumptions for scenario development	Medium Load Truck 16-32 t (Euro 6)	
Distance to landfill	50 km	

Figure 5: Stage C1_C4

Benefits and burdens beyond system boundaries, D

Module D declares the environmental benefits of reusing and recycling products, as well as energy recovery.

In this EPD, avoided environmental burdens as a result of recycling throughout the product's life cycle are considered, taking into account that 70% of the product is sent for reuse/recycling/vaporization and 30% is sent to landfill, thereby accounting for the environmental benefit.

In this module, savings from recycling throughout the product's life cycle have not been accounted for. Nor have benefits from the product's waterproofing been included. The following formula from EN15804 have been used:

$$e_{module\ D1} = \sum_i \left(M_{MR\ out}\big|_i - M_{MR\ in}\big|_i\right) \cdot \left(E_{MR\ after\ EoW\ out}\big|_i - E_{VMSub\ out}\big|_i \cdot \frac{Q_{R\ out}}{Q_{Sub}}\bigg|_i\right)$$

MmrOut: Amount of materials going to recycling.
MmrIn: Amount of total recycled content of the raw materials used.
Emr after EoW: Emissions recycled material.
Evm sub out: Emissions from virgin material.
Qrout/Qsub = is the quality of the recycled materials and the material going to recycle. Assume as 1.

Environmental impacts of the product

The LCA results are detailed in the tables on the following pages together with the interpretation of the overall impacts produced per declared unit (1 tonne of concentrated product). In this case, the environmental results of the Copper concentrate are shown, since it is the one with the highest environmental impact. Estimated impact results are only relative statements that do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins or risks.

The calculation of the environmental impacts is carried out with the impact characterization factors defined and included in the Simapro 9.6.0.1 software. The calculation methods used to calculate these impacts have been:

- CML-IA baseline V3.07/ EU25
- ReCiPe 2016 Midpoint (H) v1.06 / World (2010) H.
- EDIP 2003 V1.07 / Default.
- Cumulative Energy Demand V1.11
- EF Method 3.1 (adapted) V1.02 / EF 3.1 Standardization and Weighting Set.
- IPCC 2021 GWP100a V1

IMPACT RESULTS COPPER CONCENTRATE

The results shown for this EPD refer to the declared unit of 1 ton of concentrated product.

RUDNIK

EPD®

POTENTIAL ENVIRONMENTAL IMPACTS OF COPPER CONCENTRATE

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
Global Warming Potential, GWP - *kg CO_2 eq (NA)*	Fossil- kg CO2 eq	6,92E+03	2,53E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,50E+00	2,35E+01	1,88E+00	-3,37E+02
	Biogenic- kg CO2 eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	Land use and transformation - kg CO2 eq	7,09E+00	8,39E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,15E-03	1,56E-02	9,66E-04	-7,67E-01
	TOTAL – kg CO2 eq	6,93E+03	2,53E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,50E+00	2,35E+01	1,88E+00	-3,38E+02
Stratospheric Ozone Depletion Potential (ODP)	kg CFC11 eq (NA)	5,51E-05	5,03E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,89E-07	2,56E-07	5,43E-08	-5,94E-06
Acidification potential of soil and water resources, (PA)	mol H+ eq (NA)	9,88E+01	5,26E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,98E-02	1,06E-01	1,33E-02	-3,57E+00
Eutrophication potential, Fraction of nutrients that reach freshwater as an end compartment (EP-freshwater) (NA)	kg P eq	5,18E-01	1,97E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,41E-05	7,11E-04	1,84E-05	-5,81E-02

Eutrophication potential, Fraction of nutrients that reach seawater as an end compartment (EP-marine)	kg N eq.	2,41E+01	1,23E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,63E-03	3,88E-02	5,04E-03	-7,31E-01
Eutrophication potential, Accumulated excess (EP-terrestrial)	*mol N eq (NA)*	3,64E+02	1,36E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,13E-02	3,38E-01	5,53E-02	-8,61E+00
Tropospheric Ozone Formation Potential (POCP)	*kg NMVOC eq (NA)*	7,46E+01	8,75E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,29E-02	1,09E-01	1,98E-02	-2,39E+00
Abiotic resource depletion potential for non-fossil resources (ADP -minerals & metals)	*kg Sb eq (2)*	5,02E+00	8,22E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,09E-05	3,08E-04	2,93E-06	-6,99E-01
Abiotic resource depletion potential for fossil resources (ADP – fossil)	*MJ, net calorific value (2)*	8,44E+04	3,55E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,34E+02	2,26E+02	4,60E+01	-4,54E+03
Water (use) potential, weighted deficiency and water consumption	*m^3 depriv. (2)*	5,68E+03	1,48E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,55E-01	1,35E+00	2,01E+00	-2,19E+02

Disclaimer-(1)- This category of impact mainly refers to the possible impact of low doses of ionizing radiation on human health from the nuclear fuel cycle. It does not take into account the effects due to possible nuclear accidents, occupational exposure or underground radioactive waste disposal facilities. Potential ionizing radiation from soil, radon, and some building materials is also not measured by this indicator.
Disclaimer-(2)- The results of this environmental impact indicator should be used with caution, as uncertainties about these results are high or experience with the indicator is limited.

ADDITIONAL MANDATORY ENVIRONMENTAL IMPACTS OF COPPER CONCENTRATE

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
GWP –GHG2	*kg CO2 eq.*	8,79E+03	3,04E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,14E+01	5,56E+01	2,44E+00	-3,82E+02

Disclaimer-(1)- This category of impact mainly refers to the possible impact of low doses of ionizing radiation on human health from the nuclear fuel cycle. It does not take into account the effects due to possible nuclear accidents, occupational exposure or underground radioactive waste disposal facilities. Potential ionizing radiation from soil, radon, and some building materials is also not measured by this indicator.
Disclaimer-(2)- The results of this environmental impact indicator should be used with caution, as uncertainties about these results are high or experience with the indicator is limited.

POTENTIAL ENVIRONMENTAL IMPACTS OF COPPER CONCENTRATE ADDITIONAL AND VOLUNTARY IMPACTS

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
Potential incidence of emission diseases	PM (PM) - disease inc. (NA)	7,73E-04	1,85E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,96E-07	1,92E-06	3,02E-07	-2,51E-05
Potential of human exposure efficiency relative to	U235 (IRP) - kBq U-235 eq (1)	2,95E+02	1,64E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,17E-02	6,12E-01	1,14E-02	-1,53E+01
Potential Comparative Toxic Unit for Humans (HTP-c)	CTUh (2)	2,60E-04	3,68E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,20E-08	5,29E-07	7,39E-09	-1,09E-04
Potential Comparative Toxic Unit for Humans (HTP-nc)	CTUh (2)	7,69E-06	1,79E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,74E-08	2,05E-07	8,47E-09	-7,23E-06
Potential comparative toxic unit for ecosystems	CTUe (2)	3,66E-04	2,23E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,39E-08	5,20E-07	7,86E-09	-1,03E-04
Soil Quality Index (SQP) Potential	Pt (2)	5,91E+04	2,15E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,07E+01	7,00E+02	9,05E+01	-7,27E+03

Disclaimer-(1)- This category of impact mainly refers to the possible impact of low doses of ionizing radiation on human health from the nuclear fuel cycle. It does not take into account the effects due to possible nuclear accidents, occupational exposure or underground radioactive waste disposal facilities. Potential ionizing radiation from soil, radon, and some building materials is also not measured by this indicator.
Disclaimer-(2)- The results of this environmental impact indicator should be used with caution, as uncertainties about these results are high or experience with the indicator is limited.

COPPER CONCENTRIC PRODUCT RESOURCE USAGE

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
Primary Energy Resources - Renewables	Used as a MJ energy source, net calorific value	2,49E+04	6,10E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,29E+00	2,46E+01	4,27E-01	-5,66E+02
	Used as raw material MJ, net calorific	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL, MJ, Net Calorific Value	2,49E+04	6,10E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,29E+00	2,46E+01	4,27E-01	-5,66E+02
Primary Energy Resources - Non-Renewable	Used as a MJ energy source, net	8,97E+04	3,78E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,42E+02	2,40E+02	4,89E+01	-4,86E+03
	Used as raw material - MJ, net calorific	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL, MJ, Net Calorific Value	8,97E+04	3,78E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,42E+02	2,40E+02	4,89E+01	-4,86E+03
Secondary Materials	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Renewable secondary fuels	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net freshwater use	m3	1,49E+02	4,93E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,85E-02	8,10E-02	4,79E-02	-6,36E+00

COPPER CONCENTRATE WASTE CATEGORY

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
Hazardous waste disposed of	kg	3,32E-01	2,39E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,00E-04	1,33E-03	2,91E-04	-5,94E-02
Non-hazardous waste disposed of	kg	6,26E+01	1,72E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,45E+00	2,14E+01	3,00E+02	-3,52E+01
Radioactive waste disposed of	kg	1,93E-01	1,15E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,31E-05	4,82E-04	7,15E-06	-7,88E-03

OTHER OUTPUT STREAMS OF COPPER CONCENTRATE PRODUCT

Parameters		Product Stage	Construction Process Stage		Stage of use							End-of-life stage				Module D
		A1 / A2 / A3	A4 Transportation	A5 Installation	B1 Application	B2 Maintenance	B3 Repair	B4 Replacement	B5 Rehabilitation	B6 In-Service Energy Use	B7 Use of water in service	C1 Deconstruction/demolition	C2 Transportation	C3 Waste treatment	C4 Waste disposal	Potential for Reuse, Recovery and Recycling
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material to be recycled	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E+02	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported, thermal energy	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Interpretation of LCA

The following graphs allow to determine which stages of the Life Cycle have the greatest impact on the selected environmental indicators.

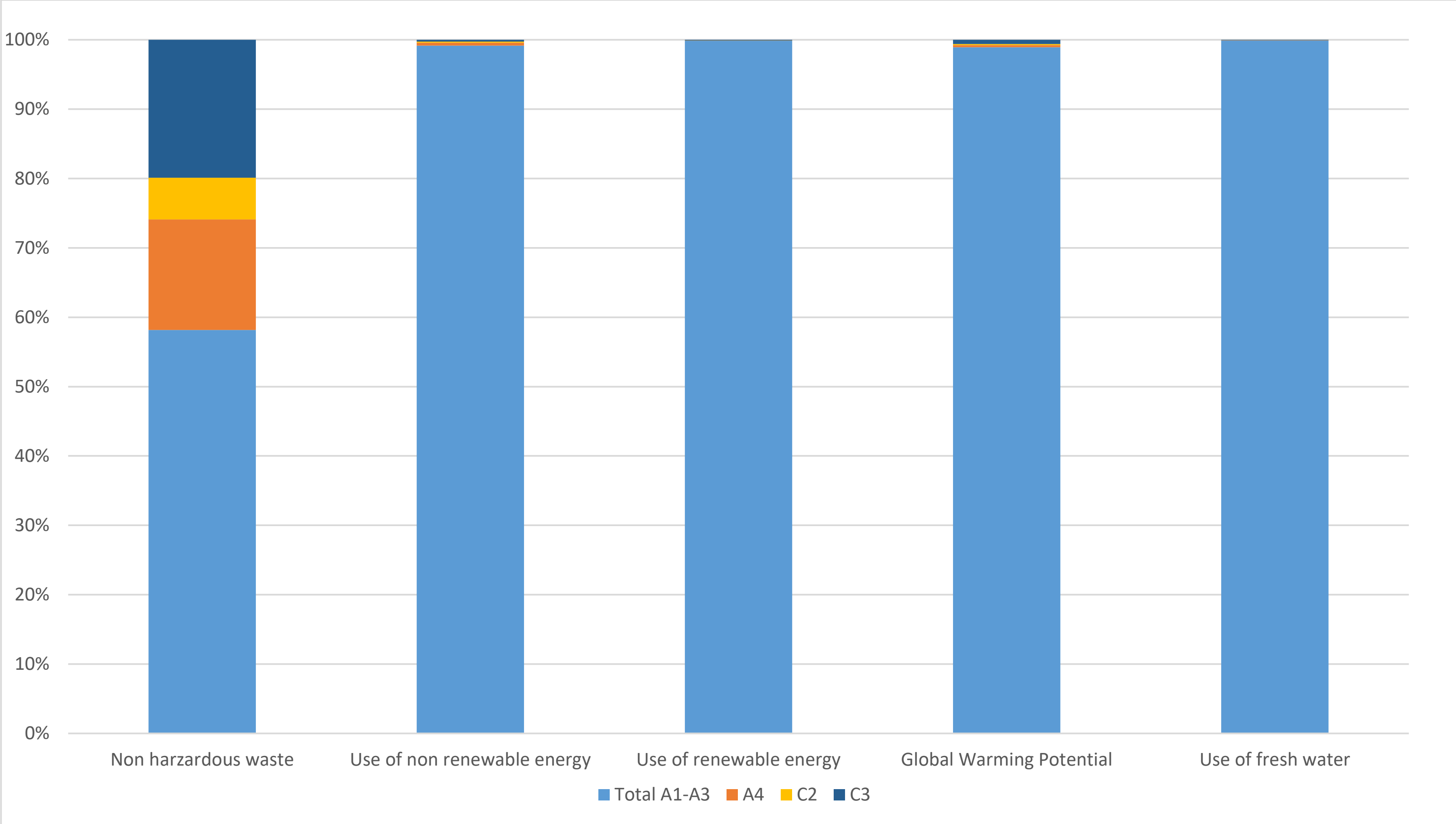

Figure 6: Environmental impacts of copper concentrate

Health information

See the safety data sheets for the system components.

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Additional Information

Environmental management is one of the essential elements of the business of the company Rudnik and the Rudnik flotation plant on the path to sustainable development, as the company implemented the ISO 14001 standard in its operations ten years ago. Responsibility towards nature is one of the most serious obligations of companies and employees. By implementing the standards, company demonstrates the compliance with the legal regulations governing the field of environmental protection. Accordingly, the company has identified the key impacts of its business on the environment and has established mechanisms to reduce the consumption of natural resources, with clearly defined objectives. Every year the company sets goals that are in line with the environmental protection policy. Also, an evaluation of environmental aspects is done every year. By applying the standards, company recognized all interested parties on whom the company has the impact.

Guided by the Environmental Policy, the company in its daily work respects and applies national laws and the highest international environmental standards - ISO 14001. The environmental protection policy has been communicated to all relevant parties, which is a proof that company is transparent on this topic.

The monitoring project defines the monitoring program for each environmental component separately, the appropriate legal basis regarding sampling and monitoring procedures, monitoring methods, sampling location, sampling time and sampling time and duration, as well as monitoring.

For more information, please visit: https://www.contangorudnik.co.rs/zastita-zivotne-sredine/

Below are the variability tables corresponding to the mineral concentrate with maximum impact versus the concentrate with minimum impacts.

Table 5. Significance analysis of products

IMPACT CATEGORY	UNIT	Maximum (copper)	Minimum (Lead)	SIGNIFICANCE ANALYSIS
Global Warming Potential - fossil fuels (GWP-fossil)	kg CO2 eq.	6,98E+03	1,65E+03	76,31%
Global Warming Potential - biogenic (GWP-biogenic)	kg CO2 eq.	5,68E+01	0,00E+00	0,00%
Global Warming Potential - land use and land use change (GWP-luluc)	kg CO2 eq.	7,12E+00	1,16E+00	83,70%
Global Warming Potential - total (GWP-total)	kg CO2 eq.	7,25E+03	1,70E+03	76,56%
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	5,61E-05	1,06E-05	81,16%

Acidifcation potential, Accumulated Exceedance (AP)	mol H+ eq.	9,90E+01	2,28E+01	76,94%
Europhication potential - freshwater (EP-freshwater)	kg P eq	5,19E-01	2,27E-01	56,15%
Europhication potential - marine (EP-marine)	kg N eq.	2,41E+01	3,79E+00	84,28%
Europhication potential - terrestrial (EP-terrestrial)	mol N eq.	3,65E+02	5,50E+01	84,92%
Photochemical Ozone Creation Potential (POCP)	kg NMVOC eq.	7,49E+01	1,22E+01	83,74%
Abiotic depletion potential - non-fossil resources (ADPE)	kg Sb eq.	5,02E+00	6,88E-01	86,28%
Abiotic depletion potential - fossil resources (ADPF)	MJ	8,51E+04	1,98E+04	76,72%
Global Warming Potential (GWP-GHG)	kg CO2 eq.	8,89E+03	1,97E+03	77,82%
Particulate Matter emissions (PM)	Disease incidence	7,77E-04	1,24E-04	84,10%
Ionizing radiation, human health (IRP)	kBq U235 eq.	2,96E+02	5,29E+01	82,12%
Eco-toxicity - freshwater (ETP-fw)	CTUe	6,28E-04	6,15E-05	90,21%
Human toxicity, cancer effect (HTP-c)	CTUh	8,15E-06	2,25E-06	72,43%
Human toxicity, non-cancer effects (HTP-nc)	CTUh	3,67E-04	6,09E-05	83,40%
Land use related impacts/Soil quality (SQP)	dimensionless	6,02E+04	9,59E+03	84,05%
Use of renewable primary energy as energy carrier (PERE)	MJ	2,50E+04	4,29E+01	99,83%
Total use of renewable primary energy (PERT)	MJ	2,50E+04	4,33E+03	82,68%
Use of non-renewable primary energy as energy carrier (PENRE)	MJ	1,15E+05	2,13E+04	81,47%
Use of non-renewable primary energy resources used as raw materials (PENRM)	MJ	0,00E+00	0,00E+00	0,00%
Total use of non-renewable primary energy resource (PENRT)	MJ	1,15E+05	2,13E+04	81,47%
Net use of fresh water (FW)	m3	1,49E+02	1,18E+02	21,02%
Hazardous waste disposed (HWD)	kg	3,37E-01	1,26E-01	62,64%
Non harzardous waste disposed (NHWD)	kg	4,07E+02	3,78E+02	7,31%
Radioactive waste disposed (RWD)	kg	1,94E-01	3,57E-02	81,6%

Information related to the EPD sector

This is an individual EPD. This EDP is a declaration of the mineral COOPER concentrate.

Differences from previous versions

This is the first version of the Environmental Product Declaration (EPD) and LCA.

Origin of information

Scope: Serbia

Period: 2022

The information has been obtained from the Ecoinvent 3.1 databases and/or from raw material suppliers

Raw Materials	Generic databases, and information from suppliers or producer associations
Production	Own data
Transport	Generic or specific information
Aplication	N/A
Life in use	N/A
NAEnd of life	Generic information
Energy	Specific information

References

- General Programme Instructions of the International EPD® System. Version 4.0.
- ISO 14020:2000: Environmental labels and declarations — General principles
- ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures (2010).
- ISO 14040, Environmental Management – Life Cycle Analysis – Principles and Framework (2006).
- ISO 14044:2006, Environmental management – Life cycle analysis – Requirements and guidelines (2006).
- PCR 2019:14 Construction products - version 1.3.4 - EN (2019): EN 15804:2012+A2:2019, Sustainability of construction works – Environmental product declarations – Core rules for product category of construction products.
- UNE-EN 15804:2012+A2:2019/AC:2021 – Environmental Product Declarations – Basic Product Category Rules for Construction Products.
- LCA RUDNIK v02 (January 2025).