International Copper Association
Copper Alliance

Carbon Footprint of Copper Production

Best Practice Guidance for Greenhouse Gas Measurements

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1ST EDITION

Acknowledgements

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INTRODUCTION

Greenhouse gas (GHG) emissions are the major driver for climate change, one of the **biggest challenges of our time**.

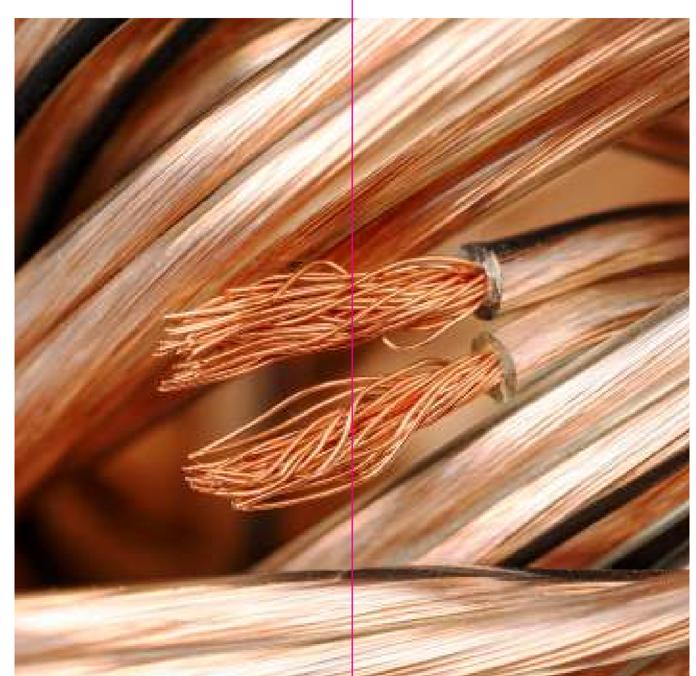
According to ICA's analysis based on 2018 data, copper production[1] represents approximately 0.2% of global GHG emissions, and while this contribution to global GHG emissions is currently low, copper demand is expected to double by 2050, driven in part by the need for copper for the clean energy transition. Given this awareness, copper miners and producers recognize that they have a responsibility to mitigate GHG emissions, and many companies have made commitments to, and are engaged in, reducing their GHG emissions.

Efforts by companies to reduce GHG emissions at corporate, site and product level, must be supported by robust, reliable and transparent method and data to enable those companies to accurately track progress towards decarbonization, to report carbon footprint (CF) data along the supply chain to direct customers and to downstream Original Equipment Manufactureres (OEMs) using copper products, and to report to market initiatives like the London Metals Exchange's (LME) LMEpassport and Copper Mark that are asking for CF disclosures. Companies also need to prepare for new regulations that may require copper, copper-product, and site CFs. Harmonized methodologies for determining the CFs of products and organizations can support and facilitate a level playing field for reporting and disclosure as we move towards product choice based on CFs comparisons in the marketplace.

The measurement of GHG emissions is therefore an important step in understanding total emissions affecting climate change, identifying hot spots where significant GHG emissions occur, demonstrating and measuring efforts in reducing GHG emissions, and determining their contribution to climate change mitigation.

With carbon accounting we refer here to the measurement of GHGs emitted into the environment during the entire life cycle of a product or activity.

There is currently no sector-specific methodology available for determining the CF of sites producing copper and copper-containing products, which can lead to differences in how CFs are calculated as those responsible for reporting rely on general standards and frameworks that do not include copper specificities. This best practice guidance has therefore been developed to provide a first harmonized and consistent approach for determining the CF of copper products and sites. This sector-specific guidance was developed with several market initiatives in mind to facilitate consistent reporting between sites producing copper and copper product CFs by copper miners and producers. As such, this best practice guidance focuses specifically on CFs as they relate to one environmental impact category: the potential to contribute to mitigate climate change.



This best practice guidance focuses specifically on carbon footprints as they relate to one environmental impact category: the potential to contribute to mitigate climate change.

1 Scope 1, 2 and certain upstream Scope 3 categories as detailed in this guidance

COMPLEMENTARY REPORTING SCHEMES

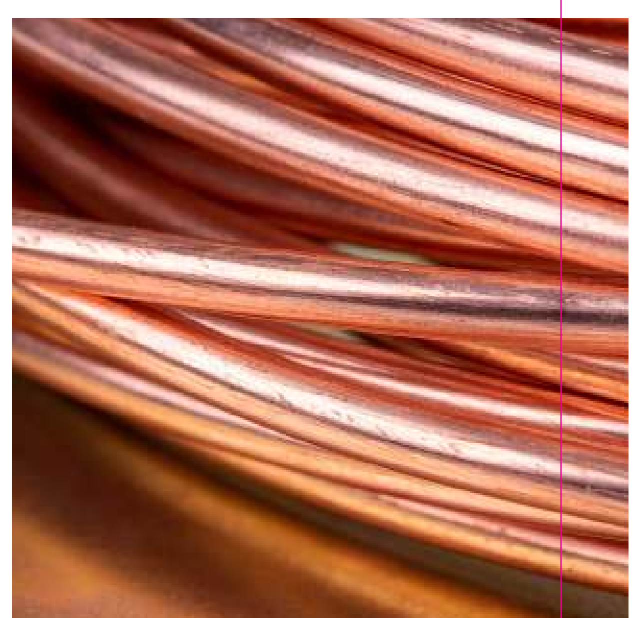
This best practice guidance document is aligned with the following existing standards and methodologies:

- ISO 14044:2006/Amd 2:2020, Environmental management — Life cycle assessment — Requirements and guidelines — Amendment 2
- ISO 14067:2018, Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification
- It is mostly aligned with the following accounting and reporting guidance e.g., Copper Mark, LMEpassport carbon footprint disclosures, EU Environmental Footprint (Product and Organization), EU Corporate Sustainability Reporting Directive

This best practice guidance also draws on the following reference materials as indicated:

- WRI/WBCSD's GHG Protocol Scope 1, 2 and 3 Guidance
- WRI/WBCSD's GHG Protocol Product Life Cycle Accounting and Reporting Standard

The goal of this guidance is to provide all stakeholders with a first version of a harmonized and consistent approach for calculating the CF for the copper production sector.



GOAL AND SCOPE

The goal of this guidance is to provide all stakeholders with a first version of a harmonized and consistent approach for calculating the CF for the copper production sector. It covers all production routes (pyrometallurgical, hydrometallurgical and secondary) and associated precursor products, including copper concentrates (**see Figure 5**). It ensures that data communicated by copper producers are coherent and based on the same calculations, methods, and parameters (**see Chapter 5, activity data**). We acknowledge however that direct comparability cannot be ensured, as different LCA/CF background data sources (e.g. for purchased electricity, transport processes etc.) can still be used. Finally, as to the scope of this guidance, the semi fabrication of products, which takes place after the cathode production step, is not included in this guidance.

The global warming impact of a product in this report is the summation of all defined GHG emissions over the production stages of the relevant product from cradle to gate. The impact is expressed in CO_2 equivalents (CO_2eq; an indicator of climate change impact) per kg of refined copper metal and includes, besides carbon dioxide (CO_2), impacts from other gases that contribute to climate change for example methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). The United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) has published emission factors [Global Warming Potentials (IPCC Second Assessment Report) | UNFCCC, 2019] for these different GHGs based on 100-year Global Warming Potential (GWP), which ICA recommends to be used for converting the life cycle inventory results into CO_2eq (**Table 1**). Emissions to air, water or/and soil that do not have the potential to contribute global warming directly, are not considered in this guidance. Moreover, as this guidance is about climate change, other potential environmental impacts are out of scope of this present guidance.

Offsetting in GHG accounting is not recommended under the GHG Protocol and is not specifically covered in this guideline. In case of the use of offsets please refer to nternationally recognized standards e.g., WRI/WBCSD's GHG Protocol for Project Accounting, Gold Standard, Voluntary Carbon Standard, and report it separately.

Gas Name	Chemical Formula	Global Warming Potential (GWP) for 100-Year Time Horizon
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
CFC-12	CCl_2F_2	10,200
HCFC-22	$CHClF_2$	1,760
Tetrafluoromethane	CF_4	6,630
Hexafluoroethane	C_2F_6	11,100
Sulfur hexafluoride	SF_6	23,500
Nitrogen trifluoride	NF_3	16,100

TABLE 1: List of some greenhouse gases (GHG) and their characterization factors (Draft-PC-Appendix_A_Global-Warming-Potentials.pdf (theclimateregistry.org))

GHG EMISSIONS MEASUREMENT

At the product level, the most common, globally accepted method framework available to measure climate change potential and other environmental impacts, is environmental life cycle assessment (LCA). LCAs provide data and information on many environmental impact categories. The life cycle approach is an agreed way for carbon accounting. LCA methodology involves analyzing the potential environmental impacts of products over their entire life cycle (from raw material extraction through manufacturing, distribution, use, and end of life disposal) or a subset of their life cycle. This guidance addresses only the climate change impact category: GWP, which is one of those covered in LCA. LCA specifies the principles, requirements and methodologies for quantifying and communicating GHG emissions from refined copper metal production processes and the associated cradle-to-gate CFs. This guidance is based on ISO 14044 standard on environmental management – life cycle assessments – requirements and guidelines, which represents a general framework and guidance for all products and systems and is not specific to the copper industry and i ts characteristics.

The WRI's GHG Protocol provides the world's most widely accepted method of carbon accounting for companies and organizations[2]. The GHG Protocol is consistent with IPCC guidelines for national GHG inventories and with the ISO GHG emissions reporting standard (ISO 14064-1). However, the GHG Protocol is limited in that there is currently no sector-specific guidance on carbon accounting in the metals and mining sector. For this reason, there is a need for the development of a sector methodology that is built on, and expands upon, the GHG Protocol Standards.

LCA typically aggregates Scope 1, Scope 2, and select Scope 3 emissions on a per product basis. In this way LCA and GHG accounting are related. As per WRI, "The sum of the life cycle emissions of each of a company's products, combined with additional Scope 3 categories (e.g., employee commuting, business travel, and investments), should approximate the company's total corporate GHG emissions (i.e., Scope 1 + Scope 2 + Scope 3)."[3]

The application of this guidance allows producers of copper concentrates and copper metal producers as well as their customers and other stakeholders to calculate the climate change impact of copper metal production and its intermediate products e.g., concentrates.

For reasons of comparability, inputs and outputs that are likely to be GHG-linked for each unit process identified are to be processed. While the activities may differ between company, accounting for all material emission sources will ensure comparability between similar companies. To determine the extent to which inventories may be compared, a review of the material categories included in the inventory should be performed. Towards this end, companies are encouraged to transparently disclose emission categories reported and include justification for any sources not included within the inventory.

No matter which system boundary is selected, data must be collected for all activities which occur in the boundary over a certain time frame. Typically, the time frame is one calendar or financial year of production (neither choice is superior, but the chosen time frame must be transparently disclosed). It is generally expected that companies produce annual emission reports.

It is helpful to create a systemized process for data collection, management, and reporting. Data management may involve monthly check-ins with leaders of various departments and automized systems for data collection. Established systems may be an eligible aspect of an environmental management system in accordance with ISO 14001[4]. It is additionally recommended that personnel are provided with general energy and GHG awareness training to support accurate data collection.

Once a company completes its GHG inventory, typically it seeks to communicate its carbon footprint externally. The ability to understand and communicate its organizational CF positions a company to satisfy both existing reporting requirements and forthcoming regulation. A landscape analysis exploring the programs, frameworks, and legislation that comprise these requirements and regulatory developments is shown in Table 2[4]. It visually displays the connections between select frameworks in the landscape when comparing measuring/reporting requirements.

1. Mandatory reporting regulations		
EU Directive No. 2003-87-EC: GHG emission allowance trading within the community	U.S. Clean Air Act	etc.
2. Reporting schemes aimed at investors		
CDP DISCLOSURE INSIGHT ACTION	TCFD TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES	Securities and Exchange Commission
EFRAG European Sustainability Reporting Standards (ESRS)	IFRS® General Requirements for Disclosure of Sustainability-Related Financial Information	The Enhancement and Standardization of Climate-Related Disclosures for Investors (ESCDI)
3. Generic accounting and reporting standards		
GRI	ISO 14044 Life Cycle Assessment ISO 14067 Carbon Footprint	PEF/OEF
GREENHOUSE GAS PROTOCOL	ISO 14064 Organizational GHG Inventories	Organizational Life Cycle Assessment (OLCA)
4. Sector-specific accounting and reporting standards		
Aluminum Carbon Footprint Guidance (CF Al)	Nickel Carbon Footprint Guidance (CF Ni)	SHG Zinc Carbon Footprint Guidance (CF Zn)
Responsible Steel	ICMM Measurement and Reporting Initial Guidance and Self Assessment Tool	THE COPPER MARK RESPONSIBLY PRODUCED COPPER

TABLE 2: Landscape assessment of GHG accounting and reporting schemes[5].

2 Greenhouse Gas Protocol Standards. https://ghgprotocol.org/standards.

3 WRI/WBCSD. Product Life Cycle Accounting and Reporting Standard. https://ghgprotocol.org/product-standard.

4 ISO 14001:2015. https://www.iso.org/standard/60857.html.

5 WAP & University of Twente: Carbon Landscape Report prepared for ICA & report prepared by Prof. Dr. Markus Berger, University of Twente for ICMM (Note that only select frameworks/programs/regulations are shown in Table 2. Within each, requirements beyond those related to climate change/emissions are not represented.)

Consistency and comparability ensure that GHG data are usable, and the final outcomes are credible.

HARMONIZED CARBON ACCOUNTING

This guidance seeks to propose a harmonized approach to carbon accounting and reporting to facilitate both intra- and inter-industry collaboration within the copper production sector. The guidance covers both site and product-level CF to avoid significant portions of the carbon reporting landscape from falling outside of the scope of the guidance. Corporate level carbon accounting encompassing other businesses beyond copper mining and production is not covered in this guidance. GHG inventory data collection should be based on a life cycle approach and aligned with the methodologies of the WRI/WBCSD's GHG protocol to the extent possible. Product-level carbon reporting should be grounded in ISO 14040 and 14044 and tackle key industry-specific issues, such as accounting for allocation between co-products, particularly for multi-materials producers. Reporting of absolute and intensity emissions data (Scope 1 and 2 at a minimum, with the intention to phase in inclusion of Scope 3 within a given timeframe) should be required to allow for industry-level aggregation and facilitate the sharing of product-specific data. All material emission sources should be reported, thereby ensuring comparability between similar companies.

Consistency and comparability ensure that GHG data are usable, and the final outcomes are credible. As a result, harmonization is essential to fulfil both voluntary and required reporting guidelines.

In the following sections key aspects (system boundary, data collection, activity data, etc.) for carbon accounting are described.

SYSTEM BOUNDARY

This guidance applies to all copper production routes, thus pyrometallurgical, hydrometallurgical and recycling (also called secondary) routes are included in the scope. Mining and concentrate production as well as all related auxiliary processes, e.g., waste management, etc. are also included (**Figure 5 and Table 3**).

Copper is produced from a variety of primary and secondary raw materials. Raw materials contain significant and variable amounts of metals other than copper. Copper smelters process sulfidic copper concentrates consisting of complex copper/iron sulfidic minerals (15 - 45 % Cu) and other metal-containing minerals (Pb, As, Zn, Ni, Ag, Au, Pt, Pd, Se). Secondary raw materials include scrap and other complex materials with different contents of copper and other metals. Some producers process oxidic and complex oxidic/sulfidic ores using hydrometallurgical techniques.

The production processes are designed to produce copper. However, other co-metal products such as lead, molybdenum (concentrate at mine level), tin and valuable metals e.g., silver, gold, platinum group metals, selenium and tellurium, are also recovered as co-products during refining operations. Most operations also recover sulfuric acid and iron silicate as co-products.

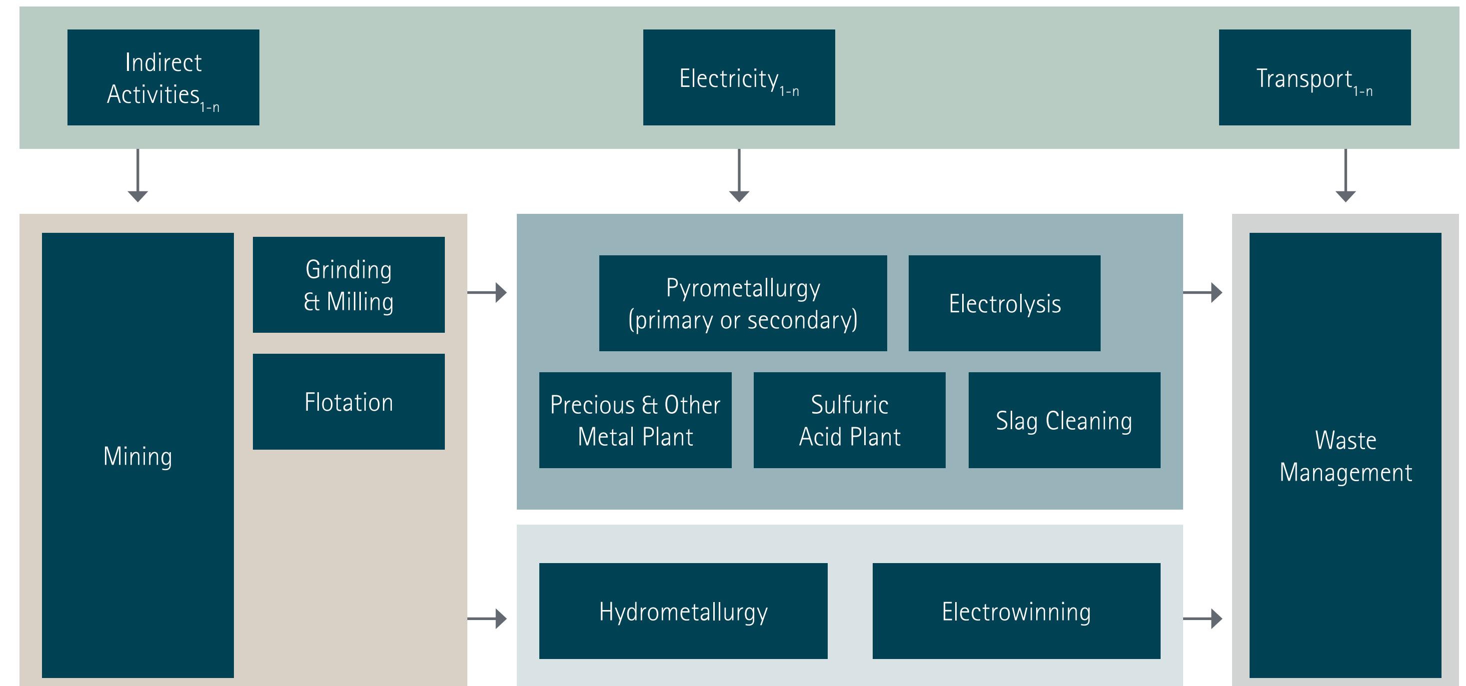


FIGURE 5: representatives processes of the copper production

INCLUDED		EXCLUDED	
Ore and overburden	Internal transportation (e.g., transport from mine to smelter)	Capital goods	Upstream and downstream Leased assets
Production and upstream transport of ancillary materials	On- and offsite electricity production	Packaging materials	Downstream transport of sold products
Waste residues managed onsite	Overhead of manufacturing facilities	Business travel	Processing of sold products
Effluents and emissions to air	Processing of materials and intermediates	Employee commuting	Use of copper products
Water usage		Collection and pre-treatment of externally sourced secondary copper	Franchises
Offsite waste disposal		Upstream transport of secondary copper	Investments
			End of life of copper products

TABLE 3: List of activities included or excluded from the scope of copper production

Production system boundaries are defined to encompass all facilities and associated processes that are fully or partially owned and/or operated by the organization and that directly contribute to the provision of the product portfolio. The activities and impacts linked to processes within the defined production system boundaries are considered "direct" activities and impacts (see **Figure 5**).

Production system boundaries may include different routes as follows:

- Mining and beneficiation
- Primary copper pyrometallurgical route
- Secondary copper pyrometallurgical route
- Integrated pyrometallurgical multi-metal route
- Hydrometallurgical route

Different sub-modules may be combined depending on the route:

- Beneficiation and separation of different metal concentrate (copper, molybdenum, low grade, high grade, others)
- Primary smelting and converting (in two process steps or in one process step)
- Secondary smelting and converting
- Fire refining and copper electrolysis
- Recovery of Pb/Sn/zinc oxide
- Recovery of precious metals, crude selenium and/or tellurium, ammonium perrhenate
- Slag cleaning (and iron converting)
- Sulfuric acid plant products (Acid and liquid SO_2 and or oleum)
- Storage of raw materials
- Secondary material pre-treatment
- Leaching
- Solvent extraction
- Electrowinning
- All related auxiliary processes such as waste treatment (e.g., landfilling on site), wastewater treatment (on-site including for treatment of process water, direct cooling water and surface run off water), gas abatement systems (including for primary and secondary off gases), boilers (including pre-treatment of feed water), internal logistics, tailing management

Upstream processes:

- Production and supply (transport) of chemicals and auxiliaries
- Production and supply (transport) of fuels and other energy carriers (e.g., Steam)
- Production and supply of electricity
- Production of purchased anodes and blister copper (in case of gate-to-gate accounting e.g., only smelters)
- Transport of raw materials (copper concentrate, scrap, purchased anodes and blister) in vehicles not owned by the organization (in case of gate-to-gate accounting e.g., only smelters)
- Others

Downstream processes other than production waste and wastewater treatment are excluded from the system boundary. Transport of products included in the Product Portfolio to the next organization shall not be included within the scope of this Guidance. End of life is excluded.

DATA COLLECTION

In general, three steps define the practice of data collection for carbon accounting: drawing a system boundary, identifying activities that are material emission sources, and measuring activities within the boundary over a certain time frame. GHG activity data is then converted to quantities of CO_2eq.

Site direct activities

The following requirements shall be applied for collection of specific data:

- Primary/site-specific data shall be collected specifically at/by the companies.
- The data shall be collected in accordance with the applied technology and the relevant material and energy flows as well as relevant burdens of the processes. Information on technology used to produce the products (example type of furnace) as well as location of manufacturing site (country scale) shall be provided in the report.
- The data shall include all known GHG inputs and outputs for the core processes, including input of resources, primary metal/secondary metal, energy, water, fluxes, reagents and additives, outputs of products, co-products, intermediates disposal of waste/production residues, consideration of related emissions to air and water, and recycling of production scrap.
- The data collection shall cover at least a calendar year (12 months) that is representative for the product portfolio produced.
- The following sources of data shall be considered:
  - Process or plant level consumption data
  - Reports, invoices and stock/inventory-changes of materials, fuels, and consumables
  - Technical balance for metals in raw materials, final products, and intermediate products
  - Technical balance for water and steam distribution. The water balance shall differentiate between type of input water per source (tap, river, lake etc.) and per use (process, cooling)
  - Emission reports to authorities as required by permits or to fulfil reporting requirements e.g., Pollutant Release and Transfer Register
  - GHG inventory calculations and reports under representative Emission Trading Scheme and international bodies (e.g., UN, International Energy Agency (IEA), IPCC)
  - Direct emission measurements (concentrations plus corresponding off-gas and wastewater amounts, based on highest standards of measurements as defined in reference documents (e.g., Best Available Techniques Reference Documents for the Non-Ferrous Metals Industries and other monitoring reference reports)
  - Reports on waste types and amounts and designated treatment (e.g. recycling, landfilling)
  - Reports from procurement and sales departments (related to purchased auxiliary materials, explosives, concentrates, secondary raw materials, reagents, sold products)
- Information on the source of data (direct measurements, material balance, calculations using certain empirical formulas and factors, expert estimates) and methodology used for calculations shall be provided in the report.

To ensure completeness and validate the system under analysis each unit process shall be subject to a material balance. Using stoichiometric calculations, the mass of input flows should be compared with the mass of corresponding output flows. The difference shall be reported in percent for each unit process separately and the overall total difference should not exceed 20% (justification shall be provided in case the 10% threshold is exceeded). If an aggregated approach is taken, then the mass balance should be reported on the aggregated system.

The calculations and measurements should follow existing standards or at least worldwide accepted guidelines relating to this topic (e.g., ISO, IEA and IPCC) and be mentioned in the report.

Fuel combustion

GHG emissions related to the combustion of fuels consumed may be calculated using the most recent default emission factors published by the IPCC.

If emission factors from other sources are used (e.g., local or national inventories), the justification shall be mentioned in the summary report.

Electricity use

Accounting for GHG emissions from electricity should take the following approach, with a preference for specific (including market-based) over default emissions factors where available:

- For purchased grid electricity the supplier specific location-based factors shall be used
- For self-generated electricity, the specific emission factor of the generation equipment will be used.
- Where default country/regional-level grid mix IEA emissions factors are used, justification shall be included.
- Use of other emission factors shall be justified in the report.
- Factors for the fossil free share of electricity from Power Purchase Agreement ("PPA") should be accounted for in the CF calculation if traceable e.g., by renewable energy certificates. The traceability shall be documented in the report.

To ensure completeness and validate the system under analysis each unit process shall be subject to a material balance.

Steam use and/or generation

For purchased steam used as an energy carrier, supplier-specific factors shall be used. If not available, default IEA-specific factors for the purchased region shall be used; justification shall be provided. In the case of self-generation of steam, the specific emission factor of the generation equipment will be used. If other emission factors are used, the justification shall be mentioned in the report.

Transport

Transport within the defined system boundary (see also **Table 3**) is included.

Secondary data

Primary data for Scope 2 and 3 should be used whenever possible. Several auxiliary materials are used in copper production processes for which the copper producer might not be able to obtain primary data from suppliers or the relevant industry associations. These include lubricants, limestone, explosives, reduction agents or any other materials used in the production process. For those materials, reviewed and high quality secondary data according to ISO 14044 data quality requirements or equivalent should be used for at least 95% of the impact contribution to the final CF, which can commonly be found in free-of-charge and/or fee-based databases. Emissions factors for Scope 3 upstream suppliers proposed by Alta Ley and International Council on Mining and Minerals (ICMM) as part of their work on mapping and harmonizing reporting of Scope 3 emissions should also be used, when available and relevant. The data used shall represent the best proxy for the system under investigation with respect to the technological, geographical and time representativeness. The justification for the use of proxy data shall be mentioned in the report.

ACTIVITY DATA

The activity data to be considered are listed for the main process steps of the copper production chain as follows (but not limited to):

Mining & benefication

- Explosives
- Diesel (for transport)
- Diesel (for electricity generation)
- Fuel (for electricity generation)
- Water
- CaO
- Sodium carbonate
- Steel balls
- Electricity
- Potassium amyl xanthate
- Sodium ethyl xanthate
- Sodium isopropyl xanthate
- Air

Slag cleaning by grinding & flotation treatment

- Thiocarbamat
- Na-isopropyl xanthate
- NH_4+ Na dibutyl dithiophosphate
- Amyl xanthate
- Electricity

Electric slag cleaning

- Electrode (carbon)
- Electricity

Slag fire-cleaning

- Coal
- Oil
- Natural gas
- Fuel

Smelting & refining (primary)

- Oxygen
- Air
- Silica flux
- Oil
- Coal
- Hydrocarbon fuel (technology dependent)
- Natural gas (technology dependent)
- Electricity (technology dependent)

Smelting & refining (secondary)

- Silica flux
- Oil
- Coal
- Hydrocarbon fuel (technology dependent)
- Natural gas (technology dependent)
- Electricity (technology dependent)

Electrolysis

- Sulfuric acid
- Electricity
- Bone meal
- Water
- Glue

Leaching & solvent extraction

- Sulfuric acid
- Electricity
- Diluent (alkyl+naphtenes+parafins)
- Extractant (LIX 984N is an aldoxime-ketoxime mixture)
- Water

Electrowinning

- Sulfuric acid
- Electricity
- Guar gum
- Hydrochloric acid
- Water

Acid plant

- Water
- Electricity
- Catalyst (K-V_2O_5)

Precious metal winning

- Catalyst
- Borax flux
- Hydrochloric acid
- Chlorine gas
- Cyanide
- Hydrogen peroxide
- Sodium hypochlorite
- Acidic gold chloride
- Nitric acid
- Hydrochloric acid
- Ammonium
- Sodium chloride
- Potassium chloride
- Titanium (cathodes)
- Water
- Electricity

DATA QUALITY REQUIREMENTS

To ensure completeness and to validate the system under analysis, each unit process within "Site Direct Activities" (Scope 1) shall be subject to a material balance. Using stoichiometric calculations, the mass of input flows should be compared with the mass of corresponding output flows. The difference shall be reported in percent for each unit process separately. Data specification as follows shall apply:

- Time representativeness: The report shall indicate the reference year or the time period for which the data were collected and in concordance with the addressed physical year.
- Technological representativeness: The activity data shall reflect the technology used.
- Geographical representativeness: The data shall reflect the geography where the process takes place.
- Data validity: The activity date shall reflect the physical year to be addressed. Secondary data and background data shall reflect the technology and the geography of the system to be assessed.

ALLOCATION

For an organizational approach to CF calculation, no allocation of by-/co-products is applied.

In principle all products produced by the organization in scope are part of the product portfolio. Products that may leave the system in the baseline scenario shall be allocated. Use of this allocation method must be determined for each organization, depending on the real product portfolio produced by the organization. Two organizations will likely have two different product portfolios, therefore, the allocation factor for products exiting the system will be organization specific.

In the case of product specific CF calculation, allocation may be applied if many products are in the organization's portfolio. The applied methods should consider the type and properties of co-products being produced.

In line with ISO 14044, ISO 14067 and with the life cycle assessment practice for copper cathode (see ICA copper environmental profile and harmonization of LCA Methodologies for Metals), the proposed allocation methods to capture the multitude of co-/by-products from the copper system are summarized in **Table 4**.

PROCESS LEVEL	CO-PRODUCTS	TREATMENT METHOD
Mining	Sulfide ore	Mass of metal content
	Oxide ore	
Concentration	Copper concentrate	Mass of metal content
	Molybdenum concentrate and other concentrates	
Smelting process	Steam	System expansion
	Lead/tin alloy	
Sulfuric acid plant	Sulfuric acid	System expansion
Electrolytic refining	Copper cathode (main product)	Economic (10-year average)
	Precious metals (via anode sludge): Ag, Au, etc.	

TABLE 4: Allocation methods for co- and by-products

REVIEW AND VERIFICATION

The reported data shall be accompanied by a certificate conducted by an independent and external, qualified third party reviewer and verifier. Qualification refers to both expertise addand experience in LCA and/or CF and to experience in the metals mining or metal production industry (including working in R&D organisationsorganizations on metal mining, winning or refining processes, or also as consultant o LCA of metals if the work experience included working with primary data of the producing industry).

COMMUNICATION

Communication and interpretation of the results must be transparent to ensure trust and reliability in the output. Hence GHG emission calculations must display an overview of the methods and modeling parameters used, distribution of emissions from different scopes and credits, as well as a sensitivity analysis. A list of products co-produced in addition to copper and covered by the calculated CF should be included.

The GHG accounting and reporting of a product inventory shall follow the principles of relevance, accuracy, completeness, consistency, and transparency. The communication of the copper GHG emissions to third parties shall follow the same quality requirements.

The results of the total GHG emissions shall be reported by the producer of the product. In case a third party did the calculations, it shall be stated in the report.

The report shall inform on the cradle-to-gate GHG emissions of 1kg of copper metal and include:

- all relevant parameters chosen as listed in this guide
- the allocation method applied together with a justification and explanation
- the electricity mix and its carbon intensity factor underlying the calculations
- the parameters used for fuel combustion
- a distinction of primary and secondary data used and their sources

Credits included in the footprint of the unit should be disclosed.

Communication and interpretation of the results must be transparent to ensure trust and reliability in the output.

GLOSSARY AND DEFINITIONS

Activity: a practice or ensemble of practices that take place on a delineated area over a given period of time (IPCC glossary).

Activity data: data of owned or controlled activity resulting in emissions taking place during a given period of time (adapted from IPCC glossary).

Allocation: partitioning the input and/or output flows of processes to the product system under study (ISO).

Background system: consists of process on which no or, at best, inderect influence may be exercised by the decision-maker for which and LCA is carried out. Such processes are called "background processes." (Frischknneckt 1998).

Carbon footprint: A total product carbon footprint is a measure of the direct and indirect greenhouse gas (GHG) emissions associated with all activities in the product's life cycle. Products are both goods and services. Such a carbon footprint can be calculated by performing (according to international standards) an LCA that concentrates on GHG emissions that have an effect on climate change (UNEP/SETAC, 2009).

End of life: the final stages of a product's existence.

Entity: comprises a chain of processing steps within an organization of one or more unit processes that are logically grouped; may also be referred to as a "business unit". If there is more than one business unit within the company then each of those business units is described as an entity within the company.

Foreground system: consists of processes which are under the control of the decision-maker for which and LCA is carried out. They are called foreground processes. (Frischkneckt 1998).

Greenhouse gases: gases that have direct effects on climate change - carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3), etc.

Intensity metric/emission intensity: calculated by dividing absolute emissions (the numerator) by an organization specific metric (the denominator).

Life cycle assessment (LCA): Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. (ISO 14040).

Primary data: Data determined by direct measurement, estimation or calculation at the producing company or its suppliers.

Product system: ISO 14040 defines product system as a collection of materially and energetically connected unit processes, which perform one or more defined functions. The term "product" used alone includes not only product systems but can also include service systems.

Scope 1: direct emissions from owned or controlled sources.

Scope 2: indirect emissions from the generation of purchased energy.

Scope 3: all indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

Secondary data: refers to data that is collected or owned by someone other than the primary user.

LITERATURE

1. GHG Protocol – Product Life Cycle Accounting and Reporting Standard
2. Global Reporting Initiative, GRI
3. Organisation Environmental Footprint Sector Rules – Copper production
4. Life Cycle initiative
5. ISO 14067:2018, Greenhouse gases — Carbon footprint of products —Requirements and guidelines for quantification
6. ISO 14044:2006, Environmental management — Life cycle assessment — Requirements and guidelines
7. Harmonization of LCA Methodologies for Metals
8. Copper environmental profile
9. IPCC report 2022
10. United Nations for Climate Change
11. Non-CO_2 GHG
12. EN 14626:2012, Ambient air - Standard method for the measurement of the concentration of carbon monoxide by non-dispersive infrared spectroscopy
13. EN 19694-2:2016, Stationary source emissions - Greenhouse Gas (GHG) emissions in energy-intensive industries - Part 2: Iron and steel industry
14. IEA Fuels & Technologies Conversion factors
15. "Life Cycle Data Bases", GHG Protocol

ANNEX I

Publicly available "carbon intensity factors" of diverse substances and products*

Links:

Understanding Global Warming Potentials | US EPA

Global Warming Potential of certain substances and their mixtures (umweltbundesamt.de)

The Role of Non-CO2 Greenhouse Gases in Meeting Kyoto Targets (1998; OECD.org)

Code of Federal Regulations: Part 98 - Mandatory Greenhouse Gas Reporting

JRC (2017). Energy efficiency and GHG emissions: Prospective scenarios for the Chemical and Petrochemical Industry

*Please ensure that any factors used is representative for the system to be assessed.

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