Organisation Environmental Footprint Sector Rules

Copper Production

2024

Sector Category	Copper production
Version Number	4.0
Date of Publication	April 12th, 2024
Time Validity	December 31st, 2025

Contents

Acronyms

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
AF	allocation factor
AR	allocation ratio
B2B	business to business
B2C	business to consumer
BoC	bill of components
BoM	bill of materials
BP	bonne practique
BSI	British Standards Institution
CF	characterization factor
CFCs	Chlorofluorocarbons
CFF	Circular Footprint Formula
CPA	Classification of Products by Activity
DC	distribution centre
DMI	dry matter intake
DNM	Data Needs Matrix
DQR	Data Quality Rating
EC	European Commission
EF	Environmental Footprint
EI	environmental impact
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management Systems
EoL	End of life
EPD	Environmental Product Declaration
FU	functional unit
GE	gross energy intake
GHG	greenhouse gas
GR	geographical representativeness
GRI	Global Reporting Initiative
GWP	global warming potential
ILCD	International Reference Life Cycle Data System
ILCD-EL	International Reference Life Cycle Data System – Entry Level
IPCC	Intergovernmental Panel on Climate Change
ISIC	international standard industrial classification
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature and Natural Resources

JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCDN	Life Cycle Data Network
LCI	life cycle inventory
LCIA	life cycle impact assessment
LCT	life cycle thinking
LT	lifetime
NACE	Nomenclature Générale des Activités Economiques dans les Communautés Européennes
NDA	non-disclosure agreement
NGO	non-governmental organisation
NMVOC	non-methane volatile compounds
P	precision
PAS	Publicly Available Specification
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PP	product portfolio
OEF	Organisation Environmental Footprint
OEF-RO	OEF study of the representative organisation
OEFSR	Organisation Environmental Footprint Sector Rules
RF	reference flow
RP	representative product
RU	reporting unit
SB	system boundary
SMRS	sustainability measurement & reporting system
SS	supporting study
TeR	technological representativeness
TiR	time representativeness
TS	Technical Secretariat
UNEP	United Nations Environment Programme
UUID	Universally Unique Identifier
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

Definitions

Activity data - Information which is associated with processes while modelling Life Cycle Inventories (LCI). The aggregated LCI results of the process chains, that represent the activities of a process, are each multiplied by the corresponding activity data[1] and then combined to derive the environmental footprint associated with that process. Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours an equipment is operated, distance travelled, floor area of a building, etc. Synonym of 'non-elementary flow'.

Acidification – EF impact category that addresses impacts due to acidifying substances in the environment. Emissions of NO_x, NH_3 and SO_x lead to releases of hydrogen ions (H^+) when the gases are mineralised. The protons contribute to the acidification of soils and water when they are released in areas where the buffering capacity is low, resulting in forest decline and lake acidification.

Additional environmental information – Environmental information outside the EF impact categories that is calculated and communicated alongside OEF results.

Additional technical information – Non-environmental information that is calculated and communicated alongside OEF results.

Aggregated dataset - Complete or partial life cycle of a product system that, next to the elementary flows (and possibly not relevant amounts of waste flows and radioactive wastes), lists in the input/output list exclusively the product(s) of the process as reference flow(s), but no other goods or services. Aggregated datasets are also called 'LCI results' datasets. The aggregated dataset may have been aggregated horizontally and/or vertically.

Allocation – An approach to solving multi-functionality problems. It refers to 'partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems'.

Application specific – Generic aspect of the specific application in which a material is used. For example, the average recycling rate of PET in bottles.

Attributional – Process-based modelling intended to provide a static representation of average conditions, excluding market-mediated effects.

Average Data – Production-weighted average of specific data.

Background processes – Refers to those processes in the product life cycle for which no direct access to information is possible. For example, most of the upstream life-cycle processes and generally all processes further

Bill of materials – A bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture the product in scope of the OEF study. In some sectors it is equivalent to the bill of components.

Business to business (B2B) – Describes transactions between businesses, such as between a manufacturer and a wholesaler, or between a wholesaler and a retailer.

Business to consumers (B2C) – Describes transactions between business and consumers, such as between retailers and consumers.

Characterisation – Calculation of the magnitude of the contribution of each classified input/output to their respective EF impact categories, and aggregation of contributions within each category. This requires a linear multiplication of the inventory data with characterisation factors for each substance and EF impact category of concern. For example, with respect to the EF impact category 'climate change', CO_2 is chosen as the reference substance and kg CO_2-equivalents as the reference unit.

Characterisation factor – Factor derived from a characterisation model which is applied to convert an assigned life cycle inventory result to the common unit of the EF impact category indicator.

Classification – Assigning the material/energy inputs and outputs tabulated in the life cycle inventory to EF impact categories according to each substance's potential to contribute to each of the EF impact categories considered.

[1] Based on GHG protocol scope 3 definition from the CoROorate Accounting and Reporting Standard (World resources institute, 2011).

Climate change – EF impact category considering all inputs and outputs that result in greenhouse gas (GHG) emissions. The consequences include increased average global temperatures and sudden regional climatic changes. Climate change is an impact affecting the environment on a global scale.

Co-function - Any of two or more functions resulting from the same unit process or product system.

Commissioner of the EF study - Organisation (or group of organisations) e.g. a commercial company, a non-profit organisation, that finances the EF study in accordance with the OEF method and the relevant OEFSR, if available.

Company-specific data – It refers to directly measured or collected data from one or multiple facilities (site-specific data) that are representative for the activities of the company (company is used as synomym of organisation). It is synonymous to 'primary data'. To determine the level of representativeness a sampling procedure may be applied.

Company-specific dataset – It refers to a dataset (disaggregated or aggregated) compiled with company-specific data. In most cases the activity data is company-specific while the underlying sub-processes are datasets derived from background databases.

Comparative assertion – An environmental claim regarding the superiority or equivalence of one organisation versus a competing organisation that performs the same function.

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of an OEF study and supporting OEFSRs.

Consumer - An individual member of the general public purchasing or using goods, property or services for private purposes.

Co-product – Any of two or more products resulting from the same unit process or product system.

Cradle to gate – A partial product supply chain, from the extraction of raw materials (cradle) up to the manufacturer's 'gate'. The distribution, storage, use stage and end of life stages of the supply chain are omitted.

Cradle to grave – A product's life cycle that includes raw material extraction, processing, distribution, storage, use, and disposal or recycling stages. All relevant inputs and outputs are considered for all of the stages of the life cycle.

Critical review – Process intended to ensure consistency between an OEFSR and the principles and requirements of the OEF method.

Data quality – Characteristics of data that relate to their ability to satisfy stated requirements. Data quality covers various aspects, such as technological, geographical and time-related representativeness, as well as completeness and precision of the inventory data.

Data quality rating (DQR) - Semi-quantitative assessment of the quality criteria of a dataset based on technological representativeness, geographical representativeness, time-related representativeness, and precision. The data quality shall be considered as the quality of the dataset as documented.

Delayed emissions - Emissions that are released over time, e.g. through long use or final disposal stages, versus a single emission at time t.

Direct elementary flows (also named elementary flows) – All output emissions and input resource use that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite.

Direct land use change (dLUC) – The transformation from one land use type into another, which takes place in a unique land area and does not lead to a change in another system.

Directly attributable – Refers to a process, activity or impact occurring within the defined system boundary.

Disaggregation – The process that breaks down an aggregated dataset into smaller unit process datasets (horizontal or vertical). The disaggregation may help making data more specific. The process of disaggregation should never compromise or threat to compromise the quality and consistency of the original aggregated dataset.

Downstream – Occurring along a product supply chain after the point of referral.

Ecotoxicity, freshwater – EF impact category that addresses the toxic impacts on an ecosystem, which damage individual species and change the structure and function of the ecosystem. Ecotoxicity is a result of a variety of different toxicological mechanisms caused by the release of substances with a direct effect on the health of the ecosystem.

EF communication vehicles – It includes all the possible ways that may be used to communicate the results of the EF study to the stakeholders (e.g. labels, environmental product declarations, green claims, websites, infographics, etc.).

EF compliant dataset – Dataset developed in compliance with the EF requirements regularly updated by DG JRC[2].

Electricity tracking[3] – Electricity tracking is the process of assigning electricity generation attributes to electricity consumption.

Elementary flows – In the life cycle inventory, elementary flows include 'material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation'. Elementary flows include, for example, resources taken from nature or emissions into air, water, soil that are directly linked to the characterisation factors of the EF impact categories.

Environmental aspect – Element of an organisation's activities or products or services that interacts or can interact with the environment.

Environmental Footprint (EF) impact assessment – Phase of the OEF analysis aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product. The impact assessment methods provide impact characterisation factors for elementary flows in order to aggregate the impact to obtain a limited number of midpoint indicators.

Environmental Footprint (EF) impact assessment method – Protocol for quantitative translation of life cycle inventory data into contributions to an environmental impact of concern.

Environmental Footprint (EF) impact category – Class of resource use or environmental impact to which the life cycle inventory data are related.

Environmental Footprint (EF) impact category indicator – Quantifiable representation of an EF impact category.

Environmental impact – Any change to the environment, whether adverse or beneficial, that wholly or partially results from an organisation's activities, products or services.

Environmental mechanism – System of physical, chemical and biological processes for a given EF impact category linking the life cycle inventory results to EF category indicators.

Eutrophication – EF impact category related to nutrients (mainly nitrogen and phosphorus) from sewage outfalls and fertilised farmland that accelerate the growth of algae and other vegetation in water. The degradation of organic material consumes oxygen resulting in oxygen deficiency and, in some cases, fish death. Eutrophication translates the quantity of substances emitted into a common measure expressed as the oxygen required for the degradation of dead biomass. Three EF impact categories are used to assess the impacts due to eutrophication: Eutrophication, terrestrial; Eutrophication, freshwater; Eutrophication, marine.

External Communication – Communication to any interested party other than the commissioner or the practitioner of the study.

Extrapolated Data – Refers to data from a given process that is used to represent a similar process for which data is not available, on the assumption that it is reasonably representative.

Flow diagram – Schematic representation of the flows occurring during one or more process stages within the life cycle of the product being assessed.

Foreground elementary flows - Direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.

Foreground Processes – Refer to those processes in the product life cycle for which direct access to information is available. For example, the producer's site and other processes operated by the producer or its contractors (e.g. goods transport, head-office services, etc.) belong to the foreground processes.

Functional unit – The functional unit defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions 'what?', 'how much?', 'how well?', and 'for how long?'.

[2] https://eplca.jrc.ec.europa.eu/permalink/Guide_EF_DATA.pdf
[3] https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii

Global warming potential (GWP) – Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO_2-equivalent units) and specified time horizon (e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years respectively)**.** It relates to the capacity to influence changes in the global average surface-air temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.

Horizontal averaging - it is the action of aggregating multiple unit process datasets or aggregated process datasets in which each provides the same reference flow in order to create a new process dataset.

Human toxicity – cancer – EF impact category that accounts for adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to cancer.

Human toxicity - non cancer – EF impact category that accounts for the adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to non-cancer effects that are not caused by particulate matter/respiratory inorganics or ionising radiation.

Independent external expert – Competent person, not employed in a full-time or part-time role by the commissioner of the EF study or the user of the EF method, and not involved in defining the scope or conducting the EF study.

Indirect land use change (iLUC) – It occurs when a demand for a certain land use leads to changes, outside the system boundary, i.e. in other land use types. These indirect effects may be mainly assessed by means of economic modelling of the demand for land or by modelling the relocation of activities on a global scale.

Input flows – Product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products.

Intermediate product – Output form of a unit process that is input to other unit processes that require further transformation within the system. An intermediate product is a product that requires further processing before it is saleable to the final consumer.

Ionising radiation, human health – EF impact category that accounts for the adverse health effects on human health caused by radioactive releases.

Land use – EF impact category related to use (occupation) and conversion (transformation) of land area by activities such as agriculture, forestry, roads, housing, mining, etc. Land occupation considers the effects of the land use, the amount of area involved and the duration of its occupation (changes in soil quality multiplied by area and duration). Land transformation considers the extent of changes in land properties and the area affected (changes in soil quality multiplied by the area).

Lead verifier – Verifier taking part in a verification team with additional responsibilities compared to the other verifiers in the team.

Life cycle – Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.

Life cycle approach – Takes into consideration the spectrum of resource flows and environmental interventions associated with a product from a supply-chain perspective, including all stages from raw material acquisition through processing, distribution, use, and end of life processes, and all relevant related environmental impacts (instead of focusing on a single issue).

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

Life cycle impact assessment (LCIA) – Phase of life cycle assessment that aims at understanding and evaluating the magnitude and significance of the potential environmental impacts for a system throughout the life cycle. The LCIA methods used provide impact characterisation factors for elementary flows to in order to aggregate the impact to obtain a limited number of midpoint and/or damage indicators.

Life cycle inventory (LCI) - The combined set of exchanges of elementary, waste and product flows in a LCI dataset.

Life cycle inventory (LCI) dataset - A document or file with life cycle information of a specified product or other reference (e.g., site, process), covering descriptive metadata and quantitative life cycle inventory. A LCI dataset could be a unit process dataset, partially aggregated or an aggregated dataset.

Loading rate – Ratio of actual load to the full load or capacity (e.g. mass or volume) that a vehicle carries per trip.

Material-specific – It refers to a generic aspect of a material. For example, the recycling rate of Polyethylene Terephthalate (PET).

Multi-functionality – If a process or facility provides more than one function, i.e. it delivers several goods and/or services ('co-products'), then it is 'multifunctional'. In these situations, all inputs and emissions linked to the process will be partitioned between the product of interest and the other co-products according to clearly stated procedures.

Non-elementary (or complex) flows – In the life cycle inventory, non-elementary flows include all the inputs (e.g. electricity, materials, transport processes) and outputs (e.g. waste, by-products) in a system that need further modelling efforts to be transformed into elementary flows. Synonym of 'activity data'.

Normalisation – After the characterisation step, normalisation is the step in which the life cycle impact assessment results are divided by normalisation factors that represent the overall inventory of a reference unit (e.g. a whole country or an average citizen). Normalised life cycle impact assessment results express the relative shares of the impacts of the analysed system in terms of the total contributions to each impact category per reference unit. When displaying the normalised life cycle impact assessment results of the different impact topics next to each other, it becomes evident which impact categories are affected most and least by the analysed system. Normalised life cycle impact assessment results reflect only the contribution of the analysed system to the total impact potential, not the severity/relevance of the respective total impact. Normalised results are dimensionless, but not additive.

OEF profile – The quantified results of an OEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to report.

OEF report – Document that summarises the results of the OEF study.

OEF study – Term used to identify the totality of actions needed to calculate the OEF results. It includes the modelling, the data collection, and the analysis of the results. OEF study results are the basis for drafting OEF reports.

OEF study of the representative organisation (OEF-RO) – OEF study carried out on the representative organisation(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and any other major requirements needed for the sector/sub-sector in scope of the OEFSR.

OEFSR supporting study – OEF study based on a draft OEFSR. It is used to confirm the decisions taken in the draft OEFSR before the final OEFSR is released.

Organisation Environmental Footprint Sectorial Rules (OEFSRs) - Sector specific, life cycle based rules that complement general methodological guidance for OEF studies by providing further specification at the level of a specific sector. OEFSRs help to shift the focus of the OEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the OEF method. Only the OEFSRs developed by or in cooperation with the European Commission, or adopted by the European Commission or as EU acts are recognised as in line with this method.

Organisation Life Cycle Assessment (OLCA) – Compilation and evaluation of the inputs, outputs, and potential environmental impacts of activities associated with the organisation as a whole or a portion thereof adopting a life cycle perspective. The results of an OLCA are sometimes referred to as an organisation's environmental footprint. (ISO 14072:2014).

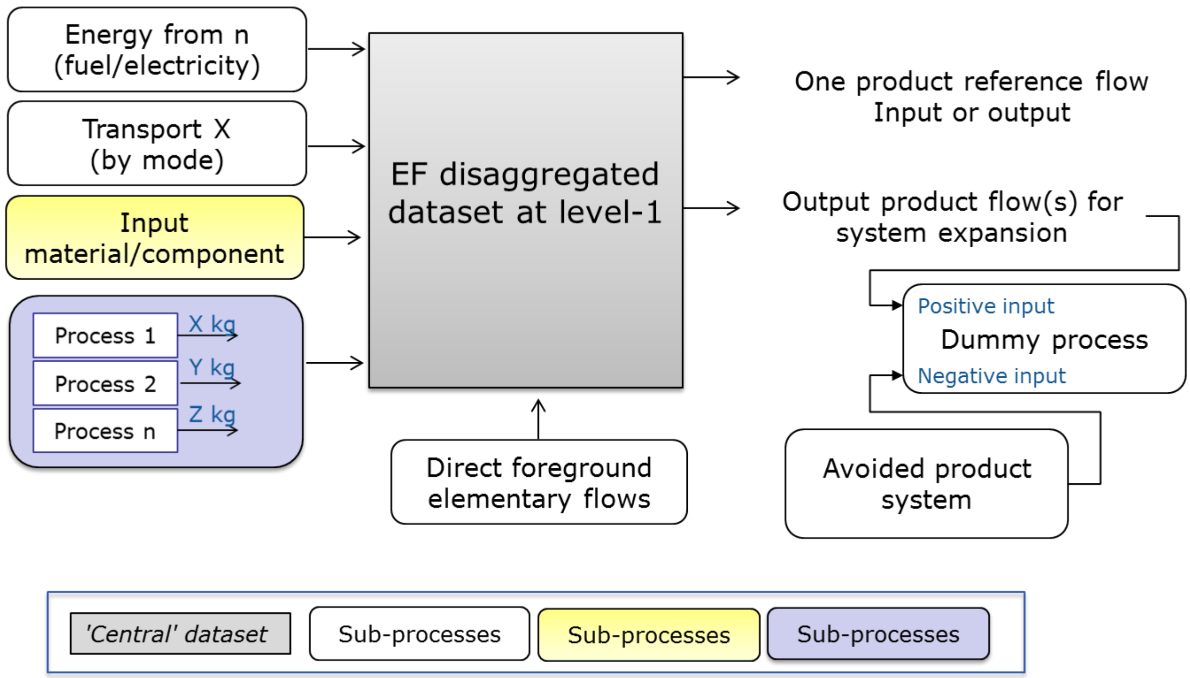
Output flows – Product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases. Output flows are also considered to cover elementary flows.

Ozone depletion – EF impact category that accounts for the degradation of stratospheric ozone due to emissions of ozone-depleting substances, for example long-lived chlorine and bromine containing gases (e.g. chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Halons).

Partially disaggregated dataset - A dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield a complete aggregated LCI data set.

Partially disaggregated dataset at level-1 - A partially disaggregated dataset at level-1 contains elementary flows and activity data of one level down in the supply chain, while all complementing underlying datasets are in their aggregated form (see **Figure 1**).

Figure 1. Example of dataset partially disaggregated at Level-1.



Particulate matter – EF impact category that accounts for the adverse health effects on human health caused by emissions of particulate matter (PM) and its precursors (NO_x, SO_x, NH_3).

Photochemical ozone formation – EF impact category that accounts for the formation of ozone at the ground level of the troposphere caused by photochemical oxidation of volatile organic compounds (VOCs) and carbon monoxide (CO) in the presence of nitrogen oxides (NO_x) and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts and manmade materials through reaction with organic materials.

Population - Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study.

Primary data - This term refers to data from specific processes within the supply chain of the user of the OEF method or user of the OEFSR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply chain specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the user of the OEF method or user of the OEFSR. In this method, primary data is synonym of 'company-specific data' or 'supply chain specific data'.

Product – Any good or service.

Product category – Group of products (or services) that can fulfil equivalent functions.

Product Category Rules (PCRs) – Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories.

Product Environmental Footprint Category Rules (PEFCRs) – Product category specific, life cycle based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF method. Only the PEFCRs developed by or in cooperation with the European Commission, or adopted by the European Commission or as EU acts are recognised as in line with this method.

Product flow – Products entering from or leaving to another product system.

Product system – Collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product.

Raw material – Primary or secondary material that is used to produce a product.

Reference flow – Measure of the outputs from processes in a given product system required to fulfil the function expressed by the funtional unit.

Refurbishment – It is the process of restoring components to a functional and/ or satisfactory state to the original specification (providing the same function), using methods such as resurfacing, repainting, etc. Refurbished products may have been tested and verified to function properly.

Releases – Emissions to air and discharges to water and soil.

Reporting unit (RU) – The organisation is the reference unit for the analysis and, along with the product portfolio, the basis for defining the reporting unit (RU). It is parallel to the concept of 'functional unit' in a traditional Life Cycle Assessment (LCA).

Representative organisation (model) - The RO model is in many cases a virtual (non-existing) organisation built, for example, from the average EU sales-weighted characteristics of all existing technologies, production processes and organisation types

Representative sample – A representative sample with respect to one or more variables is a sample in which the distribution of these variables is exactly the same (or similar) as in the population from which the sample is a subset.

Resource use, fossil – EF impact category that addresses the use of non-renewable fossil natural resources (e.g. natural gas, coal, oil).

Resource use, minerals and metals – EF impact category that addresses the use of non-renewable abiotic natural resources (minerals and metals).

Review – Procedure intended to ensure that the process of developing or revising an OEFSR has been carried out in accordance with the requirements provided in the OEF method and the part A of the Annex II.

Review report - a documentation of the review process that includes the review statement, all relevant information concerning the review process, the detailed comments from the reviewer(s) as well as the corresponding responses and the outcome. The document shall carry the electronic or handwritten signature of the reviewer, or in case of a reviewer panel, of the lead reviewer

Review panel – Team of reviewers that will perform the process of conducting the review of the OEFSR

Reviewer – Independent external expert conducting the review of the OEFSR and eventually taking part in a reviewer panel.

Sample – A subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.

Secondary data- Data not from a specific process within the supply-chain of the company performing an OEF study. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third party LCI database or other sources. Secondary data includes industry average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and may also be based on financial data, and contain proxy data, and other generic data. Primary data that go through a horizontal aggregation step are considered as secondary data.

Sensitivity analysis – Systematic procedures for estimating the effects of the choices made regarding methods and data on the results of an OEF study.

Site-specific data – It refers to directly measured or collected data from one facility (production site). It is synonymous to 'primary data'.

Single overall score - Sum of the weighted EF results of all impact categories.

Specific Data – Refers to directly measured or collected data representative of activities at a specific facility or set of facilities. Synonymous with 'primary data'.

Subdivision – Subdivision refers to disaggregating multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output. The process is investigated to see whether it may be subdivided. Where subdivision is possible, inventory data should be collected only for those unit processes directly attributable to the products/services of concern.

Sub-population – Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study that constitutes a homogenous sub-set of the whole population. Synonymous with 'stratum'.

Sub-processes - Those processes used to represent the activities of the level 1 processes (=building blocks). Sub-processes may be presented in their (partially) aggregated form (see Figure 1).

Sub-sample - A sample of a sub-population.

Supply chain – It refers to all of the upstream and downstream activities associated with the operations of the user of the OEF method, including the use of sold products by consumers and the end of life treatment of sold products after consumer use.

Supply chain specific – It refers to a specific aspect of the specific supply chain of a company. For example the recycled content value of an aluminium may produced by a specific company.

System boundary – Definition of aspects included or excluded from the study. For example, for a 'cradle-to-grave' EF analysis, the system boundary includes all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages.

System boundary diagram – Graphic representation of the system boundary defined for the OEF study.

Temporary carbon storage – It happens when a product reduces the GHGs in the atmosphere or creates negative emissions, by removing and storing carbon for a limited amount of time.

Type III environmental declaration – An environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information.

Uncertainty analysis – Procedure to assess the uncertainty in the results of an OEF study due to data variability and choice-related uncertainty.

Unit process – Smallest element considered in the LCI for which input and output data are quantified.

Unit process, black box – Process chain or plant level unit process. This covers horizontally averaged unit processes across different sites. Covers also those multi-functional unit processes, where the different co-products undergo different processing steps within the black box, hence causing allocation problems for this dataset[4].

Unit process, single operation - Unit operation type unit process that cannot be further subdivided. Covers multi-functional processes of unit operation type[5].

Upstream – Occurring along the supply chain of purchased goods/ services prior to entering the system boundary.

User of the OEFSR – A stakeholder producing an OEF study based on an OEFSR.

User of the OEF method – A stakeholder producing an OEF study based on the OEF method.

User of the OEF results – A stakeholder using the OEF results for any internal or external purpose.

Validation - Confirmation by the environmental footprint verifier, that the information and data included in the OEF study, OEF report and the communication vehicles are reliable, credible and correct.

Validation statement – Conclusive document aggregating the conclusions from the verifiers or the verification team regarding the EF study. This document is mandatory and shall carry the electronic or handwritten signature of the verifier or, in case of a verification panel, of the lead verifier.

Verification - Conformity assessment process carried out by an environmental footprint verifier to demonstrate whether the OEF study has been carried out in compliance with Annex III.

Verification report – Documentation of the verification process and findings, including detailed comments from the verifier(s), as well as the corresponding responses. This document is mandatory, but it may be confidential. The document shall carry the electronic or handwritten signature of the verifier, or in case of a verification panel, of the lead verifier.

[4] More details can be found in the Guide for EF compliant datasets at https://eplca.jrc.ec.europa.eu/permalink/Guide_EF_DATA.pdf.
[5] More details can be found in the Guide for EF compliant datasets at https://eplca.jrc.ec.europa.eu/permalink/Guide_EF_DATA.pdf.

Verification team – Team of verifiers that will perform the verification of the EF study, of the EF report and the EF communication vehicles.

Verifier – Independent external expert performing a verification of the EF study and eventually taking part in a verification team.

Vertical aggregation - Technical- or engineering-based aggregation refers to vertical aggregation of unit processes that are directly linked within a single facility or process train. Vertical aggregation involves combining unit process datasets (or aggregated process datasets) together linked by a flow.

Waste – Substances or objects which the holder intends or is required to dispose of.

Water use – EF impact category that represents the relative available water remaining per area in a watershed, after the demand of humans and aquatic ecosystems has been met. It assesses the potential of water deprivation, to either humans or ecosystems, building on the assumption that the less water remaining available per area, the more likely another user will be deprived.

Weighting – Weighting is a step that supports the interpretation and communication of the results of the analysis. OEF results are multiplied by a set of weighting factors (in %), which reflect the perceived relative importance of the impact categories considered. Weighted EF results may be directly compared across impact categories, and also summed across impact categories to obtain a single overall score.

Introduction

The Organisation Environmental Footprint (OEF) method provides detailed and comprehensive technical rules on how to conduct OEF studies that are more reproducible, consistent, robust, verifiable and comparable. Results of OEF studies are the basis for the provision of EF information and they may be used in a diverse number of potential fields of applications, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this OEFSR the user of the OEFSR shall refer to the documents this OEFSR is in conformance with (see section 2.7*).*

The compliance with the present OEFSR is optional for OEF in-house applications, whilst it is mandatory whenever the results of an OEF study or any of its content is intended to be communicated.

Terminology: shall, should and may

This OEFSR uses precise terminology to indicate the requirements, the recommendations and options that could be chosen when an OEF study is conducted.

- The term “shall” is used to indicate what is required in order for an OEF study to be in conformance with this OEFSR.
- The term “should” is used to indicate a recommendation rather than a requirement. Any deviation from a “should” requirement has to be justified when developing the OEF study and made transparent.
- The term “may” is used to indicate an option that is permissible. Whenever options are available, the OEF study shall include adequate argumentation to justify the chosen option.

2 General information about the OEFSR

2.1. Technical Secretariat

Name of the organisation	*Type of organisation*	*Name of the members (not mandatory)*
International Copper Association, Ltd.	Sector Association	*Ladji Tikana*
Aurubis AG	Industry	*Daniela Cholakova* *Karin Hinrichs Petersen*
Boliden	Industry	*Arziv Babikian*
KGHM	Industry	*Daniel Glowacki*
Freeport MC Spain (Atlantic Copper)	Industry	*Pablo Garcia Vila and Sergej Osipov*
Metso Outotec	Industry	*Mari Lindgren*

2.2. Consultations and stakeholders

One public consultation was conducted:

- Opening and closing date of the public consultation: Nov 3rd 2023 – Dec 1st 2023
- Number of comments received: 6
- Names of organisations that have provided comments: EF Technical Helpdesk on behalf of the European Commission
-

The OEFSR v 4.0 has been updated according to the "light review procedure" (launched by the EC in the EF transition phase), starting from the OEFSR v. 3.0 published in 2018. The light review procedure foresees one stakeholder consultation.

2.3. Review panel and review requirements of the OEFSR

Name of the member	***Affiliation***	***Role***
Ugo Pretato	Studio Fieschi e soci srl	Chair
Alessandra Zamagni	Ecoinnovazione srl	Reviewer
Chris Foster	EuGeos srl	Reviewer

The reviewers have verified that the following requirements are fulfilled:

- The OEFSR has been developed in accordance with the requirements provided in Annex III and Annex IV (of the EF Recommendation 2021/2279) ;
- The OEFSR supports the creation of credible, relevant and consistent OEF profiles;
- The OEFSR scope and the representative organisations are adequately defined;
- The Reporting unit, allocation and calculation rules are adequate for the sector under consideration;
- Datasets used in the OEF-ROs (supporting studies are not applicable to the light review procedure) are relevant, representative, reliable, and in compliance with data quality requirements;
- The selected additional environmental and technical information are appropriate for the product category under consideration and the selection is done in accordance with the requirements stated in Annex III,
- The model of the RO represent correctly the sector category or sub-category;
- The RO model in its corresponding excel version is compliant with the rules outlined in section A.2.3 of Annex IV (not applicable, as there is no Excel version made available by the EC. Furthermore the model of the ROs are confidential, as they are based on real organizations. In agreement with the EC the Excel models shall not be developed nor made available);
- The Data Needs Matrix is correctly implemented;
- The OEFSR has been updated according to the “light review procedure” launched by the European Commission

The public review reports are provided in Annex 3 of this OEFSR.

2.4. Review statement

This OEFSR was developed in compliance with the OEF Method adopted by the Commission in 2021, namely the Recommendation 2021/2279.

The representative organisation(s) correctly describe the average organisation(s) active in Europe for the sector/ sub-sector(s) in scope of this OEFSR.

OEF studies carried out in compliance with this OEFSR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions (see section on limitations).

2.5. Geographic validity

This OEFSR is valid for products in scope sold or consumed in the European Union + EFTA+UK.

Each OEF study shall identify its geographical validity listing all the countries where the organisation’s activities take place, together with the relative market share.

2.6. Language

The OEFSR is written in English. The original in English supersedes translated versions in case of conflicts.

2.7. Conformance to other documents

This OEFSR has been prepared in conformance with the following documents (in prevailing order):

- Organisation Environmental Footprint (OEF) method, Annex III to IV to the Recommendation 2021/2279/EU, 15th December 2021, published the official journal of the European Union Volume 471 on 30th December 2021.

This OEFSR was developed as light review of the OEFSR version 3.0 published in 2018 and developed during the EF pilot phase.

This OEFSR was developed taking into account the Best Available Techniques Reference Document for the Non-Ferrous Metals Industries (Final Draft, October 2014)

3. OEFSR scope

3.1. The sector

This OEFSR applies to the sector: Copper Production.

The NACE codes for the sectors included in this OEFSR are:

- Blister copper, copper anodes and copper cathodes – **NACE Code: 24.44** Copper production
- Sulphuric acid – **NACE Code: 20.13** Manufacture of other inorganic chemicals
- Iron silicate (Final slag) – **NACE Code: 23.99** Manufacture of other non-metallic mineral products
- Anode slime – **NACE Code: 24.45** Production of other non-ferrous metals
- $NiSO_4$, $CuSO_4$, other salts – **NACE Code: 24.45** Production of other non-ferrous metals
- Silver /Gold/PGM concentrate – **NACE Code: 24.41** Precious metals production
- Lead, Pb-Sn alloys, Tin – **NACE Code: 24.43** Pb, Zn and Sn production
- Crude Selenium/Tellurium – **NACE Code: 24.45** Production of other non-ferrous metals
- Zinc Oxide **- NACE Code: 24.43** Pb, Zn and Sn production
- Ammonium Perrhenate - **NACE Code: 24.45** Production of other non-ferrous metals

Further details on products which could be included in an OEF compliant with this OEFSR, and not mentioned in the above list, can be found at paragraph 3.3.

The production of these metals is related to copper containing raw materials associated with copper production. The production of these metals from other different sources (e.g. production of lead from lead batteries or mainly from primary lead concentrates) shall be excluded.

Copper is produced from a variety of primary and secondary raw materials. Raw materials contain significant and variable amounts of metals other than copper. European smelters process sulphidic copper concentrates: they consist of complex copper/iron sulphidic minerals (15 - 45 % Cu) and other metal containing minerals (Pb, As, Zn, Ni, Ag, Au, Pt, Pd, Se). Secondary raw materials are scrap and other complex materials with different content of copper and other metals.

The production processes are designed to recover copper. However due to the unique properties of copper to capture other valuable metals (silver, gold, PGMs, selenium, tellurium), those are recovered as co-products in the refining operations.

So most of copper smelters in addition to high-purity cathode copper produce silver, gold, selenium, tellurium and /or extract other co-metal products such as lead and tin. Most organisations also recover sulphuric acid and iron silicate.

Lead and tin are usually recovered from intermediates of secondary copper refining processes.

3.2. Representative organisation(s)

Three different options were taken into consideration by the Technical Secretariat to define the Representative Organisation. The selected approach was based on screening each production route (i.e. primary pyrometallurgy, secondary pyrometallurgy, integrated multimetal pyrometallurgy) based on a real organisation in order to take into proper consideration the differences in process configuration and product portfolio.

This OEFSR is for the pyrometallurgical route of copper production, thus the hydrometallurgical route is excluded from the scope of the OEFSR.

Life cycle stages within the cradle-to-gate boundaries were included in the OEF boundary.

Use stage and end-of-life were excluded because the Product Portfolio is made of intermediate products, with a high variety of possible applications. Accordingly, the modelling of the use stage would not be meaningful if included in the OEFSR. Information on recyclability potential at end of life shall be provided as mandatory additional Environmental Information

The model of the RO was based on separate organizations for primary copper pyrometallurgy, secondary copper pyrometallurgy, and integrated multimetal pyrometallurgy and it was built on a modular approach, especially for the integrated multimetal pyrometallurgy route, as shown in **Figure 2**. A detailed description of the Representative Organisation can be made available upon request to the TS.

The screening study is available upon request to the TS coordinator that has the responsibility of distributing it with an adequate disclaimer about its limitations.

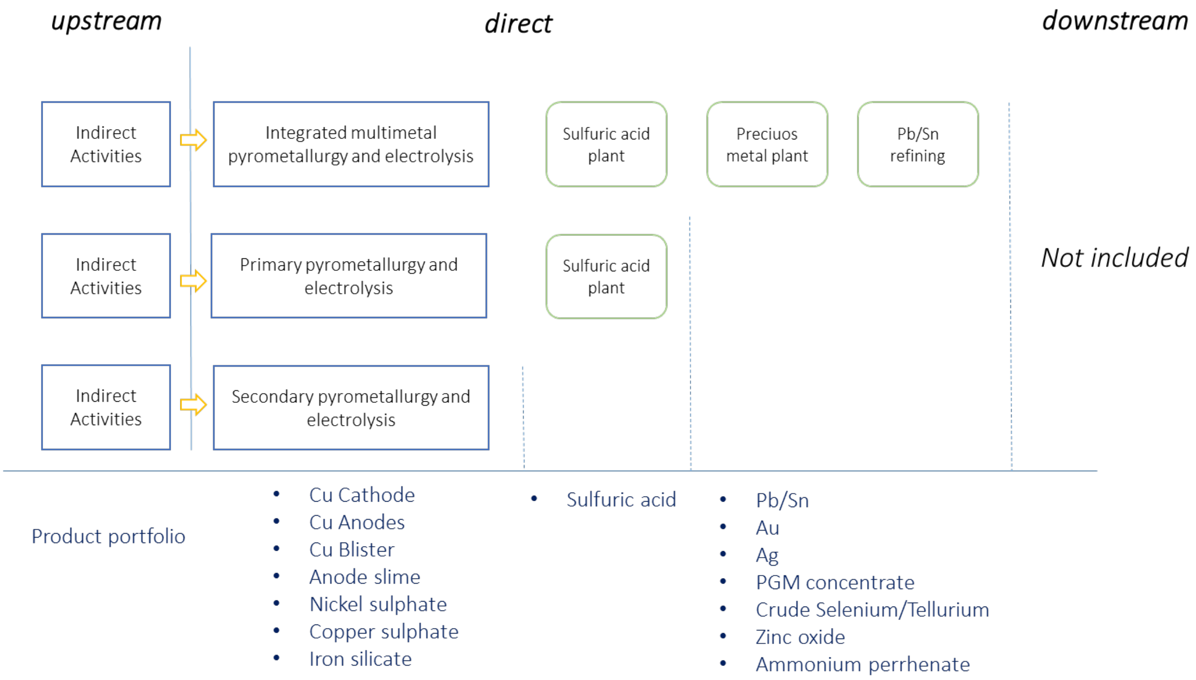


Figure 2. Model of the Representative organisation.

3.3. Reporting unit and reference flow

The Reporting unit (RU) is the organisation with reference to the product portfolio and it is defined both as a single site and as a full organisation, when it is constituted by multiple sites. The OEFSR applies both to the single sites and the full organisation. The OEF report shall report if the OEFSR is applied to the single site or the full organisation.

The product portfolio includes:

- for organizations that have "clear" copper production route: copper cathodes, anodes and blister, sulphuric acid, iron silicate, anode slime, nickel sulphate/copper sulphate
- for those organizations that produce also other metals and substances together with copper, the product portfolio shall also include: silver, gold, PGM concentrate, (crude) selenium and tellurium, lead and tin, zinc oxide, ammonium perrhenate

This OEFSR identifies a typical product portfolio, which includes those products common to the majority of European copper smelters. Such products are delivered by the operations included in the system boundaries of a typical copper smelter and refinery as described in paragraph 3.4 of this OEFSR.

Table 1 defines the aspects and details of the typical product portfolio.

The Product Portfolio of an OEF study compliant with this OEFSR shall include products listed in **Table 1**. Copper cathode shall always be included in the Product Portfolio. An organisation may produce only some of the products listed in **Table 1,** thus the PP of such organisation could be narrower.

An organisation may process further (e.g. via refining) some of the products listed in Table 1. Inclusion of further refined products in a broader Product Portfolio is allowed within the scope of the OEFSR: this means that further products may be included in the OEF, however the inventory and the environmental impact of the operations needed to produce such products shall be reported separately.

In addition, the OEF report will have to include, in relation to these additional products, a detailed analysis compliant with the Recommendation 2021/2279 to evaluate most relevant impact categories, most relevant life cycle stages, processes and elementary flows. Specific verification for these additional analyses shall be performed (see verification chapter).

Table 1. Key aspects of the product portfolio

What?	**Blister copper, copper anodes and copper cathodes** – NACE Code: 24.44 Copper production **Sulphuric acid** – NACE Code: 20.13 Manufacture of other inorganic chemicals **Iron silicate (Final slag)** – NACE Code: 23.99 Manufacture of other non-metallic mineral products **Anode slime** – NACE Code: 24.45 Production of other non-ferrous metals **NiSO4 , CuSO4, other salts** – NACE Code: 24.45 Production of other non-ferrous metals **Silver /Gold/PGM concentrate** – NACE Code: 24.41 Precious metals production **Lead, Pb-Sn alloys, Tin** – NACE Code: 24.43 Pb, Zn and Sn production **Crude Selenium/Tellurium** – NACE Code: 24.45 Production of other non-ferrous metals **Zinc oxide** - NACE Code: 24.43 Pb, Zn and Sn production **Ammonium perrhenate** - – NACE Code: 24.45 Production of other non-ferrous metals **<u>All metals are associated with copper production and exclude production of these metals from other different sources.</u>**
How much?	Quantities produced will be specified over the reporting calendar year. Quantities shall be expressed as mass of each product in the product portfolio.
How well?	Excluded from system boundaries as the product portfolio is linked to intermediate products and not to finished products. There are a lot of different possible applications of the products included in the Product Portfolio, so it is not possible to define reliable scenarios for all possible different use phases. The organisation has no influence on the use stage of its products.
How long?	Excluded from system boundaries as the product portfolio is linked to intermediate products and not to finished products. There are a lot of different possible applications of the products part of the Product Portfolio, so it is not possible to define all possible different end-of-life scenarios. The organisation has no influence on the end-of-life of its products. Information on recyclability potential at end of life shall be provided. [6]
Reference year	Specify year of reporting.
Reporting interval	1 year

[6] Such potential shall be related to the amount of copper cathodes produced.

3.4. System boundary

Organisational boundaries of OEF studies are defined so as to encompass all facilities and associated processes that are fully or partially owned and/or operated by the Organisation and that directly contribute to the provision of the Product Portfolio.

The activities and impacts linked to processes within the defined Organisational boundaries are considered “direct” activities and impacts.

Organisational boundaries may include three different routes:

- Primary copper pyrometallurgical route,
- Secondary copper pyrometallurgical route,
- Integrated pyrometallurgical multimetal route

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

- o A - Primary smelting and converting (in two process steps or in one process step)
- o B - Secondary smelting and converting
- o C - Fire refining and copper electrolysis
- o D - Recovery of Pb/Sn/zinc oxide
- o E - Recovery of precious metals, crude selenium and/or tellurium, ammonium perrhenate
- o F- Slag cleaning (and iron converting)
- o G- Sulfuric acid plant products (Acid and liquid SO2 and or oleum)

These sub-modules may be included in different combinations depending on processes and recovery of other metals: e.g.: (A+C+(D)+E+F+G), or (B+C+(D)+E+F), or (A+B+C+(D)+E+F+G).

Within the Organisational boundaries a difference shall be made between:

- o processes which are necessary to contribute to providing the Product Portfolio over the reporting interval,
- o processes which are not necessary to provide the PP over the reporting interval. Such processes shall be reported separately (see reporting rules in the next paragraphs). Results shall be included under “Additional Environmental Information”.

<u>Processes necessary to provide the PP</u>

The following processes shall be included in the Organisational boundaries (in relation to route of production):

Primary Route

- o Transport of raw materials in vehicles owned or operated by the organisation (transport run by external companies fall outside the organisational boundaries, but within the OEF boundaries.)
- o Storage of raw materials
- o Concentrate drying
- o Smelting
- o Converting
- o Sulfuric acid production
- o Slag cleaning
- o Anode refining and anode casting
- o Copper electrolysis
- o Spent electrolyte treatment

- All related auxiliary processes such as Waste water treatment (on site including for treatment of process waters, 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

Secondary Route

- Transport of raw materials in vehicles owned or operated by the organisation (transport run by external companies fall outside the organisational boundaries, but within the OEF boundaries.)
- Storage of raw materials
- Secondary material pre-treatment
- Smelting
- Converting
- Anode refining and anode casting
- Copper electrolysis
- Spent electrolyte treatment
- All related auxiliary processes such as Waste water 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.

Integrated Route

- Transport of raw materials in vehicles owned or operated by the organisation (transport run by external companies fall outside the organisational boundaries, but within the OEF boundaries.)
- Storage of raw materials
- Concentrate drying
- Secondary material pre-treatment
- Smelting
- Converting
- Fire refining Anode refining (furnace) and anode casting
- Copper electrolysis
- Spent electrolyte (bleed) treatment (Ni sulphate /salts)
- Sulphuric acid production (Sulphuric acid)
- Slag treatment/cleaning (Iron silicate slags)
- Dore production (volatilization and recovery of selenium/tellurium and pre-step for Ag and Au production)
- Ag and Au refining (Ag , Au and PGM concentrate)
- Recovery of (Pb and Sn)
- All related auxiliary processes such as Waste treatment (e.g. landfilling on site), Waste water 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.

Processes which are not necessary to provide the Product Portfolio

Within the processes not necessary to provide the product portfolio, only electricity used for non-metallurgical operations (e.g. canteen, administration, etc) shall be included in the Organisational boundaries.

Processes not necessary to provide the Product Portfolio shall be reported separately (except the ones following within the cut-off criteria which may be excluded from the analysis).

OEF studies claiming to be compliant with this OEFSR shall be performed according to cradle-to-gate boundaries. All processes occurring upstream the organisational boundaries shall be included in the OEF study.

Processes to be included in the OEF boundaries, in addition to the ones occurring in the Organisational boundaries, are:

Upstream processes

- Generation of raw feed materials: copper concentrates as virgin materials, and scrap input as recycled materials
- Production and supply (transport) of chemicals, auxiliaries
- Production and supply (transport) of fuels
- Production and supply of electricity
- Production of purchased anode slimes, copper anodes, blister copper and nickel sulphate
- Transport of raw materials (copper concentrate, scrap, purchased materials) in vehicles not owned by the organisation
- Treatment of manufacturing waste

Downstream processes

Downstream processes are excluded from the system boundaries because products included in the Product Portfolio are intermediate materials. Transport of products included in the Product Portfolio to the next organisation shall not be included within the scope of this OEFSR.

End-of-Life

End of life is excluded.

As Additional Technical Information, the EoL stage of copper cathode (the main product in the portfolio) should be considered (section 3.6). This refers to transformation of copper products at the end of life to secondary copper cathode, including collection, sorting and mechanical pre-treatment (e.g. shredding).

System diagram

A system diagram is available in **Figure 3.** The hydrometallurgy route is excluded from the scope of this OEFSR. OEF studies shall indicate a system boundary diagram with identification of organizational boundaries and OEF boundaries, following the example in the OEFSR.

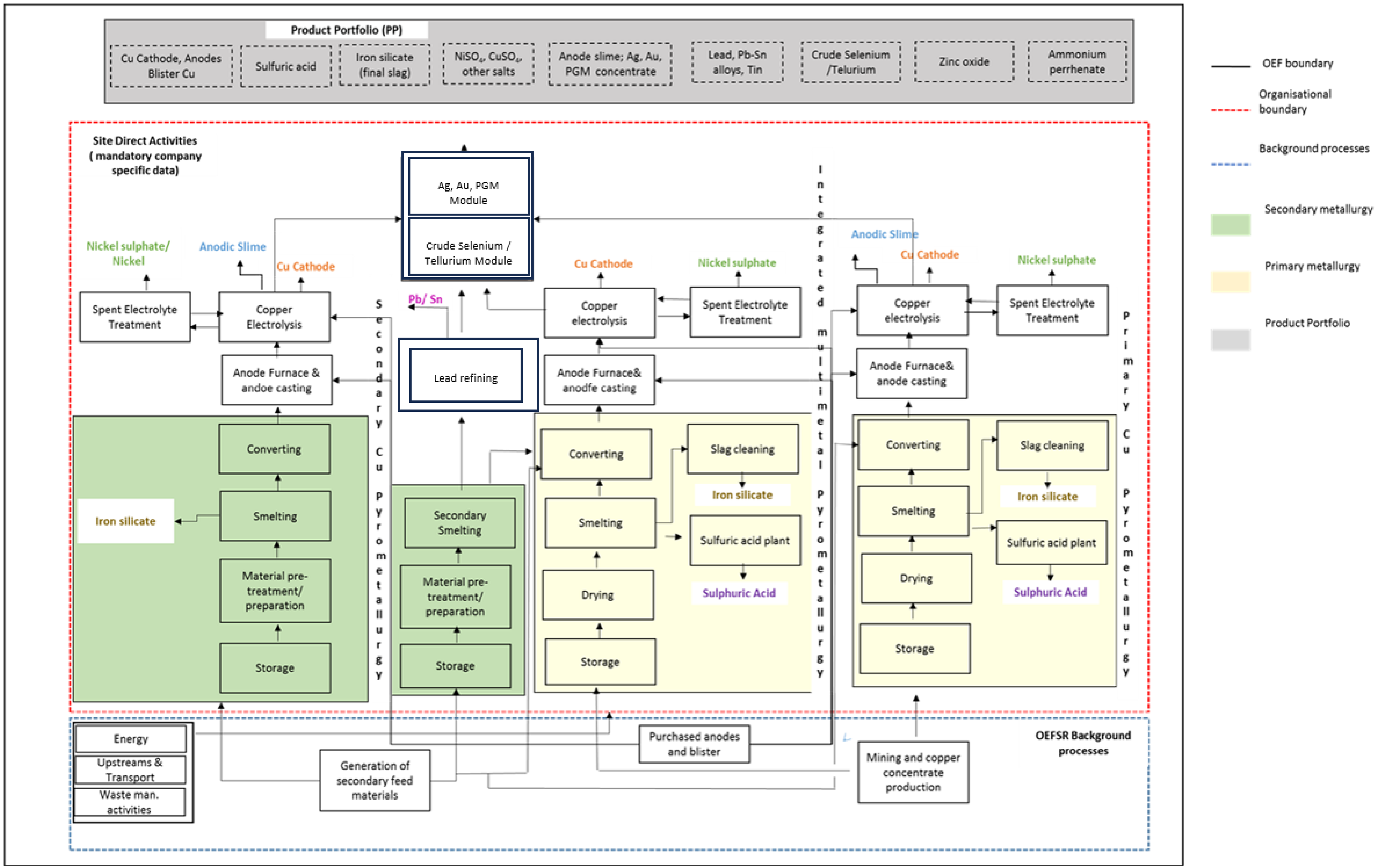


Figure 3. System diagram reporting OEF and Organisational boundaries. An organization may be composed of all, one or two routes.

The following life cycle stages and processes shall be included in the system boundary (see **Table 2***):*

Table 2. Life cycle stages

Life cycle stage	***Short description of the processes included***
Raw material acquisition and pre-processing	For the purpose of an OEF study on copper this life cycle stage shall be split into: 1a – Virgin material production. 1b – Secondary material production*. 1c – Production of purchased anodes and blister copper and anode slime. **including collection, sorting and mechanical pre-treatment (e.g. shredding) of scrap.*
Manufacturing	• Upstream (chemicals/auxiliary materials), including transports (their contribution to the impact shall be reported in a dedicated table) • Energy (indirect emissions related to the supply chain of all forms of energy used within the site). • Waste management activities (e.g. waste-water treatment plant, if occurring outside the organisational boundaries). • Site direct activities (Organisational boundaries): o Material pre-treatment. o Smelting. o Converting. o Anode refining (furnace) and anode casting. o Copper electrolysis. o Spent electrolyte (bleed) treatment (Ni sulphate /salts). o Sulphuric acid plant (Sulphuric acid). o Slag treatment/cleaning (Iron silicate slags). o Dore production (volatilization and recovery of selenium/tellurium and pre-step for Ag and Au production). o Ag and Au refining (Ag, Au and PGM concentrate). o Recovery of (Pb and Sn). o All related auxiliary processes such as Waste water treatment (including 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.

According to this OEFSR, the following processes can be excluded based on the cut-off rule:

Processes not necessary to provide the Product Portfolio, other than electricity used for non-metallurgical operations[7]. For example, the production of computers, supply of food to the canteen may be excluded. Capital goods, commuting of employees, business travels, packaging (if any) may be excluded.

Each OEF study done in accordance with this OEFSR shall provide in the OEF report a diagram indicating the organizational boundary, to highlight those activities under the control of the organization and those falling into Situation 1, 2 or 3 of the data need matrix.

All processes defined within the OEFSR boundaries shall be modelled by the applicant.

The applicant of this OEFSR shall define its organisation with reference to the PP through its name, kind of goods and services produced, location of operation, and NACE codes.

3.5. List of EF impact categories

Each OEF study carried out in compliance with this OEFSR shall calculate the OEF-profile including all EF impact categories listed in Table 3 below.

Table 3. List of the impact categories to be used to calculate the OEF profile

EF Impact category	Impact category Indicator	Unit	Characterization model	Robust-ness
Climate change, total[8]	Radiative forcing as global warming potential (GWP100)	kg $CO_{2\ eq}$	Bern model - Global Warming Potentials (GWP) over a 100 year time horizon (based on IPCC 2021)	I
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	EDIP model based on the ODPs of the World Meteorological Organisation (WMO) over an infinite time horizon (WMO 2014 + integrations)	I
Human toxicity, cancer	Comparative Toxic Unit for humans (CTU_h)	CTUh	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Human toxicity, non-cancer	Comparative Toxic Unit for humans (CTU_h)	CTUh	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Particulate matter	Impact on human health	disease incidence	PM model (Fantke et al., 2016 in UNEP 2016)	I

[7] The relevance of processes subject to cut-off was evaluated in the OEF supporting studies developed during the EF pilot phase

[8] The indicator "Climate Change, total" is constituted by three sub-indicators: Climate Change, fossil; Climate Change, biogenic; Climate Change, land use and land use change. The sub-indicators are further described in section 4.4.10 of annex III. The sub-indicators "Climate Change - biogenic" and "Climate Change - Land Use and Land transformation" shall not be reported separately, because their contribution because their contribution to the total climate change impact, based on the Representative Organisation results, is less than 5% each.

EF Impact category	Impact category Indicator	Unit	Characterization model	Robust-ness
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq $U^{235}{}_{eq}$	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)	II
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van Zelm et al, 2008) as applied in ReCiPe 2008	II
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P $_{eq}$	EUTREND model (Struijs et al, 2009) as applied in ReCiPe	II
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N $_{eq}$	EUTREND model (Struijs et al, 2009) as applied in ReCiPe	II
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Land use[9]	Soil quality index[10]	Dimensionless (pt)	Soil quality index based on LANCA model (De Laurentiis et al. 2019) and on the LANCA CF version 2.5 (Horn and Maier, 2018)	III
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 water eq of deprived water	Available WAter REmaining (AWARE) model (Boulay et al., 2018; UNEP 2016)	III
Resource use[11]**, minerals and metals**	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	van Oers et al., 2002 as in CML 2002 method, v.4.8	III

[9] Refers to occupation and transformation

[10] This index is the result of the aggregation, performed by JRC, of 4 indicators (biotic production, erosion resistance, mechanical filtration, and groundwater replenishment) provided by the LANCA model for assessing impacts due to land use as reported in De Laurentiis et al, 2019.

[11] The results of this impact category shall be interpreted with caution, because the results of ADP after normalization may be overestimated. The European Commission intends to develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources

EF Impact category	Impact category Indicator	Unit	Characterization model	Robust-ness
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[12]	MJ	van Oers et al., 2002 as in CML 2002 method, v.4.8	III

The full list of normalization factors and weighting factors are available in Annex 1 - List of EF normalisation factors and weighting factors.

The full list of characterization factors is available at this link [http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.](http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml)

The EF 3.1 Reference Package shall be used.

3.6. Additional technical information

- The recycled content (R1) shall be reported (at least for copper cathode).
- Results with application-specific A-values, if relevant.

This OEFSR requires mandatory additional technical information to be calculated (shall requirement) and recommended additional technical information (should requirement).

Mandatory additional technical information

1) The composition of the Product Portfolio shows that other products (precious metals, Pb Sn, sulphuric acid, silicates, etc.) are associated with copper production and recovered from the same copper bearing raw materials (from both primary materials and secondary materials) as additional value. This is due to the specificities of copper metallurgy and refining and the unique properties of copper to bind other valuable products. All marketable by-products of copper production could be included in Product Portfolio (see section 3.3), regardless their legal status (product, byproduct or waste). Therefore, results from the OEF shall be expressed per created value (market value of all products in the product portfolio). Results shall refer both to the characterized and normalized values. This information will give insights on the overall resource efficiency of the system under investigation. The calculation shall be done in the following way:

a) Calculate the total revenue (€) accounting all products in the product portfolio.

- Total revenue (€) = ∑ [amount of product produced for the calendar year (kg) x market value (€/kg)]

The market value shall be based on average price for latest 10 years.

The sources to be used to determine the reference price are:

- the London Metal Exchange (LME) listings: copper, tin, zinc, lead (refined not raw)
- the London Bullion Market Association listings: gold, silver

Approximate value of the other products could be found in:

- MetalBulletin.com/MetalPrices.com: tellurium, selenium, rhenium;
- CRU group, Argus media: sulphuric acid

rm

There are some products in the PP (not the main ones) that have no market listings. Their price differ significantly depending on the content of valuable elements (anode slime, PGM concentrate, copper sulphate and nickel sulphate). Prices of these products are also an effect of contractors negotiations and are based on the general formula: Prices = market value of the valuable elements – contractors unit processing cost. It cannot be determined a common price to valuate these in the PP therefore every organization shall take into account its own prices and give evidence for the used price.

b) Divide the impact for each category (cradle to gate) per the total revenue.

- In addition to the OEF profile calculated using the default requirements for electricity modelling, the OEF profile shall also be calculated using the EU + EFTA + UK electricity grid mix, related to electricity used as input to the organization (i.e. electricity activity data in excel file "Copper OEFSR_4.0 - Life cycle inventory"). This refers only to the electricity used in the "manufacturing" life cycle stage, used by the organisation to provide the Product Portfolio. It applies also to "raw material acquisition and pre-processing" when it falls under Situation 1, option 1 of the Data Needs Matrix.
- Potential impacts associated to fugitive emissions, if this information is available, shall be calculated and reported separately.

Recommended Additional technical information

- End-of-life stage of the main product (copper cathode) should be calculated and reported.

For metal products, it is relevant to consider properly the recycling aspects over their full life cycle.
Recycling strongly contributes towards a circular economy and as such is a key asset of copper metal products in terms of resource efficiency. It is particularly important to reconcile the two sides of recycling taking place respectively at the manufacturing stage and at the end of life stage. This is because copper smelters do actually recycle the end-of-life copper products and especially allow recovery of copper from low quality/complex scrap thanks to the technology developed by the recyclers. In such context, it is essential to reflect properly the end-of-life stage of the main output product (copper cathode) and complement the information of cradle-to-gate for the organization.

Calculation rules

Results shall be calculated as the sum of the cradle-to-gate assessment of the copper cathode and the end-of-life (i.e. recycling activities, disposal) stage of copper. Rules to calculate the EF of the copper cathode are common to the ones used to calculate the OEF of a copper producing company.

In addition, when calculating the EF of the copper cathode (Additional Technical Information), sulfuric acid ,iron silicate, lead and tin shall be allocated using direct substitution based on physical relationship (EF compliant datasets shall be used, applying the information available in the documentation of the datasets. If no EF compliant datasets are available, rules at par 5.6 apply), anodes/blister shall be allocated according to mass allocation, while all the other products in the product portfolio shall be allocated according to their economic value.(average price for latest 10 years)

To calculate the end of life stage of the main product, copper cathode, this OEFSR prescribes:

- The calculations shall be made using A=0.2, as material-specific default value provided in the Annex C of the Recommendation 2021/2279.
- Modelling the point of substitution:
  - ✓ the points of substitution to be used to identify the correct datasets to model Ev and Erec shall be identified at level 1 (See Recommendation 2021/2279 for details). This means that the true points of substitution are modelled: for example, scrap input to various metallurgical operations is substituting the primary material input to the same operation (**see Figure 4**). The CFF does not apply to internal loops (e.g. scrap generated within the organization and recycled within the organization).
  - ✓ The following points of substitution may be identified:

        - Anode Furnace (M8 in Excel file "Copper OEFSR_4.0 - Life cycle inventory):
            - Secondary blister (Erec) – Primary blister (Ev)
            - Copper scrap (Erec) – Primary blister (Ev)
        - Electrolysis (M11 in Excel file "Copper OEFSR_4.0 - Life cycle inventory):
            - Secondary anodes (Erec) – Primary anodes (Ev)
            - Copper scrap (Erec) – Primary anodes (Ev)
- The dataset to be used to model ErecEoL is: Secondary Copper Cathode (open scrap input); copper scrap smelting and refining; single route, at plant; 8.92 g/cm3 (uuid: abb90c26-e1de-4a8a-8a86-462529b5d669).
- The dataset to be used to model E*v is: primary copper cathode (26c8c453-8b15-4583-889c-fa4fb56a5771). This is a gate-to-gate process to be complemented with GLO copper concentrate (Mining, mix technologies) (uuid: 1e96df1c-0a73-4d57-a3d8-7ab45ba9d8ef).
- The datasets to model Ed (landfilling) is: landfill of inert material (other materials) (uuid: 448ab0f1-4dd6-4d85-b654-35736bb772f4).
- Modelling the quality factors

    In this case the quality factors at the input side are always equal to 1, this is because scrap and primary materials input to the same metallurgical operations are of the same quality. For example high purity scrap input to the anode furnace is of the same quality of the primary material input to the same furnace.

Example how to apply the CFF for Additional Environmental Information

- Smelting and converting: model the real scrap flows and real impacts of smelting and converting activities.

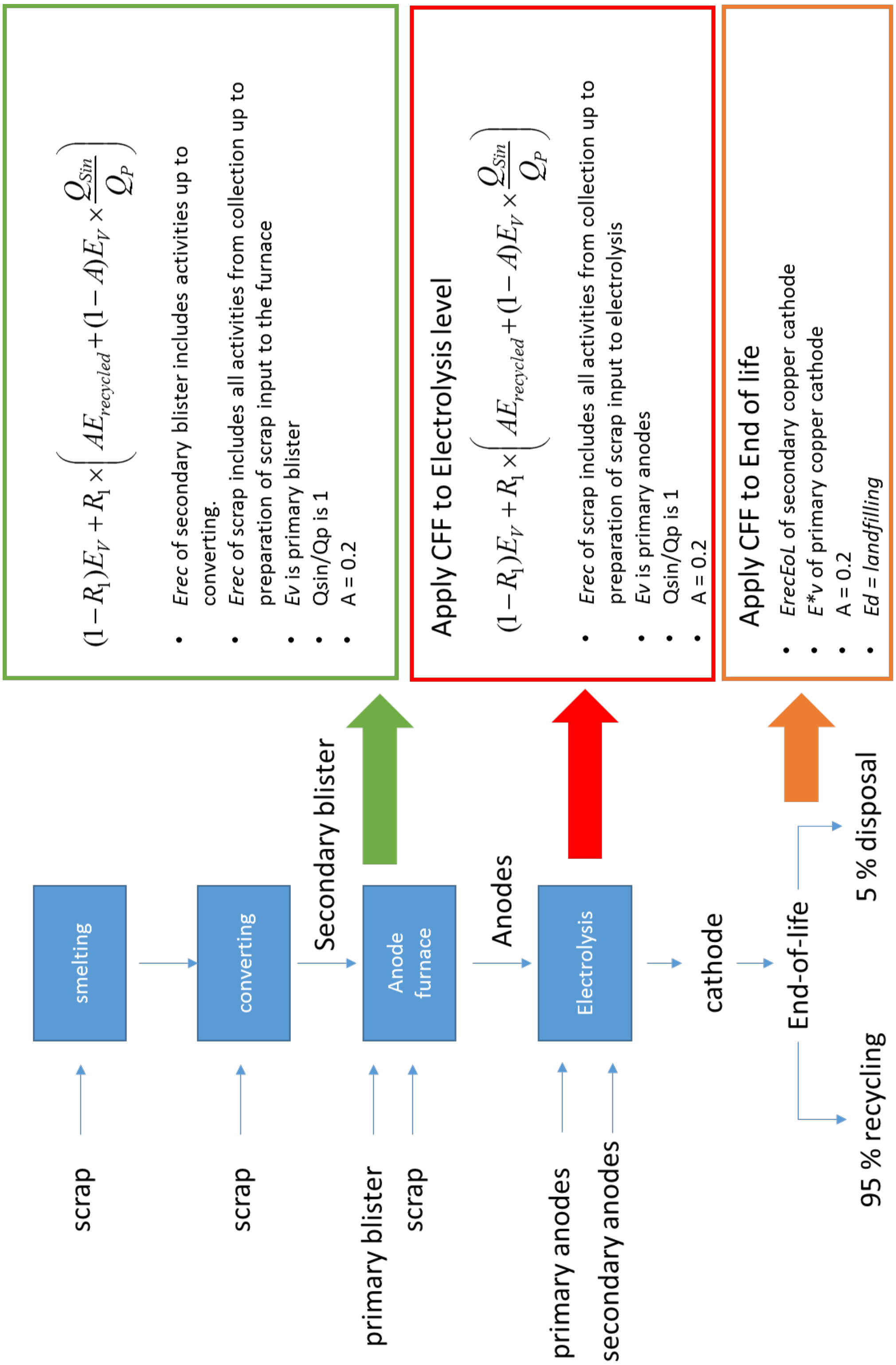


Figure 4. Example on how to model virgin and secondary input in the CFF when calculating the profile of copper cathode for Additional Environmental Information, using Option 1 (Recommended in this OEFSR).

- Anode level: model primary and secondary flows, as in **Figure 5.**

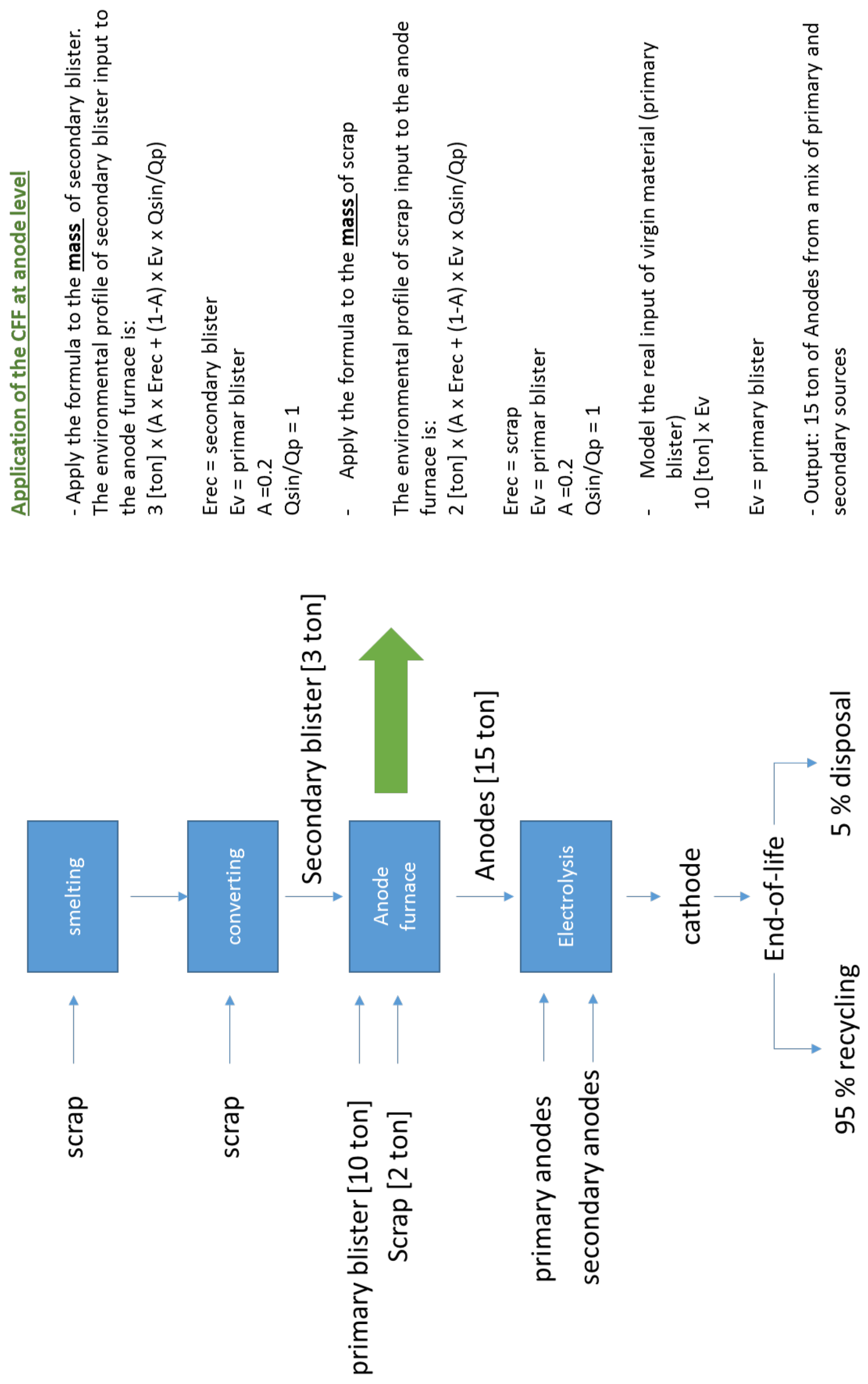


Figure 5. Example of application of the CFF to Anode level.

- Electrolysis: model primary and secondary flows, as in **Figure 6.**

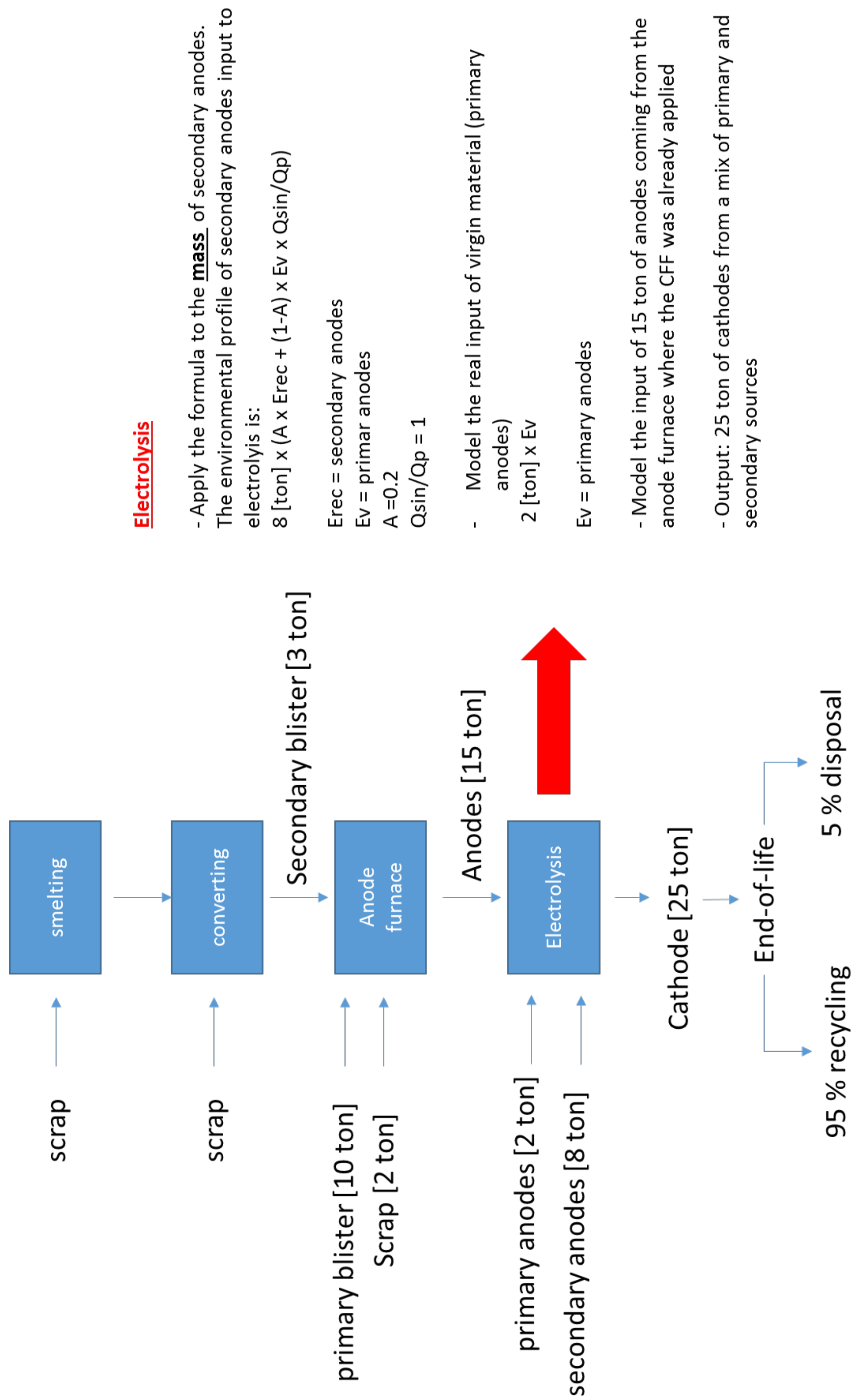


Figure 6. Example of application of the CFF to Electrolysis.

- End of life: model as in Figure 7.

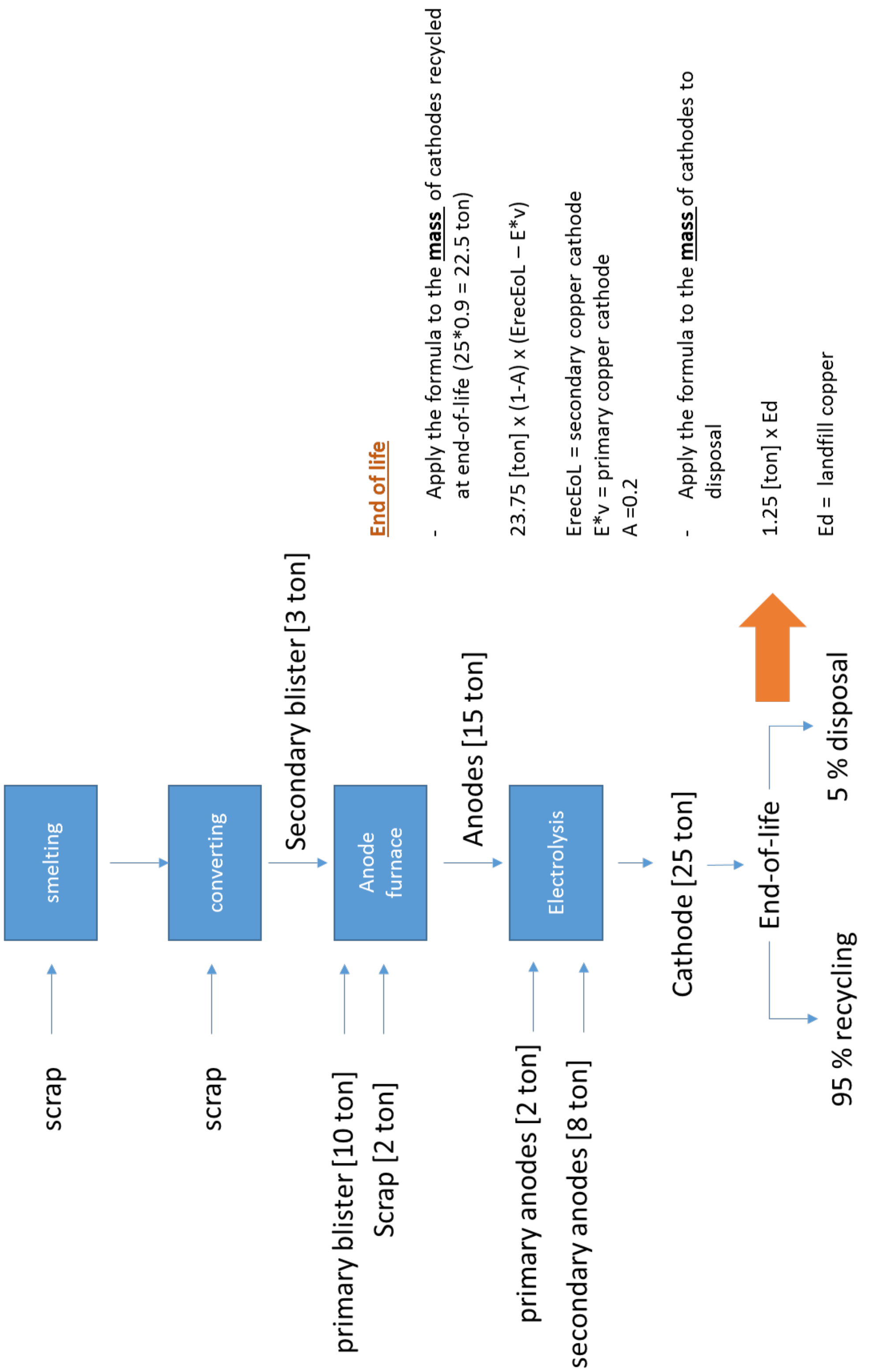


Figure 7. Example of application of the CFF to End-of-Life.

3.7. Additional environmental information

Biodiversity is considered as relevant for this OEFSR: YES.

The OEF results for climate change; acidification; eutrophication – terrestrial; eutrophication – aquatic (freshwater); eutrophication – aquatic (marine); water scarcity; and land use collectively address potential impacts on biodiversity (Global Reporting Initiative (2007)).

Biodiversity impacts may also arise from site-based practices rather than material flows and depend on the local situation and operational areas. In most jurisdictions, mining operations assess potential biodiversity impacts through Environmental Impact Assessment and as part of their licence to operate have management plans in place where appropriate. Voluntary responsible sourcing schemes may also be applicable (e.g., disclosure of biodiversity data as part of the Global Reporting Initiative).

It is recommended to indicate under additional environmental information if biodiversity impacts resulting from site-based practices is identified, the nature of these impacts and relevant management approach (disclosure of information as part of the Global Reporting Initiative Guidelines biodiversity (Global Reporting Initiative (2016) GRI 304 Biodiversity).

3.8. Limitations

- In a cradle-to-gate OEF context, Resource Use, mineral and metals based on the ADP method is the dominating impact category also because credits at end of life are not accounted for. Therefore, the applicant of the OEFSR should calculate the end of life of the main product (copper cathode) as Additional technical information (chapter 3.6). Resource Use – minerals, metals is the dominating impact category also for secondary copper production when applying the current method ("ADP crustal content/ultimate reserves") for assessing minerals and metals and current normalisation factors. This outcome shall be interpreted with caution, because the results of ADP after normalization may be overestimated. The ADP crustal content/ultimate reserves is considered as an intermediate recommendation[13]. The EU Commission should develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources.
- The copper concentrate dataset used is modelled for a fixed copper content (28% Cu) and it is the only one currently available in the EF database. However, concentrates with different copper contents have varying impacts, hence, relying on a dataset with a constant copper content cannot accurately capture these varying impacts. If EF-compliant datasets become more readily available in future EF database releases, encompassing various copper content levels, they should be incorporated in subsequent revisions of this OEFSR.
- The Land Use impact category shows to be the second most relevant impact category. However, this impact category has a low robustness (level III, as detailed in section 3.5), indicating that it should be utilized with caution. It's important to highlight that the Land Use impact category has undergone updates in the transition from the EF 2.0 to the EF3.1 impact assessment method, and its testing has been limited at this point. Consequently, the Technical Secretariat has reservations about deeming this impact category sufficiently robust for decision support. Therefore additional impact categories, that are more relevant for decision support, such as climate change and particulate matter, have been added to the list of the most relevant impact categories.

3.8.1. Comparisons and comparative assertions

Benchmark

The TS evaluated the possibility of establishing a benchmark for the sector. It was found not meaningful to establish a benchmark for organisations in the copper production sector due to variability in the scale of operation and product portfolios, heterogeneous production routes and process configuration even though the Representative Organization (based on a real organisation) represented all the production routes in scope. Also, strong limitations related to the availability of secondary datasets for copper concentrates (in terms of differentiating datasets as a

[13] Minutes of the Meeting of the Environmental Footprint Technical Advisory Board (16-18 November 2016, Brussels).

function of ore grade and concentrate grade), which are driving the overall OEF profile, prevented the establishment of a meaningful benchmark.

This OEFSR, therefore does not support a benchmark and classes of performance.

The opinion of the TS is that progress in improvement of organizations will contribute to the environment while benchmarking organizations is not seen as the key factor to positively contribute to the environment[14].

This OEFSR supports two types of comparisons: i) comparisons of performance of an organization over time, ii) comparisons of different organizations.

Comparative assertions

Comparative assertions are not allowed.

Comparison of performance of an organization over time

The aim is to compare single organisation's OEF over years, track its environmental performance and report on it. In this respect OEF information may supplement measurement of environmental performance improvement by standard indicators as outlined in EMAS.

The comparison shall be based on the following requirements:

a. Compare and report results both of the OEF boundaries and the Organisational boundaries. In relation to these two boundaries, compare and report:
    - Environmental Footprint results
    - Environmental Footprint results expressed per total value, calculated according to chapter 3.6 of this OEFSR.

b. Organisations reporting their OEF periodically shall track and inform on changes in structure of the most important factors that caused OEF result change in reference to previous reporting period, e.g. production volumes, copper concentrate mass & copper grade in concentrate, change in country energy mix, technological improvements, higher operational efficiency, change in intermediate product stock, etc.

c. To allow comparisons over time the OEF has to be based on LCI data of analogous quality and source. The OEF profiles are compliant with this OEFSR. Changes to the Product Portfolio over time are reflected in the value generated: in this case, the Environmental Footprint results shall be compared expressed per total value, calculated according to chapter 3.6 of this OEFSR.

Comparisons of different organisations[15]

Comparisons of two or more organisations are supported by this OEFSR only when the below listed conditions are all fully respected and described in the OEF report[16].

Conditions:

- The OEF profile of each organisation is calculated compliant with this OEFSR
- The OEF profile of each organisation is calculated using data of high quality (≤ 1.6; the score of each data quality criteria for these processes shall be ≤3) also for the most relevant upstream processes (i.e. copper concentrate and energy production for site direct processes). The default datasets for copper concentrate shall be based on primary data provided by industry.

[14] Comparing the environmental performance of organizations is challenging, even when the scope of products and processes are similar and the same performance indicators are applied. This has been the reason to develop sectorial reference documents in the EMAS context, whose give only subjective views on performance benchmarks.

[15] In this OEFSR organisation is referring both to production sites within a same organisation and different organisations.

- Compare and report results both of the OEF boundaries and the Organisational boundaries
- Compare and report OEF profiles based on both EU + EFTA + UK electricity grid mix (consumption mix) and electric energy provider specific data (or country mix)
- Environmental Footprint results expressed per total value, calculated according to chapter 3.6 of this OEFSR.
- Rules for interpreting results of the OEF studies shall be followed.

Even when the above conditions are met, no comparative assertions[17] are supported.

Rules for interpreting results of the OEF study

When comparing OEF results, it is important to study the roots of the results and take into account the external factors, which cannot be changed by the organization, to complement the overall OEF results.

The relevance of the external factors for the organizations in copper production shall be checked according to Table 4. Interpretation of the results shall consider the similarities and differences in external factors.

Table 4. External factors that shall be taken into account when interpreting OEF results

Factors of Copper Smelting operations in European Union	Is it external to the system (difficult to change by organization)	Will it have an impact on the environmental performance
Production route (primary , secondary , integrated)	Yes	Yes
Product portfolio	Yes	Yes
Share of imported concentrate or anodes/blisters, % Cu	Yes	Yes
Ore type (ore grade), % Cu	Yes	Yes
Size of the site/Capacity	Yes	Yes
Electrical energy mix	Yes	Yes
Concentrate grade, % Cu	Yes	Yes
Accessibility to energy	Yes	Yes
Use of secondary raw materials, % of output	Yes	Yes
Deployed technology	Yes	Yes
Use of primary or secondary data to model copper concentrates	Yes	Yes

[17] In this OEFSR comparative assertions are defined as in ISO 14044. Comparisons do not include an environmental claim of superiority of one organisations versus a competing one in the same sector.

Use of primary or secondary data to model electricity	Yes	Yes

Each European copper smelter has its own specificities, related to factors listed Table 4 since it is within the organization's decision-making capability to change all other factors to improve the environmental performance.

The external factors listed in Table 4 provide a basis to be taken into account when comparing OEF results of two organisations, in order to consider the fundamental elements to correctly interpret the OEF profiles.

For example, a company operating in a country where the electricity mix is very clean may have a better environmental profile than a company operating in a country where the electricity mix is less clean, despite the energy consumption may be higher in the first case. Therefore, to avoid biased conclusions, all the listed external factors shall be taken into account when comparing the environmental profile of two organisations

3.8.2. Data gaps and proxies

- Purchased blister copper. Own produced blister copper may be used as a proxy also for externally supplied blister copper : data that best fit the profile of purchased blister copper shall be used.

- Purchased copper anodes. Own produced copper anodes may be used as a proxy also for externally supplied copper anodes: data that best fit the profile of purchased copper anodes shall be used.

- Very low quality, low quality and medium quality copper scrap. The dataset for high quality copper scrap shall be used as proxy if rules at chapter 5.6 do not allow identifying more appropriate datasets.

- Primary silver may be used as proxy for Silver Dore

- Silver, recycled, post-consumer may be used as a proxy for Secondary silver.

- Copper concentrate may be used proxy for Cu & Pb- containing materials.

- For Electrodes there is currently no proxy currently available. Therefore it is a data gap.

- Electrodes, catalysts and electrolytes may in some cases have no suitable proxies and may be treated as a data gap.

All proxies to fill in data gaps can also be found in the Excel file "Copper OEFSR_4.0 - Life cycle inventory" in the "remarks" column.

4. Most relevant impact categories, life cycle stages, processes and elementary flows

4.1. Most relevant EF impact categories

The most relevant impact categories for the sector in scope of this OEFSR are the following:

- Primary Route: Resource use, minerals and metals; Land use; Particulate Matter; Climate Change
- Secondary Route: Resource use, minerals and metals; Land use; Climate Change; Particulate Matter
- Integrated Route: Resource use, minerals and metals; Land use; Particulate Matter; Climate Change

Resource Use – minerals, metals, is the dominating impact category also for secondary copper production when applying the current method ”ADP crustal content/ultimate reserves” for assessing minerals and metals and current normalisation factors. This outcome shall be interpreted with caution, because the results of ADP after normalization may be overestimated. The ADP crustal content/ultimate reserves is considered as an intermediate recommendation[18]. The EU Commission in cooperation with industry should develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources.

4.2. Most relevant life cycle stages

The most relevant life cycle stages for the sector in scope of this OEFSR are the following:

- Primary Route: Raw Materials Acquisition and pre-processing; Manufacturing
- Secondary Route: Raw Materials Acquisition and pre-processing; Manufacturing
- Integrated Route: Raw Materials Acquisition and pre-processing

4.3. Most relevant processes

*The most relevant processes for the sector in scope of this OEFSR are the following (**Table 5, 6 and** 7):*

Table 5. List of the most relevant processes - Primary Route

Impact category	***Processes***
Resource use – Minerals and Metals	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
Land use	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
Particulate Matter	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
Climate Change	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing)) Energy (Electricity grid mix (EU+EFTA+UK) (from life cycle stage Manufacturing))

[18] Minutes of the Meeting of the Environmental Footprint Technical Advisory Board (16-18 November 2016, Brussels).

Table 6. List of the most relevant processes - Secondary Route

Impact category	*Processes (life cycle stage)*
Resource use – Minerals and Metals	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
Land use	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
Climate Change	Site Direct Activities (from life cycle stage Manufacturing)
	Energy (Electricity grid mix (EU+EFTA+UK) (from life cycle stage Manufacturing))
	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
	Lorry Transport (from life cycle stage Raw Materials Acquisition and Pre-processing)
Particulate matter	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
	Transoceanic ship Transport (from life cycle stage Raw Materials Acquisition and Pre-processing)
	Site Direct Activities (from life cycle stage Manufacturing)

Table 7. List of the most relevant processes - Integrated Route

Impact category	*Processes (life cycle stage)*
Resource use – Minerals and Metals	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
Land use	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
Particulate Matter	Virgin material production (Copper Concentrate Mining and Production, including its transport (from life cycle stage Raw Materials Acquisition and Pre-processing))
	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
	Transoceanic Ship transport (from life cycle stage Raw Materials Acquisition and Pre-processing)

Climate change	Virgin material production (Copper Concentrate Mining and Production (from life cycle stage Raw Materials Acquisition and Pre-processing))
	Production of purchased anodes and blister copper and anode slime (from life cycle stage Raw Materials Acquisition and Pre-processing)
	Energy production (Electricity grid mix (EU+EFTA+UK) (from life cycle stage Manufacturing)

4.4. Most relevant direct elementary flows

The most relevant direct elementary flows for the sector in scope of this OEFSR are the following:

They cannot be identified when a most relevant process is a secondary dataset, due to the lack of level-1 datasets availability at the time of writing the OEFSR.

- For Site Direct Activities, the most relevant direct elementary flows are:
- Climate Change – Carbon dioxide, fossil

The list of mandatory company-specific elementary flows to be collected is in any case broader than the most relevant ones and it is available in following sections.

5. Life cycle inventory

All newly created datasets shall be EF-compliant.

Sampling is: not allowed.

5.1. List of mandatory company-specific data

Mandatory activity data to be collected are:

- The modelling of transports of fee materials (i.e. copper concentrates, scrap, blister copper and copper anodes) to the copper production site shall be done using primary activity data for the distance. For other upstream transport activities, if specific data reflecting the current specific situation are available, they shall be used, otherwise default values of the OEFSR Recommendation 2021/2279 shall be applied (Chapter 4.2.3 "From supplier to factory").
- All inputs to the organization shall be modelled with primary activity data

Mandatory processes to be modelled with company specific data only are:

- Site direct activities

Process: Site direct activities

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

- Primary/site-specific data shall be collected specifically 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 OEF report.
- The data shall include all known inputs and outputs for the core processes, including input of 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 a calendar year (12 months) that are representative for the product portfolio produced.
- The following sources of data shall be considered:
  - Process or plant level consumption data;
  - Reports and stock/inventory-changes of materials and consumables;
  - Technical balance for metals in raw materials, final products and intermediate;
  - Technical balance for water and steam distribution. The water balance shall differentiate between type of input water per source (tap, river , lake, ..) and per use (process, cooling). The water balance shouldbe modelled at site-level. Water balance may be provided for whole site or separate installations. The user of the OEFSR needs to ensure that no double counting occurs, if data are collected for separate installations.
  - Emission reports to authorities as required by the permits or fulfilling reporting requirements like according to the European Pollutant Release and Transfer Register (E-PRTR);

- o GHG inventory calculations and reports under EU Emission Trading Scheme (ETS);
- o Direct emission measurements (concentrations plus corresponding off-gas and wastewater amounts, based on highest standards of measurements as defined in the BREF for the Non-Ferrous Metals Industries (NFM BREF) and Monitoring Reference report);
- o Reports on waste;
- o Reports from procurement and sale department. (related to purchased concentrates, secondary raw materials, reagents, auxiliary materials, sold products)

- Information on the source of data (direct measurements, material balance, calculations using certain empirical formulas and factors) and methodology used for calculations shall be provided in the OEF report.

- The stack emissions to air shall be monitored based on continuous measurements or periodic measurements and recognized standards in accordance with the requirements set in the NFM BREF (11.2.1.1 – Monitoring of Emissions to Air). The loads [kg/a] for air emissions shall be calculated as the (*Annual average concentration by point source (mg/Nm^3) X Annual average flow rate (Nm^3/h) X Operating hours(h/a)/1000000*. All emission points shall be taken into consideration. Calculations shall be based on all available measurements. The loads of air emissions in the baseline scenario shall only be based on point source emissions. In case Information on the magnitude of fugitive emissions from most relevant sources is available, it shall be reported as Additional Environmental Information. The fugitive emissions **shall not** be included in the calculation of OEF baseline results[19].

- The emissions to water shall be monitored after the water treatment plant and before the discharge of water into the receiving water at the point where the emission leaves the installation based on composite (flow proportional or time proportional) or spot samples and recognized standards in accordance with the requirements in the NFM BREF (11.2.1.2 – Monitoring of emissions to water). The loads [kg/a] for water emissions shall be calculated as (Annual average metal concentration by discharge point(mg/m^3) X Annual discharged flow by discharge point(m^3)/1000000. All discharge points shall be taken into account (treated process water, clean indirect cooling water and surface runoff water). Process water calculations shall be based on all available measurements)

- The energy (fuel) consumption [MJ] shall be calculated from the amount of fuel used (per type of fuel) and the Net calorific value. The steam consumption (MJ) shall be calculated by the steam (kg) and enthalpy (kJ/kg). Specific enthalpy shall be used based on the actual steam pressure and temperature (saturated steam tables). The direct (fuel related) CO_2 emissions to air [kg] shall be calculated based on Fuel consumption by source (kg) X net calorific value (MJ/unit) X Emission factor (kg CO_2/MJ). The net caloric values [MJ/kg] and emission factors [kg CO_2/MJ] shall be based on specific information from suppliers if available or national country specific values (in accordance with reports on greenhouse gas emissions pursuant to Directive 2003/87)

Table 8 and **Table 9** provide an example on the inventory of substance/elementary flows and activity data that shall be collected for each sub-process within the Organisational boundaries: the minimum list of data to be collected is available in the Excel file, annex to this OEFSR, "Copper OEFSR_4.0 – Life Cycle Inventory". Sub-processes and activity data not listed in the Annex "Copper OEFSR_4.0 - Life cycle inventory" and belonging within the Organisational boundaries needed to produce the Product Portfolio are mandatory company specific:

[19] This is because quantification of fugitive emissions is not implemented as standard practice. There are methods available but the uncertainty might be relatively high and therefore the level of confidence in results might be low. (Reference report on monitoring of emissions from IED installations, 4.2.4).

the completeness of data in this situation shall be checked during the verification of the OEF study compliant with this OEFSR[20].

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 20% threshold is exceeded.)

When a dataset is not listed in the Annex, rules at section 5.5 apply.

The EF-compliant dataset of "Site Direct Activities" is the result of the aggregation of the LCI result of all the sub-processes within the organizational boundaries: in the Annex "Copper OEFSR_4.0 - Life cycle inventory" the worksheet "M-Site Direct Activities" describes the EF-compliant dataset and the worksheets M1- to M16- are the disaggregated sub-processes for which mandatory company-specific data shall be collected.

When dealing with energy (all energy types, including electricity), the applicant of the OEFSR shall:

- Ensure no double counting occurs between direct emissions and emissions already included in EF-compliant datasets used to link the company-specific activity data. For example, if emissions from fuel burning are collected as direct emissions, the EF-compliant datasets selected shall not include emissions from burning of the fuel.
- Apply requirements at Par. 5.8 and 6.2 of this OEFSR regarding electricity.

Table 8. Data collection requirements for mandatory process "Site Direct Activities" – Example of sub-process "Secondary smelting furnace". The full list of data to be collected for "Site Direct Activities" is available in the Excel file Copper OEFSR_4.0 – Life Cycle Inventory

Requirements for data collection purposes			Requirements for modelling purposes			
Activity data to be collected	Specific requirements (e.g. frequency, measurement standard, etc)	***Unit of measure***	***Default dataset to be used***	***Dataset source (i.e. node)***	***UUID***	***DQR***
High quality (Copper /copper alloy scrap)	Yearly	*kg*	*Recycling of copper from clean scrap {EU+EFTA +UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%, copper losses 1% | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5*	*2*

[20] This applies also to on-site electricity generation.

Medium quality (Shredder material)	Yearly	*kg*	*Recycling of copper from clean scrap {EU+EFTA +UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%, copper losses 1% | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5*	*2*
Low quality (Electronic scrap and residues)	Yearly	*kg*	*Recycling of copper from clean scrap {EU+EFTA +UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%, copper losses 1% | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5*	*2*
Very low quality (Waste / residues)	Yearly	*kg*	*Recycling of copper from clean scrap {EU+EFTA +UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%, copper losses 1% | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5*	*2*

Oxygen	Yearly	*kg*	*Not applicable (only electricity modelled; see below at electricity)*	/	/	/
Fuel (Oil, natural gas, ..)	Yearly	*kg*	*Heavy fuel oil at refinery {EU+EFTA +UK} | from crude oil | production mix, at refinery | 1 wt.% sulphur | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0d3757fb-e445-4315-be99-94410c05a7b1*	*1,25*
Steam (including for heating of buildings)	Yearly	*MJ*	*Not applicable; internally produced only*	/	/	/
Electricity (including for oxygen production)	Yearly	*kWh*	*Electricity grid mix 1kV-60kV {EU+EFTA +UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result*	*http://lcdn.thinkstep.com/Node/*	*34960d4d-af62-43a0-aa76-adc5fcf57246*	*1,25*
Electrodes (for el. furnace)	Yearly	*kg*	*Data Gap*	/	/	/
Outputs						

Black copper	Yearly	*kg*	*Internal flow*	-	-	-
Lead bullion	Yearly	*kg*	*Internal flow*	-	-	-
Iron Silicate	Yearly	*kg*	*Product in the PP*	-	-	-
Dust containing ZnO	Yearly	*kg*	*Internal flow*	-	-	-

Table 9. Data collection requirements for mandatory process "Site Direct Activities" – Example for elementary flows to be collected for sub-process "Secondary smelting furnace". The full list of data to be collected for "Site Direct Activities" is available in the Excel file Copper OEFSR_4.0 – Life Cycle Inventory.

Emissions/resources	***Elementary flow***	***Frequency of measurement***	***Default measurement method[21]***	***Remarks***
Emissions to air			Measurement requirements of emissions are described in the main text in this section.	
SO_2	fe0acd60-3ddc-11dd-ac48-0050c2490048	Yearly		
NO_x	08a91e70-3ddc-11dd-96e5-0050c2490048	Yearly		
CO_2	08a91e70-3ddc-11dd-923d-0050c2490048	Yearly		
Dust PM10	08a91e70-3ddc-11dd-91be-0050c2490048	Yearly		
Dust PM2.5	08a91e70-3ddc-11dd-9293-0050c2490048	Yearly		
TOC	d86b9e8b-6555-11dd-ad8b-0800200c9a66	Yearly		

[21] Unless specific measurement methods are foreseen in a country specific legislation

PCDD/F	fe0acd60-3ddc-11dd-ab67-0050c2490048	Yearly		
Cu	fe0acd60-3ddc-11dd-a7a0-0050c2490048	Yearly		
As	256c7700-d975-4e38-b8cf-baa4cd9a2a9b	Yearly		
Cd	08a91e70-3ddc-11dd-9674-0050c2490048	Yearly		
Pb	4d9a8790-3ddd-11dd-91dc-0050c2490048	Yearly		
Hg	fe0acd60-3ddc-11dd-a8c4-0050c2490048	Yearly		

See excel file named 'Copper OEFSR_4.0 - Life cycle inventory' for the list of all company-specific data to be collected.

5.2. List of processes expected to be run by the company

The following processes are expected to be run by the company applying the OEFSR:

- *Copper concentrate production*

Some copper producing companies may directly operate mines and concentrators. When this is the case, rules for data collection are provided at point 1 (Case 1: the process is run by the organisation applying the OEFSR). Some copper producing companies do not directly operate mines and concentrators. When this is the case, rules provided at point 2 shall be applied (Case 2: the process is not run by the organisation applying the OEFSR).

1) Case 1: the process is run by the organisation applying the OEFSR

In this case, according to the Data Needs Matrix, specific data on mining and concentration shall be collected following the examples in **Table 10** and **Table 11** and the full list of data to be collected provided in the Excel file, annex to this OEFSR, "Copper OEFSR_4.0 - Life cycle inventory", in worksheets "S1-copper concentrate mining; S2-milling and concentration; S3-waste management". 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.

The stack emissions to air shall be monitored based on continuous measurements or periodic measurements and recognized standards in accordance with the requirements set in the NFM BREF (11.1.5 – Monitoring of Emissions to Air). The loads [kg/a] for air emissions shall be calculated as the (Annual average concentration by point source (mg/Nm3) X Annual average flow rate (Nm3/h) X Operating hours(h/a)/1000000. All emission points shall be taken into consideration. Calculations shall be based on all available measurements. The loads of air emissions in the baseline scenario shall only be based on point source emissions.

Emissions related to mining waste shall be monitored in accordance with the requirements set in the Management of Waste from the Extractive Industries (MWEI) BREF.

When dealing with energy (all energy types, including electricity), the applicant of the OEFSR shall:

- Ensure no double counting occurs between direct emissions and emissions already included in EF-compliant datasets used to link the company-specific activity data. For example, if emissions from fuel burning are collected as direct emissions, the EF-compliant datasets selected shall not include emissions from burning of the fuel.

- Apply requirements at Par. 5.8 and 6.2 of this OEFSR regarding electricity.

2) Case 2: the process is not run by the organisation applying the OEFSR:

✓ If primary data are available (situation 2, option 1), use the data set for the relevant share of concentrate input it is associated to. Demonstrate that the data set represents the profile of the concentrate input to the smelter in terms of copper content and mining technology (open pit vs underground if information is available). Evidence shall be provided in the report.

✓ If primary data are not available, use the default dataset identified/provided in the OEFSR and apply the requirements of situation 2 option 2 or situation 3 option 1 according to the specific situation and demonstrate that the data set represents the profile of the total concentrate input to the smelter in terms of average copper content and mining technology (open pit vs underground if information is available).

✓ If the actual concentrate input deviates from the data set (e.g., different grade or domination of open pit or underground technology) this shall be highlighted as limitation in the OEF report. A sensitivity analysis shall be included in the OEF report, to show the relevance of this limitation.

Table 10. Data collection requirements for the process "Copper concentrate – sub process: mining" expected to be in Situation 1 of the DNM – Example. The full list of data to be collected for "Copper concentrate" is available in the Excel file Copper OEFSR_4.0 - Life cycle inventory

Requirements for data collection purposes			Requirements for modelling purposes			
Activity data to be collected	Specific requirements (e.g. frequency, measurement standard, etc)	***Unit of measure***	***Default dataset to be used***	***Dataset source (i.e. node)***	***UUID***	***DQR***
Inputs:		[Example: kwh/year]	[Example: Electricity grid mix 1kV-60kV/AT]	[Example: http://lcdn.thinkstep.com/Node/]	[Example: 0af0a6a8-aebc-4eeb-99f8-5ccf2304b99d]	[Example: 1.6]
Electricity (including for oxygen production)	Yearly	*kWh*	*Electricity grid mix 1kV-60kV {EU+EFTA+UK}* |	*http://lcdn.thinkstep.com/Node/*	*34960d4d-af62-43a0-aa76-adc5fcf57246*	*1,25*

			technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result			
Fuel (Oil, natural gas, ..)	Yearly	*kg*	*Heavy fuel oil at refinery {EU+EFTA+UK} | from crude oil | production mix, at refinery | 1 wt.% sulphur | LCI result*	*http://lcdn.thinkstep.com/Node/*	*0d3757fb-e445-4315-be99-94410c05a7b1*	*1,25*
Explosives	Yearly	*kg*	*Data gap*	*/*	*/*	*/*
In-situ Ore	Yearly	*kg*	*Elementary flow*	*/*	*/*	*/*
Steel for rock bolting	Yearly	*kg*	Steel cast part alloyed {EU+EFTA+UK} | electric arc furnace route, from steel scrap, secondary production | single route, at plant | carbon steel | Partly terminated system	*http://lcdn.thinkstep.com/Node/*	*77aa35c5-7007-4621-8115-cb8cfa77690d*	*2,5*

Concrete	Yearly	*kg*	Concrete, production mix, at plant {GLO} | aggregates mixing | production mix, at plant | C20/25 | LCI result	http://lcdn.thinkstep.com/Node/	c43e6703-303c-43a1-8e54-03cd595ff62f	*2,5*
Sand	Yearly	*kg*	Silica sand production {EU+EFTA+UK} | technology mix | production mix, at plant | 100% active substance | LCI result	*http://ecoinvent.lca-data.com/*	573168e4-8f9e-46a3-a684-6187deeea33d	*1,25*
Tires	Yearly	*kg*	*Follow rules in section 5.5*			
Oils and lubricants	Yearly	*kg*	*Follow rules in section 5.5*			
Outputs						
Mined ore	Yearly	*Kg*	*Internal flow*			
Waste rock	Yearly	*Kg*	*Follow rules in section 5.5*			
Overburden	Yearly	*Kg*	*Follow rules in*			*Applicable for*

			section5. 5			*undergro und mine*
Other waste	Yearly	*Kg*	*Follow rules in section 5.5*			*Applicab le for open pit mine*
Salt (NaCl)	Yearly	*kg*	*Follow rules in section 5.5*			
Mining water (Mine Dewatering)	Yearly	*kg*	*Internal flow*			
Waste water	Yearly	*kg*	*Internal flow*			

Table 11. Data collection requirements for the process "Copper concentrate" expected to be in Situation 1 of the DNM – Example for direct elementary flows. The full list of data to be collected for "Copper concentrate" is available in the Excel file "Copper OEFSR_4.0 - Life cycle inventory"

Emissions/resources	**Elementary flow**	**Frequency of measurement**	**Default measurement method**[22]	**Remarks**
Emissions to air		Yearly	Requirements available in the main text.	
SO_2	fe0acd60-3ddc-11dd-ac48-0050c2490048	Yearly		
NO_x	08a91e70-3ddc-11dd-96e5-0050c2490048	Yearly		
CO_2	08a91e70-3ddc-11dd-923d-0050c2490048	Yearly		
Dust PM10	08a91e70-3ddc-11dd-91be-0050c2490048	Yearly		
Dust PM2.5	08a91e70-3ddc-11dd-9293-0050c2490048	Yearly		
Cu	fe0acd60-3ddc-11dd-a7a0-0050c2490048	Yearly		

[22] Unless specific measurement methods are foreseen in a country specific legislation

As	256c7700-d975-4e38-b8cf-baa4cd9a2a9b	Yearly		
Cd	08a91e70-3ddc-11dd-9674-0050c2490048	Yearly		
Pb	4d9a8790-3ddd-11dd-91dc-0050c2490048	Yearly		
Hg	fe0acd60-3ddc-11dd-a8c4-0050c2490048	Yearly		

See excel file named "Copper OEFSR_4.0 - Life cycle inventory" for the list of all processes and sub-processes to be expected in situation 1.

5.3. Data quality requirements

In this section the applicant of the OEFSR finds data quality requirements for mandatory processes (chapter 5.3.1), processes in situation 1 (chapter 5.4.1), processes in situation 2 (chapter 5.4.2) and processes in situation 3 (chapter 5.4.3).

- Data Quality Requirements for processes to be modelled with mandatory company-specific data (i.e. Site Direct Activities) are found in table 12,
- Data Quality Requirements for copper concentrates, when in Situation 1 Option 1, are in table 12,
- Data Quality Requirements for copper concentrates, when not in Situation 1 Option 1, are in table 15.
- Data Quality Requirements for all remaining secondary datasets are in table 14.

The data quality of each dataset and the total EF study shall be calculated and reported. The calculation of the DQR shall be based on the following formula with 4 criteria:

$$DQR = \frac{TeR+GR+TiR+P}{4} \quad \text{[Equation 1]}$$

where TeR is the Technological-Representativeness, GR is the Geographical-Representativeness, TiR is the Time-Representativeness, and P is the Precision/uncertainty. The representativeness (technological, geographical and time-related) characterises to what degree the processes and products selected are depicting the system analysed, while the precision indicates the way the data is derived and related level of uncertainty.

The next chapters provide tables with the criteria to be used for the semi-quantitative assessment of each criteria. If a dataset is constructed with company-specific activity data, company-specific emission data and secondary sub-processes, the DQR of each shall be assessed separately.

5.3.1. Company-specific datasets

The DQR shall be calculated at the level-1 disaggregation, before any aggregation of sub-processes or elementary flows is performed. The DQR of company-specific datasets shall be calculated as following:

1) *Select the most relevant activity data and direct elementary flows: most relevant activity data are the ones linked to sub-processes (i.e. secondary datasets) that account for at least 80% of the total environmental impact of the company-specific dataset, listing them from the most contributing to the least contributing one. Most relevant direct elementary flows are defined as those direct elementary flows contributing cumulatively at least with 80% to the total impact of the direct elementary flows.*
2) *Calculate the DQR criteria TeR, TiR, GeR and P for each most relevant activity data and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table 12.*
    a. *Each most relevant direct elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, the user of the OEFSR shall*

evaluate the 4 DQR criteria named TeR_{-EF}, TiR_{-EF}, GeR_{-EF}, P_{EF} in Table 12. For example, the user of the OEFSR shall evaluate the timing of the flow measured, for which technology the flow was measured and in which geographical area.

b. *For each most relevant activity data, the 4 DQR criteria shall be evaluated (named T_eR_{-AD} TiR_{-AD}, GeR_{-AD}, P_{AD})by the user of the OEFSR.*

c. *Considering that the data for the mandatory processes shall be company-specific, the score of P cannot be higher than 3, while the score for TiR, TeR, and GeR cannot be higher than 2 (The DQR score shall be ≤1.5).*

3) *Calculate the environmental contribution of each most relevant activity data (through linking to the appropriate sub-process) and direct elementary flow to the total sum of the environmental impact of all most-relevant activity data and direct elementary flows, in % (weighted, using all EF impact categories). For example, the newly developed dataset has only two most relevant activity data, contributing in total to 80% of the total environmental impact of the dataset:*

- Activity data 1 carries 30% of the total dataset environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).
- Activity data 2 carries 50% of the total dataset environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).

4) *Calculate the TeR, TiR, GeR and P criteria of the newly developed dataset as the weighted average of each criteria of the most relevant activity data and direct elementary flows. The weight is the relative contribution (in %) of each most relevant activity data and direct elementary flow calculated in step 3.*

5) *The user of the OEFSR shall calculate the total DQR of the newly developed dataset using Equation.2, where $\overline{TeR}, \overline{TiR}, \overline{GeR}, \overline{P}$ are the weighted average calculated as specified in point (4).*

$$DQR = \frac{\overline{Te_R}+\overline{Ge_R}+\overline{Ti_R}+\overline{P}}{4} \quad \text{[Equation 2]}$$

NOTE: in case the newly developed dataset has most relevant processes filled in by non-EF compliant datasets (and thus without DQR), then these datasets cannot be included in step 4 and 5 of the DQR calculation. (1) The weight of step 3 shall be recalculated for the EF-compliant datasets only. Calculate the environmental contribution of each most-relevant EF compliant process and elementary flow to the total environmental impact of all most-relevant EF compliant processes and elementary flows, in %. Continue with step 4 and 5. (2) The weight of the non-EF compliant dataset (calculated in step 3) shall be used to increase the DQR criteria and total DQR accordingly. For example:

- *Process 1 carries 30% of the total dataset environmental impact and is ILCD entry level compliant. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Process 1 carries 50% of the total dataset environmental impact and is EF compliant. The contribution of this process to all most-relevant EF compliant processes is 100%. The latter is the weight to be used in step 4.*
- *After step 5, the parameters $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ and the total DQR shall be multiplied with 1.375.*

Criteria in **Table 12** apply to:

- Site Direct Activities
- Copper concentrate when in Situation 1 Option 1.

Table 12. How to assess the value of the DQR criteria for datasets with company-specific information

Rating	P_{EF} and P_{AD}	TiR_{-EF} and TiR_{-AD}	TeR_{-EF} and TeR_{-AD}	GeR_{-EF} and GeR_{-AD}

1	Measured/calculated and externally verified	The data refers to the most recent annual administration period with respect to the EF report publication date	The elementary flows and the activity data exactly the technology of the newly developed dataset	The activity data and elementary flows reflects the exact geography where the process modelled in the newly created dataset takes place
2	Measured/calculated and internally verified, plausibility checked by reviewer	The data refers to maximum 2 annual administration periods with respect to the EF report publication date	The elementary flows and the activity data is a proxy of the technology of the newly developed dataset	The activity data and elementary flows) partly reflects the geography where the process modelled in the newly created dataset takes place
3	Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data refers to maximum three annual administration periods with respect to the EF report publication date	Not applicable	Not applicable
4-5	Not applicable	Not applicable	Not applicable	Not applicable

P_{EF}: Precision for elementary flows; **P_{AD}**: Precision for activity data; **TiR_{-EF}**: Time Representativeness for elementary flows; **TiR_{-AD}**: Time representativeness for activity data; **TeR_{-EF}**: Technology representativeness for elementary flows; **TeR_{-AD}**: Technology representativeness for activity data**;** **GeR_{-EF}**: Geographical representativeness for elementary flows; **GeR_{-AD}:** Geographical representativeness for activity data.

To ensure completeness and validate the system under analysis each unit process within "Site Direct Activities" 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.

5.4. Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific data (listed in section 5.1) shall be evaluated using the Data Needs Matrix (see **Table 13***). The user of the OEFSR shall apply the DNM to evaluate which data is needed and shall be used within the modelling of its OEF, depending on the level of influence the user of the OEFSR (company) has on the specific process. The following three cases are found in the DNM and are explained below:*

1. ***Situation 1:*** *the process is run by the company applying the OEFSR;*
2. ***Situation 2:*** *the process is not run by the company applying the OEFSR but the company has access to (company-)specific information;*
3. ***Situation 3:*** *the process is not run by the company applying the OEFSR and this company does not have access to (company-)specific information.*

Table 13. Data Needs Matrix (DNM) . *Disaggregated datasets shall be used.

<table>
<tr><th></th><th></th><th>Most relevant process</th><th>Other process</th></tr>
<tr><td rowspan="2">Situation 1: process run by the organisation in the scope of the OEF study</td><td>Option 1</td><td colspan="2">Provide company-specific data (as requested in the OEFSR) and create a company-specific dataset, in aggregated form (DQR≤1.5)[23]

Calculate the DQR values (for each criterion + total)</td></tr>
<tr><td>Option 2</td><td></td><td>Use default secondary dataset in OEFSR, in aggregated form (DQR≤3.0)

Use the default DQR values</td></tr>
<tr><td rowspan="3">Situation 2: process <u>not</u> run by the the organisation in the scope of the OEF study but with access to company-specific information</td><td>Option 1</td><td colspan="2">Provide company-specific data (as requested in the OEFSR) and create a company-specific dataset, in aggregated form (DQR≤1.5)

Calculate the DQR values (for each criterion + total)</td></tr>
<tr><td>Option 2</td><td>Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤3.0)*

Re-evaluate the DQR criteria within the product specific context</td><td></td></tr>
<tr><td>Option 3</td><td></td><td>Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤4.0)*

Use the default DQR values.</td></tr>
<tr><td rowspan="2">Situation 3: process <u>not</u> run by the organisation in the scope of the OEF study and without access to company-specific information</td><td>Option 1</td><td>Use default secondary data set in aggregated form (DQR≤3.0)

Re-evaluate the DQR criteria within the product specific context</td><td></td></tr>
<tr><td>Option 2</td><td></td><td>Use default secondary data set in aggregated form (DQR≤4.0)

Use the default DQR values</td></tr>
</table>

[23] Company-specific datasets shall be made available to the Commission.

5.4.1. Processes in situation 1

For each process in situation 1 there are two possible options:

- o The process is in the list of most relevant processes as specified in the OEFSR or is not in the list of most relevant process, but still the company wants to provide company-specific data (option 1);
- o The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 2).

Situation 1/Option 1

For all processes run by the company and where the user of the OEFSR applies company-specific data. The DQR of the newly developed dataset shall be evaluated as described in section 5.3.1.

Situation 1/Option 2

For the non-most relevant processes only, if the user of the OEFSR decides to model the process without collecting company-specific data, then the user shall use the secondary dataset listed in the OEFSR together with its default DQR values listed here.

If the default dataset to be used for the process is not listed in the OEFSR, the user of the OEFSR shall take the DQR values from the metadata of the original dataset.

5.4.2. Processes in situation 2

When a process is not run by the user of the OEFSR, but there is access to company-specific data, then there are three possible options:

- o The user of the OEFSR has access to extensive supplier-specific information and wants to create a new EF compliant dataset (Option 1);
- o The company has some supplier-specific information and want to make some minimum changes (Option 2);
- o The process is not in the list of most relevant processes and the company wants to make some minimum changes (Option 3).

Situation 2/Option 1

For all processes not run by the company and where the user of the OEFSR applies company-specific data, the DQR of the newly developed dataset shall be evaluated as described in section 5.3.1

Situation 2/Option 2

The user of the OEFSR shall use company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific OEF compliant datasets, starting from the default secondary dataset provided in the OEFSR.

Please note that the OEFSR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

The user of the OEFSR shall make the DQR context-specific by re-evaluating TeR and TiR using the table(s) provided. The criteria GeR shall be lowered by 30%[24] *and the criteria P shall keep the original value.*

Situation 2/Option 3

The user of the OEFSR shall apply company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets, starting from the default secondary dataset provided in the OEFSR.

[24] In situation 2, option 2 it is proposed to lower the parameter GeR by 30% in order to incentivise the use of company-specific information and reward the efforts of the company in increasing the geographic representativeness of a secondary dataset through the substitution of the electricity mixes and of the distance and means of transportation.

Please note that the OEFSR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

In this case, the user of the OEFSR shall use the default DQR values. If the default dataset to be used for the process is not listed in the OEFSR, the user of the OEFSR shall take the DQR values from the original dataset.

Table 14. How to assess the value of the DQR criteria when secondary datasets are used.

	TiR	***TeR***	***GeR***
1	*The EF report publication date happens within the time validity of the dataset*	*The technology used in the EF study is exactly the same as the one in scope of the dataset*	*The process modelled in the EF study takes place in the country the dataset is valid for*
2	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The technologies used in the EF study is included in the mix of technologies in scope of the dataset*	*The process modelled in the EF study takes place in the geographical region (e.g. Europe) the dataset is valid for*
3	*The EF report publication date happens not later than 4 years beyond the time validity of the dataset*	*The technologies used in the EF study are only partly included in the scope of the dataset*	*The process modelled in the EF study takes place in one of the geographical regions the dataset is valid for*
4	*The EF report publication date happens not later than 6 years beyond the time validity of the dataset*	*The technologies used in the EF study are similar to those included in the scope of the dataset*	*The process modelled in the EF study takes place in a country that is not included in the geographical region(s) the dataset is valid for, but sufficient similarities are estimated based on expert judgement.*
5	*The EF report publication date happens later than 6 years after the time validity of the dataset*	*The technologies used in the EF study are different from those included in the scope of the dataset*	*The process modelled in the EF study takes place in a different country than the one the dataset is valid for*

When assessing the DQR of copper concentrates (when not in Situation 1, Option 1), criteria in **Table 15** substitute the criteria provided in **Table 14.**

Table 15. Criteria to assess the DQR of copper concentrates.

	TiR	*TeR*	*G_R*[25]
1	*The EF report publication date happens within the time validity of the dataset*	*The technology used in the EF study is exactly the same as the one in scope of the dataset*	*The concentrate mix processed by the organization is covered by the data set at least 95 % based on weighted average coverage across country. This means max 5% weighted average deviation.*
2	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The technologies used in the EF study is included in the mix of technologies in scope of the dataset.)*	*The concentrate mix processed by the organization is covered by the data set between 95 – 70 % based on weighted average coverage across country.*
3	*The EF report publication date happens not later than 4 years beyond the time validity of the dataset*	*The technologies used in the EF study are only partly included in the scope of the dataset*	*The concentrate mix processed by the organization is covered by the data set between 70 - 45 based on weighted average coverage across country.*
4	*The EF report publication date happens not later than 6 years beyond the time validity of the dataset*	*The technologies used in the EF study are similar to those included in the scope of the dataset*	*The concentrate mix processed by the organization is covered by the data set between 45 - 15 % as weighted average coverage across country.*
5	*The EF report publication date happens later than 6 after the time validity of the dataset*	*The technologies used in the EF study are different from those included in the scope of the dataset*	*The concentrate mix processed by the organization is covered by the data set below 15% based on weighted average coverage across country.*

5.4.3. Processes in situation 3

If a process is not run by the company using the OEFSR and the company does not have access to company-specific data, there are two possible options:

- It is in the list of most relevant processes (situation 3, option 1);

[25] To assess Geographical representativeness one shall look at the share of concentrate from each relevant country (% weight) as part of concentrate mix processed by the organization , check the deviation in comparison with the share of same country/region as covered by the data set and calculate weighted average deviation (%).
In some specific and justified cases, one may refer to "regions"(e.g. Black Sea) instead of "countries"

Example on how to determine the weighted average deviation

Country/region	Data set	Organization	Deviation
A	35%	44%	9%
B	15%	5%	10%
C	40%	35%	5%
D	0%	3%	3%
		Weighted average deviation	6.3%

- It is not in the list of most relevant processes (situation 3, option 2).

Situation 3/Option 1

In this case, the user of the OEFSR shall make the DQR values of the dataset used context-specific by re-evaluating TeR, TiR and GeR, using the table(s) provided. The criteria P shall keep the original value.

Situation 3/Option 2

For the non-most relevant processes, the user of the OEFSR shall apply the corresponding secondary dataset listed in the OEFSR together with its DQR values.

If the default dataset to be used for the process is not listed in the OEFSR, the user of the OEFSR shall take the DQR values from the original dataset.

5.5. Datasets to be used

The secondary datasets to be used by the applicant are those listed in this OEFSR. Whenever a dataset needed to calculate the OEF-profile is not among those listed in this OEFSR, then the applicant shall choose between the following options (in hierarchical order):

- *Use an EF-compliant dataset available on one of the following nodes:*
  - *http://eplca.jrc.ec.europa.eu/EF-node*
  - *http://lcdn.blonkconsultants.nl*
  - http://ecoinvent.lca-data.com
  - http://lcdn-cepe.org
  - *http://lcdn.thinkstep.com/Node*
- *Use an EF-compliant dataset available in a free or commercial source;*
- *Use another EF-compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitation" section of the PEF report.*
- *Use an ILCD-entry level-compliant dataset. In such case this information shall be included in the "data gap" section of the PEF report.*

5.6. How to calculate the average DQR of the study

To calculate the average DQR of the OEF study, the user of the OEFSR shall calculate separately the TeR, TiR, GeR and P for the OEF study as the weighted average of all most relevant processes, based on their relative environmental contribution to the total single overall score. The calculation rules explained in section 4.6.5 of Annex III shall be used.

5.7. Allocation rules

In principle all products produced by the organisation in scope are part of the Product Portfolio. Products that may leave the system in the baseline scenario (i.e. OEF study, cradle-to-gate), not included in the Product Portfolio, shall be allocated taken into account their economic value, divided by the overall value generated by all the products in the product portfolio.

It is not possible within this OEFSR to provide a default allocation factor, because it has to be determined for each organisation, depending on the real product portfolio produced by the organisation: indeed, two organisations will likely have two different products portfolios, therefore the allocation factor for products exiting the system will be organisation-specific.

Table 16. Allocation rules.

Process	***Allocation rule***	***Modelling instructions***

Products not included in the Product Portfolio	Economic allocation	The allocation factor is calculated as follows: the economic value of the product(s) not included in the Product Portfolio shall be divided by the overall value generated by all the products in the product portfolio.
Steam from waste heat recovery	Direct substitution	Direct substitution shall be applied based on the alternative production of steam if supplied externally (e.g. using dataset Process steam from natural gas {EU+EFTA+UK}; UUID 2e8bee44-f13b-4622-9af3-74954af8acea), see process M10 in Excel file "Copper OEFSR_4.0 - Life cycle inventory"

5.8. Electricity modelling

The guidelines in this section shall only be used for the processes where company-specific information is collected (situation 1 / Option 1, situation 2 / Option 1 of the DNM).

The following electricity mix shall be used in hierarchical order:

(a) Supplier-specific electricity product shall be used if for a country there is a 100% tracking system in place, or if :

(i) available, and

(ii) the set of minimum criteria to ensure the contractual instruments are reliable is met.

(b) The supplier-specific total electricity mix shall be used if:

(i) available, and

(ii) the set of minimum criteria to ensure the contractual instruments are reliable is met.

(c) The 'country-specific residual grid mix, consumption mix' shall be used. Country-specific means the country in which the life cycle stage or activity occurs. This may be an EU country or non-EU country. The residual grid mix prevents double counting with the use of supplier-specific electricity mixes in (a) and (b).

(d) As a last option, the average EU residual grid mix, consumption mix (EU+EFTA+UK), or region representative residual grid mix, consumption mix, shall be used.

Note: if for a country, there is a 100% tracking system in place, case (i) shall be applied.

Note: for the use stage, the consumption grid mix shall be used.

The environmental integrity of the use of supplier-specific electricity mix depends on ensuring that contractual instruments (for tracking) ***reliably and uniquely convey claims to consumers****. Without this, the OEF lacks the accuracy and consistency necessary to drive product/ corporate electricity procurement decisions and accurate consumer (buyer of electricity) claims. Therefore, a set of* ***minimum criteria*** *that relate to the integrity of the contractual instruments as reliable conveyers of environmental footprint information has been identified. They represent the minimum features necessary to use supplier-specific mix within OEF studies.*

Set of minimum criteria to ensure contractual instruments from suppliers

A supplier-specific electricity product/ mix may only be used if the user of the OEF method ensures that the contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then country-specific residual electricity consumption-mix shall be used in the modelling.

The list of criteria below is based on the criteria of the GHG Protocol Scope 2 Guidance[26]–. A contractual instrument used for electricity modelling shall:

Criterion 1 – Convey attributes

- Convey the energy type mix associated with the unit of electricity produced.
- The energy type mix shall be calculated based on delivered electricity, incorporating certificates sourced and retired (obtained or acquired or withdrawn) on behalf of its customers. Electricity from facilities for which the attributes have been sold off (via contracts or certificates) shall be characterized as having the environmental attributes of the country residual consumption mix where the facility is located.

Criterion 2 – Be a unique claim

- Be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.
- Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g. by an audit of contracts, third party certification, or may be handled automatically through other disclosure registries, systems, or mechanisms).

Criterion 3 – Be as close as possible to the period to which the contractual instrument is applied

Modelling 'country-specific residual grid mix, consumption mix':

Datasets for residual grid mix, consumption mix, per energy type, per country and per voltage are made available by data providers.

If no suitable dataset is available, the following approach should be used:

Determine the country consumption mix (e.g. X% of MWh produced with hydro energy, Y% of MWh produced with coal power plant) and combine them with LCI datasets per energy type and country/region (e.g. LCI dataset for the production of 1MWh hydro energy in Switzerland):

- Activity data related to non-EU country consumption mix per detailed energy type shall be determined based on:
- Domestic production mix per production technologies;
- Import quantity and from which neighbouring countries;
- Transmission losses;

[26] *World Resources Institute (WRI) and World Business Council for Sustainable Development WBCSD (2015): GHG Protocol Scope 2 Guidance. An amendment to the GHG Protocol. Corporate Standard*

- o Distribution losses;
- o Type of fuel supply (share of resources used, by import and / or domestic supply).

These data may be found in the publications of the International Energy Agency (IEA (www.iea.org).

- o Available LCI datasets per fuel technologies. The LCI datasets available are generally specific to a country or a region in terms of:
- o fuel supply (share of resources used, by import and/ or domestic supply);
- o energy carrier properties (e.g. element and energy contents);
- o technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.

Allocation rules:

No allocation rules to subdivide the electricity consumption among multiple products for each process and to reflect the ratios of the production/ratios of sales between EU countries/regions is needed in the context of this OEFSR.

If the consumed electricity comes from more than one electricity mix, each mix source shall be used in terms of its proportion in the total kWh consumed. For example, if a fraction of this total kWh consumed is coming from a specific supplier a supplier-specific electricity mix shall be used for this part. See below for on-site electricity use.

A specific electricity type may be allocated to one specific product in the following conditions:

(a) If the production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site may be used.

(b) If the production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product-specific information (measure, record, bill) may be used.

(c) *If all the products produced in the specific plant are supplied with a publicly available OEF study, the company wanting to make the claim shall make all OEF studies available. The allocation rule applied shall be described in the OEF study, consistently applied in all OEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.*

On-site electricity generation:

If on-site electricity production is equal to the site own consumption, two situations apply:

1. No contractual instruments have been sold to a third party: the own electricity mix (combined with LCI datasets) shall be modelled.
2. Contractual instruments have been sold to a third party: the ‘country-specific residual grid mix, consumption mix’ (combined with LCI datasets) shall be used.

If electricity is produced in excess of the amount consumed on-site within the defined system boundary and is sold to, for example, the electricity grid, this system may be seen as a multifunctional situation. The system will provide two functions (e.g. product + electricity) and the following rules shall be followed:

1. If possible, apply subdivision.
2. Subdivision applies both to separate electricity productions or to a common electricity production where you may allocate based on electricity amounts the upstream and direct emissions to your own consumption and to the share you sell out of your company (e.g. if a company has a windmill on its production site and exports 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the OEF study).
3. If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[27].

[27] For some countries, this option is a best case rather than a worst case.

4. Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.

5.9. Climate change modelling

The impact category 'climate change' shall be modelled considering three sub-categories:

1. ***Climate change – fossil:*** *This sub-category includes emissions from peat and calcination/carbonation of limestone. The emission flows ending with '(fossil)' (e.g., 'carbon dioxide (fossil)' and 'methane (fossil)') shall be used, if available.*

2. ***Climate change – biogenic:*** *This sub-category covers carbon emissions to air (CO2, CO and CH4) originating from the oxidation and/or reduction of biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO_2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or aboveground plant residues, such as litter and dead wood. Carbon exchanges from native forests*[28] *shall be modelled under sub-category 3 (incl. connected soil emissions, derived products, residues). The emission flows ending with '(biogenic)' shall be used.*

   A simplified modelling approach shall be used when modelling foreground emissions. Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. If methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane.

   The biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.

3. ***Climate change – land use and land use change****: This sub-category accounts for carbon uptakes and emissions (CO2, CO and CH4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (including soil carbon emissions). For native forests, all related CO_2 emissions are included and modelled under this sub-category (including connected soil emissions, products derived from native forest*[29] *and residues), while their CO_2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.*

   For land use change, all carbon emissions and removals shall be modelled following the modelling guidelines of PAS 2050:2011 (BSI 2011) and the supplementary document PAS2050-1:2012 (BSI 2012) for horticultural products. PAS 2050:2011 (BSI 2011): 'Large emissions of GHGs can result as a consequence of land use change. Removals as a direct result of land use change (and not as a result of long-term management practices) do not usually occur, although it is recognized that this could happen in specific circumstances. Examples of direct land use change are the conversion of land used for growing crops to industrial use or conversion from forestland to cropland. All forms of land use change that result in emissions or removals are to be included. Indirect land use change refers to such conversions of land use as a consequence of changes in land use elsewhere. While GHG emissions also arise from indirect land use change, the methods and data requirements for calculating these emissions are not fully developed. Therefore, the assessment of emissions arising from indirect land use change is not included.

   The GHG emissions and removals arising from direct land use change shall be assessed for any input to the life cycle of a product originating from that land and shall be included in the assessment of GHG emissions. The emissions arising from the product shall be assessed on the basis of the default land use change values provided in PAS 2050:2011 Annex C, unless better data is available. For countries and land use changes not included in this annex, the emissions arising from the product shall be assessed using the included GHG emissions and removals occurring as a result of direct land use change in accordance with the relevant sections of the IPCC (2006). The assessment of the impact of land use change shall include all direct land use change occurring not more than 20 years, or a single harvest period, prior to undertaking the assessment (whichever is the longer). The total GHG emissions and removals arising from direct land use change over the period shall be included in the quantification of

[28] Native forests – represents native or long-term, non-degraded forests. Definition adapted from table 8 in Annex V C(2010)3751 to Directive 2009/28/EC.

[29] Following the instantaneous oxidation approach in IPCC 2021 (Section 2).

GHG emissions of products arising from this land on the basis of equal allocation to each year of the period[30].

1. *Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out, no emissions from land use change should be included in the assessment.*

2. *Where the timing of land use change cannot be demonstrated to be more than 20 years, or a single harvest period, prior to making the assessment (whichever is the longer), it shall be assumed that the land use change occurred on 1 January of either:*

- the earliest year in which it can be demonstrated that the land use change had occurred; or
- on 1 January of the year in which the assessment of GHG emissions and removals is being carried out.

The following hierarchy shall apply when determining the GHG emissions and removals arising from land use change occurring not more than 20 years or a single harvest period, prior to making the assessment (whichever is the longer):

1. *where the country of production is known and the previous land use is known, the GHG emissions and removals arising from land use change shall be those resulting from the change in land use from the previous land use to the current land use in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*

2. *where the country of production is known, but the former land use is not known, the GHG emissions arising from land use change shall be the estimate of average emissions from the land use change for that crop in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*

3. *where neither the country of production nor the former land use is known, the GHG emissions arising from land use change shall be the weighted average of the average land use change emissions of that commodity in the countries in which it is grown.*

Knowledge of the prior land use can be demonstrated using a number of sources of information, such as satellite imagery and land survey data. Where records are not available, local knowledge of prior land use can be used. Countries in which a crop is grown can be determined from import statistics, and a cut-off threshold of not less than 90% of the weight of imports may be applied. Data sources, location and timing of land use change associated with inputs to products shall be reported.'

Soil carbon storage shall not be modelled, calculated and reported as additional environmental information.

The sum of the three sub-categories shall be reported.

The sub-category 'Climate change-biogenic' shall not be reported separately.

The sub-category 'Climate change-land use and land transformation' shall not be reported separately.

5.10. Modelling of end of life and recycled content

The end of life of products used during the manufacturing, distribution, retail, the use stage or after use shall be included in the overall modelling of the life cycle of the organisation. Overall, this should be modelled and reported at the life cycle stage where the waste occurs. This section provides rules on how to model the end of life of products as well as the recycled content.

The circular footprint formula (CFF) is used to model the end of life of products as well as the recycled content and is a combination of 'material + energy + disposal', i.e.:

Material

30 In case of variability of production over the years, a mass allocation should be applied.

$$(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_p}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$$

Energy $(1-B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$

Disposal $(1-R_2-R_3) \times E_D$

With the following parameters

A: *allocation factor of burdens and credits between supplier and user of recycled materials.*

B: *allocation factor of energy recovery processes. It applies both to burdens and credits. It shall be set to zero for all OEF studies.*

Q_{Sin}: *quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.*

Q_{Sout}: *quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.*

Q_p: *quality of the primary material, i.e. quality of the virgin material.*

R_1: *it is the proportion of material in the input to the production that has been recycled from a previous system.*

R_2: *it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.*

R_3: *it is the proportion of the material in the product that is used for energy recovery at EoL.*

$E_{recycled}$ (E_{rec}): *specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.*

$E_{recyclingEoL}$ (E_{recEoL}): *specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.*

E_v: *specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.*

E^*_v: *specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.*

E_{ER}: *specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, etc.).*

$E_{SE,heat}$ and $E_{SE,elec}$: *specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.*

ED: *specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.*

$X_{ER,heat}$ and $X_{ER,elec}$: *the efficiency of the energy recovery process for both heat and electricity.*

LHV: *lower heating value of the material in the product that is used for energy recovery.*

How to apply the Circular Footprint Formula in an OEF context

Modelling the recycled content

Recycled content may apply to copper scrap (100% recycled content), blister copper and copper anodes.

The following formula is used to model the recycled content:

$$(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_p}\right)$$

The R_1 values applied shall be supply-chain or default as provided in the table above, in relation with the DNM. Material-specific values based on supply market statistics are not accepted as a proxy. The applied R_1 values shall be subject to OEF study verification.

When using supply-chain specific R_1 values other than 0, traceability throughout the supply chain is necessary. The following general guidelines shall be followed when using supply-chain specific R_1 values:

- *The supplier information (through e.g., statement of conformity or delivery note) shall be maintained during all stages of production and delivery at the converter;*
- *Once the material is delivered to the converter for production of the end products, the converter shall handle information through their regular administrative procedures;*
- *The converter for production of the end products claiming recycled content shall demonstrate through his management system the [%] of recycled input material into the respective end product(s).*
- *The latter demonstration shall be transferred upon request to the user of the end product. In case an OEF profile is calculated and reported, this shall be stated as additional technical information of the OEF profile.*
- *Company-owned traceability systems can be applied as long as they cover the general guidelines outlined above.*

Default A, Qsin/Qp values and Erecycled are provided in **Table 17**. To properly model secondary input materials in the OEF study, guidance is provided also in Section 7.2 (Additional Technical Information). In an OEF study, the Circular Footprint Formula shall be applied to:

- Secondary materials input to the metallurgical operations in scope of the OEFSR (copper scrap, secondary blister copper and secondary copper anodes);
- Waste generated within the scope of the OEFSR.

Modelling the point of substitution:

- the points of substitution to be used to identify the correct datasets to model Ev and Erec shall be identified at level 1 (See Recommendation 2021/2279 for details). This means that the true points of substitution are modelled: for example, scrap input to various metallurgical operations is substituting the primary material input to the same operation (see **Figure 4**). The CFF does not apply to internal loops (e.g. scrap generated within the organization and recycled within the organization).
- The following points of substitution may be identified:
    - Anode Furnace (sub-process M8 in Excel file "Copper OEFSR_4.0 - Life cycle inventory):
        - Secondary blister (Erec) – Primary blister (Ev)
        - Copper scrap (Erec) – Primary blister (Ev)
    - Electrolysis (sub-process M11 in Excel file "Copper OEFSR_4.0 - Life cycle inventory):
        - Secondary anodes (Erec) – Primary anodes (Ev)
        - Copper scrap (Erec) – Primary anodes (Ev)

Table 17. Default A, Qsin/Qp values, Erecycled of Secondary input materials.

	A	R_1	Qsin/Qp	Erecycled
Secondary feed materials	1	1	1	*Recycling of copper from clean scrap {EU+EFTA+UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%,*

				copper losses 1% | LCI result
Secondary Blister copper	1	1	1	*Check data gap procedure (Chapter 3.8.2)*
Secondary Copper anodes	1	1	1	*Check. data gap procedure (Chapter 3.8.2)*

The OEF profile shall be calculated and reported using A equal to 1.

Under additional technical information the results shall be reported for different applications with the following A values (see details in section 3.6):

Application	***A value to be used***
Copper cathode	*0.2 (material specific value for copper)*

6. Life cycle stages

A detailed table with processes belonging to the different life cycle stages is available in Annex "Copper OEFSR 4.0_Life Cycle Inventory". In sections 6.1 and 6.2 examples are provided.

Processes included in each life cycle stage shall be grouped and reported in the OEF report according to Table 2 in section 3.4.

6.1. Raw material acquisition and pre-processing

The life cycle stage "raw material acquisition and pre-processing" includes the production of raw materials input to the organisational boundaries, such as:

- copper concentrates
- copper anodes, purchased
- blister copper, purchased
- Anode slime, purchased
- copper scrap

The raw materials input included in this life cycle stage are the ones needed to directly produce the products included in the product portfolio and additional raw materials may be added to the list provided above. Raw materials that are not needed to directly produce the products in the product portfolio belong the Manufacturing life cycle stage (see Upstream process in Table 2).

Requirements related to the above processes are detailed in Chapter 5.

Table 18. Raw material acquisition and processing – Example. Full list available in Excel file "Copper OEFSR 4.0_Life Cycle Inventory".

*Process name**	*Unit of measurement (output)*	*Default*				*UUID*	*Default DQR*				*Most relevant process [Y/N]*
		R_1	*Amount per RU*	*Dataset*	*Dataset source*		*P*	*TiR*	*GR*	*TeR*	
COPPER CONCENTRATE PRODUCTION	*ton*	*0*	*Company specific*	*Copper Concentrate (Mining, mix technologies) {GLO} | copper ore mining and processing | single route, at plant | Copper - gold - silver - concentrate (28% Cu; 22.3*	*http://lcdn.thinkstep.com/*	*1e96df1c-0a73-4d57-a3d8-7ab45ba9d8ef*	*2*	*2*	*3*	*2*	*Y*

				Au gpt; 37.3 Ag gpt) | LCI result							
Copper scrap	*ton*	*1*	*Company specific*	*Recycling of copper from clean scrap {EU+EFTA+UK} | collection, transport, pretreatment | production mix, at plant | copper content in input scrap 90%, copper losses 1% | LCI result*	*http://lcdn.thinkstep.com/*	*0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5*	*2*	*2*	*2*	*2*	*N*
PURCHASED ANODES BLISTER COPPER AND ANODE SLIME	*ton*	*0*	*Company specific*	*See rules at chapter 3.8.2*							*Y*

** in CAPITAL LETTERS are the names of those processes expected to be run by the company (see section 5.2)*

The user of the OEFSR shall report the DQR values (for each criterion + total) for all the datasets used.

The modelling of transports of feed materials (i.e. copper concentrates, scrap, blister copper and copper anodes) to the copper production site shall be done using primary activity data: a data collection example is provided in the Annex "Copper OEFSR_4.0 - Life cycle inventory". The user shall check and adapt the i) transport mode, ii) distance per transport mode, iii) utilisation ratios for truck transport, iv) empty return modelling for truck transport.

For other upstream transport activities, if specific data reflecting the current specific situation are available, they shall be used, otherwise default values in the OEFSR Recommendation 2021/2279 shall be applied (Section 4.4.3 "From supplier to factory")

Table 19. Transport (capitals indicate those processes expected to be run by the company).

		Default (per FU)			***UUID***	***Default DQR***	

Process name*	***Unit of measure-ment (output)***	***Distance***	***Utilisa-tion ratio****	***Empty return***	***De-fault data-set***	***Data-set source***		*P*	*TiR*	*GeR*	*TeR*	***Most relevant [Y/N]***
Lorry transport, Total weight >32 t	*tkm*	*Company specific*	*Default*	*Default*	*Articulated lorry transport, Total weight >32 t, mix Euro 0-5 {RER}*	*http://lcdn.thinkstep.com/*	*328984f2-4a54-419a-b88a-5426a75d0b27*	*2*	*1*	*3*	*1*	*Y*
Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo	*tkm*	*Company specific*	*Default*	*Default*	*Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000-200.000 dwt payload capacity, ocean going*	*http://lcdn.thinkstep.com/*	*82b202c3-826c-4053-b49f-bc6ef737420a*	*2*	*1*	*2*	*2*	*Y*

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>| LCI result</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Freight train, electricity traction {EU+EFTA+UK}</td><td>tkm</td><td>Company specific</td><td>Default</td><td>Default</td><td>Freight train, electricity traction {EU+EFTA+UK} | electricity driven, cargo | consumption mix, to consumer | average train, gross tonne weight 1000t / 726t payload capacity | LCI result</td><td>http://lcdn.thinkstep.com/</td><td>dbde67a3-af4f-4d60-9568-4e0ef6eaaf07</td><td>2</td><td>1</td><td>1</td><td>1</td><td>N</td></tr>
<tr><td>Freight train, diesel traction {EU+EFTA+UK}</td><td>tkm</td><td>Company specific</td><td>Default</td><td>Default</td><td>Freight train, diesel traction {EU+EFTA+UK}</td><td>http://lcdn.thinkstep.com/</td><td>f4476d2b-9dee-4edd-b6c1-9f04aa407b82</td><td>2</td><td>1</td><td>1</td><td>1</td><td>N</td></tr>
</table>

					| diesel driven, cargo | consumption mix, to consumer | average train, gross tonne weight 1000t / 726t payload capacity | LCI result							

**The user of the OEFSR shall always check the utilisation ratio applied in the default dataset and adapt it accordingly.*

6.2. Manufacturing

The manufacturing life cycle stage covers the activities of the organisation from the reception and storing of feed materials up to the provision of the products in the Product Portfolio. Therefore, all technical requirements to be used by the applicant of the OEFSR are available at Par. 5.1: in addition, the activity data listed at Par 5.1 shall be linked to the appropriate EF-compliant secondary datasets. Processes covered within this life cycle stage are listed in the Excel file (Copper OEFSR 4.0_Life Cycle Inventory) and an example is given in **Table 20.**

When dealing with electricity, the applicant of the OEFSR shall make sure that:

- Rules at chapter 5.8 are respected,
- The appropriate voltage is used. The EF-compliant datasets are related to medium voltage (1-60 kV): if low voltage electricity is used, the transformation from medium to low voltage shall be modelled (using the EF-dataset with uuid: 8d21c6d3-cc85-49c4-b275-21827ce193b7, available at http://lcdn.thinkstep.com/Node/index.xhtml).

The products in the product portfolio are intermediate bulk materials that generally do not need any packaging, which falls under the cut-off rule.

Table 20. Manufacturing – Example. Full list available in Excel file "Copper OEFSR 4.0_Life Cycle Inventory".

					UUID	***Default DQR***	

<table>
<tr><th>Process name</th><th>Unit of measurement (output)</th><th>Default amount per RU</th><th>Default dataset</th><th>Dataset source</th><th></th><th>P</th><th>TiR</th><th>GR</th><th>TeR</th><th>Most relevant process [Y/N]</th></tr>
<tr><td>Site Direct Activities</td><td>Product Portfolio</td><td>Company specific</td><td>Mandatory company-specific data</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Y</td></tr>
<tr><td>Electricity</td><td>kWh</td><td>Company specific (as specified in the process "Site Direct Activities)</td><td>Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result</td><td></td><td>34960d4d-af62-43a0-aa76-adc5fcf57246</td><td>2</td><td>1</td><td>1</td><td>1</td><td>Y</td></tr>
<tr><td colspan="11">Check Excel file “Copper OEFSR 4.0_Life Cycle Inventory” for full list</td></tr>
</table>

** in CAPITAL LETTERS are the names of those processes expected to be run by the company (see section 5.2)*

The user of the OEFSR shall report the DQR values (for each criterion + total) for all the datasets used.

The waste of products used during the manufacturing shall be included in the modelling.

7. OEF results – The OEF profile

The applicant shall calculate the OEF profile of its organisation in compliance with all requirements included in this OEFSR. The following information shall be included in the OEF report:

- full life cycle inventory;
- characterised results in absolute values, for all impact categories (including toxicity; as a table);
- normalised and weighted result in absolute values, for all impact categories (including toxicity; as a table);
- the aggregated single score in absolute values,
    - results expressed per created value (market value of all products in the product portfolio);
    - in addition to the OEF profile calculated using the default requirements for electricity modelling, results calculated using the EU + EFTA + UK electricity grid mix, related to electricity used as input to the organization;
    - potential impacts associated to fugitive emissions, if this information is available, shall be calculated and reported separately;
    - results including the end-of-life stage of the main product (copper cathode) (if calculated);
    - OEF results for OEF boundaries and organizational boundaries shall be reported separately;
    - the OEF report shall report if the OEFSR is applied to the single site or the full organisation;
    - the OEF report shall provide information about the product portfolio;
    - the OEF report shall provide information about the company and location of manufacturing site(s) as well as he production route (primary, secondary or integrated);
    - if additional products, other than these listed in **Table 1** (section 3.3) are included, the OEF report shall include a detailed analysis compliant with the OEFSR Recommendation 2021/2279 to evaluate most relevant impact categories, most relevant life cycle stages, processes and elementary flows;
    - the OEF report shall include a diagram with system boundary and indication of the processes according to Data Need Matrix;
    - the OEF report shall list and describe the processes included in the system boundaries, separately for OEF and organizational boundaries;
    - the OEF report shall provide information on the sources of company specific data and methodology used for measurements /calculations;
    - each OEF study report shall include a check list according to Annex 2.

Together with the OEF report, the user of the OEFSR shall develop an aggregated EF compliant dataset of its product in scope. This dataset shall be made available to the European Commission and may be made public. The disaggregated version may remain confidential.

8. Verification

The verification of an OEF study/ report carried out in compliance with this OEFSR shall be done according to all the general requirements included in Section 8 of the Annex III, including part A of this Annex and the requirements listed below.

The verifier(s) shall verify that the OEF study is conducted in compliance with this OEFSR.

In case policies implementing the OEF method define specific requirements regarding verification and validation of OEF studies, reports and communication vehicles, the requirements in said policies shall prevail.

The verifier(s) shall validate the accuracy and reliability of the quantitative information used in the calculation of the study. As this can be highly resource intensive, the following requirements shall be followed:

1. the verifier(s) shall check if the correct version of all impact assessment methods was used. For each of the most relevant EF impact categories (ICs), at least 50% of the characterisation factors shall be verified, while all normalisation and weighting factors of all ICs shall be verified. In particular, the verifier(s) shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with[31] . This may also be done indirectly, for example:
   a. Export the EF-compliant datasets from the LCA software used to do the OEF study and run them in Look@LCI[32] to obtain LCIA results. If Look@LCI results are within a deviation of 1% from the results in the LCA software, the verifier(s) may assume that the implementation of the characterisation factors in the software used to do the OEF study was correct.
   b. Compare the LCIA results of the most relevant processes calculated with the software used to do the OEF study with the ones available in the metadata of the original dataset. If the compared results are within a deviation of 1%, the verifier(s) may assume that the implementation of the characterisation factors in the software used to do the OEF study was correct
2. cut-off applied (if any) fulfils the requirements at section 4.6.4 of Annex III.
3. all datasets used shall be checked against the data requirements (sections 4.6.3 and 4.6.5. of Annex III).
4. For at least 80% (in number) of the most relevant processes (as defined in section 6.3.3 of Annex III), the verifier(s) shall validate all related activity data and the datasets used to model these processes. If relevant, CFF parameters and datasets used to model them shall also be validated in the same way. The verifier(s) shall check that the most relevant processes are identified as specified in section 6.3.3 of Annex III;
5. For at least 30% (in number) of all other processes (corresponding to 20% of the processes as defined in section 6.3.3 of Annex III) the verifier(s) shall validate all related activity data and the datasets used to model these processes. If relevant, CFF parameters and datasets used to model them shall also be validated in the same way;
6. The verifier(s) shall check that the datasets are correctly implemented in the software (i.e. LCIA results of the dataset in the software are within a deviation of 1% to the ones in the metadata). At least 50% (in number) of the datasets used to model most relevant processes and 10% of those used to model other processes shall be checked.
7. An organisation may process further (e.g. via refining) some of the products listed in Table 1. Inclusion of further refined products in a broader Product Portfolio is allowed: this means that further products may be included in the OEF, however the inventory and the environmental impact of the operations needed to produce such products shall be reported separately. In addition, the OEF will have to include, in relation to these additional products, a detailed analysis compliant with the OEF Recommendation 2021/2279 to evaluate hotspots, most relevant life cycle stages, processes and elementary flows.
8. **Table 8** and **Table 9** provide an example on the inventory of substance/elementary flows and activity data that shall be collected for each sub-process within the Organisational boundaries: the minimum list of data to be collected is available in the Excel file, annex to this OEFSR, "Copper OEFSR_4.0 - Life cycle inventory". Sub-processes and activity data not listed in the Annex "Copper OEFSR_4.0 - Life cycle inventory" and belonging within the Organisational boundaries needed to produce the Product

[31] Available at: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml
[32] https://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

Portfolio are mandatory company specific: the completeness of data in this situation shall be checked during the verification of the OEF study compliant with this OEFSR.

In particular, verifier(s) shall verify if the DQR of the process satisfies the minimum DQR as specified in the DNM for the selected processes.

These data checks shall include, but should not be limited to, the activity data used, the selection of secondary sub-processes, the selection of the direct elementary flows and the CFF parameters. For example, if there are 5 processes and each one of them includes 5 activity data, 5 secondary datasets and 10 CFF parameters, then the verifier(s) has to check at least 4 out of 5 processes (70%) and, for each process, (s)he shall check at least 4 activity data (70% of the total amount of activity data), 4 secondary datasets (70% of the total amount of secondary datasets), and 7 CFF parameters (70% of the total amount of CFF parameters), i.e. the 70% of each of data that could be subject to a check.

The verification of the OEF report shall be carried out by randomly checking enough information to provide reasonable assurance that the OEF report fulfils all the conditions listed in section 8 of Annex III, including part A of this Annex.

References

- DIRECTIVE 2003/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

- EU EMISSIONS TRADING SCHEME (ETS) – www.ec.europa.eu/clima/policies/ets/monitoring/index_en.htm

- EUROPEAN COMMISSION– JOINT RESEARCH CENTRE - Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries. Final Draft October 2014.

- EUROPEAN COMMISSION– JOINT RESEARCH CENTRE - Best Available Techniques (BAT) Reference Document for the Management of Waste from the Extractive Industries. Final Draft June 2016.

- European Commissions (2021): Organisation Environmental Footprint (OEF) method, Annex III to IV to the Recommendation 2021/2279/EU, 15th December 2021, published the official journal of the European Union Volume 471 on 30th December 2021.

- EUROPEAN COMMISSION – JOINT RESEARCH CENTRE – JRC Reference Report on Monitoring of emissions from IED-installations. Final Draft October 2013.

- European Copper Institute/International Copper Association, Life cycle assessment of primary cathode (copper concentrate). http://copperalliance.org/2017/12/13/copper-environmental-profile-most-comprehensive-data-set-on-copper-production/

- Global Reporting Initiative 304: Biodiversity (2016) – ISBN: 978-90-8866-067-2

- Life Cycle Data Network (LC-DN). www.eplca.jrc.ec.europa.eu/?page_id=134

- Technical secretariat of the OEFSR on copper production Scope of the OEFSR and Representative Organisation (document can be made available upon request to the TS).

- Technical secretariat of the OEFSR on copper of existing product category rules, sector guidance and relevant documents and comparisons with key requirements for the OEFSR on copper production. (document can be made available upon request to the TS).

- Zampori L, Sala S, *Feasibility study to implement resource dissipation in LCA*, EUR 28994 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-77238-2, doi 10.2760/869503, JRC 109396

ANNEX 1 – List of EF normalisation and weighting factors

Global normalisation factors are applied within the EF. The normalisation factors as the global impact per person are used in the EF calculations.

Impact category	Unit (per capita)	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Climate change	kg $CO_{2\ eq}$	7,55E+03	I	II	I	
Ozone depletion	kg CFC-11 $_{eq}$	5,23E-02	I	III	II	
Human toxicity, cancer	CTUh	1,73E-05	II/III	III	III	
Human toxicity, non-cancer	CTUh	1,29E-04	II/III	III	III	
Particulate matter	disease incidence	5,95E-04	I	I/II	I /II	NF calculation takes into account the emission height both in the emission inventory and in the impact assessment.
Ionising radiation	kBq $U^{235}{}_{eq}$	4,22E+03	II	II	III	
Photochemical ozone formation	kg NMVOC $_{eq}$	4,09E+01	II	III	I/II	
Acidification	mol H+ $_{eq}$	5,56E+01	II	II	I/II	
Eutrophication, terrestrial	mol N $_{eq}$	1,77E+02	II	II	I/II	
Eutrophication, freshwater	kg P $_{eq}$	1,61E+00	II	II	III	
Eutrophication, marine	kg N $_{eq}$	1,95E+01	II	II	II/III	
Land use	pt	8,19E+05	III	II	I I	The NF is built by means of

						regionalised CFs.
Ecotoxicity, freshwater	CTUe	5,67E+04	II/III	III	III	
Water use	m^3 water eq. of deprived water	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
Resource depletion, fossils	MJ	6,50E+04	III	I	II	
Resource depletion, minerals and metals	kg Sb $_{eq}$	6,36E-02	III			

Weighting factors for Environmental Footprint

	Weighting factors
Climate change	**21,06%**
Ozone depletion	**6,31%**
Particulate matter	**8,96%**
Ionizing radiation	**5,01%**
Photochemical ozone formation	**4,78%**
Acidification	**6,20%**
Eutrophication, terrestrial	**3,71%**
Eutrophication, freshwater	**2,80%**
Eutrophication, marine	**2,96%**
Land use	**7,94%**
Water use	**8,51%**
Resource depletation, minerals and metals	**7,55%**
Resource depletion, fossils	**8,32%**
Ecotoxicity, freshwater	**1,92%**
Human toxicity, cancer	**2,13%**
Human toxicity, non-cancer	**1,84%**

ANNEX 2 – OEF study template

Each OEF study shall include this annex, completed with all the requested information.

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
This column shall list all the items that shall be included in OEF studies. One item per row shall be listed.	The OEF study shall indicate if the item is included or not in the study.	The OEF study shall indicate in which section of the study the item is included.	The OEF study shall indicate in which page of the study the item is included.
Summary			
General information about the product portfolio			
General information about the company and location of manufacturing site(s)			
Information about the production route (primary, secondary or integrated)			
Diagram with system boundary and indication of the processes according to DNM			
List and description of processes included in the system boundaries, separately for OEF and organizational boundaries			
In case applicable, sub-set of the organisation's activities on which the study was carried out			
OEFSR is applied to the single site or the full organisation.			
If products additional to these listed in Table 1 are included, the OEF include a detailed analysis to evaluate most relevant impact categories, most relevant life cycle			

stages, processes and elementary flows			
List of products not included in the product portfolio			
List of activity data used			
Information on the sources of company specific data and methodology used for measurements /calculations provided in the OEF report.			
List of secondary datasets used			
Data gaps			
Assumptions			
Additional technical information results			
Additional environmental information			
Scope of the study			
Sub-set of the organisation's activities on which the study was carried out (if applicable)			
DQR calculation of each dataset used for the most relevant processes and new ones created			
DQR (of each criteria and total) of the study			
OEF results for OEF boundaries and organizational boundaries reported separately			

ANNEX 3 – Review reports of the OEFSR and OEF-RO(s)

Review report – Available at: https://internationalcopper.org/resource/copperoefsr/

ANNEX 4 – Life cycle inventory

Excel file “Copper OEFSR_4.0 – Life Cycle Inventory” - Available at: https://internationalcopper.org/resource/copperoefsr/

ANNEX 5 – Dissipative use of resources

During the pilot phase, the Technical Secretariat of the OEFSR on copper production proposed a possible way forward to overcome the limitations of the current method to assess resource depletion. The original proposal is reported here as an Annex. The proposal has been further elaborated by the JRC (Zampori L, Sala S, *Feasibility study to implement resource dissipation in LCA*, EUR 28994 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-77238-2, doi 10.2760/869503, JRC 109396).

Since 2018, until 2023 the concept of the dissipative use of resources has been addressed by several initiatives and projects, including at UNEP level. The JRC has also developed an approach on how to deal with the dissipative use of resources[33]. Therefore, it is recommended that the limitations already identified with the ADP method are overcome by the use of more meaningful methods, based on the dissipation concept.

Below the original recommendations available in the first version of the OEFSR are reported.

Possible way forward as presented by the Technical Secretariat in the first version of the OEFSR

According to the current LCA practice, depletion of resources[34] is considered occurring only at the interface between nature and technosphere.

Depletion of resources, due to the intrinsic properties of a product is not well captured (e.g. a specific design preventing the possibility of recovering valuable materials; the inherent properties of an alloy which prevents the recovery of the dissolved elements or loses them into the slag phase; the combination of different materials or material connections which do not allow proper recycling, economics of the system, etc.). If the potential impact of resource depletion is only considered in relation to the exchanges of resources at the interface between ecosphere and technosphere, the information associated to what happens within the technosphere is irremediably lost: in other words, the burdens and benefits associated to depletion of resources are shifted exclusively to the life cycle stages where extraction of raw materials takes place and to the end-of-life in the case of recycling (e.g. through modelling of displaced primary resources due to recycling). This approach does not help in identifying how to depict and improve the resource efficiency of a supply-chain: as such, it is not fully aligned to what LCA aims at, as also stated in ISO 14040 (2006): "*shifting of a potential environmental burden between life cycle stages or individual processes can be identified and possibly avoided*."

To be able to capture what happens also within the technosphere, the TS advise to take the following steps:

1) Life Cycle Inventories need to be adapted: the TS advise to track flows of resources also within the technosphere. For example the production of a 1 kg copper sheet will have as output a flow called "*copper, to anthropogenic stock"* (amount 1 kg), meaning that the copper included in the sheet has not been depleted. Therefore, the concept of «depletion» of resources is associated to those processes which will not allow (with current technologies) the recovery of a specific resource. The name of the flow " […], to anthropogenic stock" is used as example and will have to be refined in future developments.

2) Associate a characterization model to the new built inventories: this means that characterization factors will need to be developed to associate a potential impact to the resource flows occurring within the technosphere.

An example of how the above concept could work, is shown in the below figures.

"Current practice" should be understood as the way Resource Depletion is assessed

"Alternative practice" should be understood as the way forward proposed here.

1) re-think the life cycle inventories: Initial proposal

[33] A price-based life cycle impact assessment method to quantify the reduced accessibility to mineral resources value - Ardente, F., Beylot, A., Zampori, L., 2023, 28(1), pp. 95–109

[34] *Resource depletion*: the process of physically reducing the global amount of a specific resource. It refers to the reduction of geological/natural stocks over time (Drielsma, et al., 2016). In this Annex we still use "Resource Depletion", even though it may not be the most appropriate name for the suggested way forward.

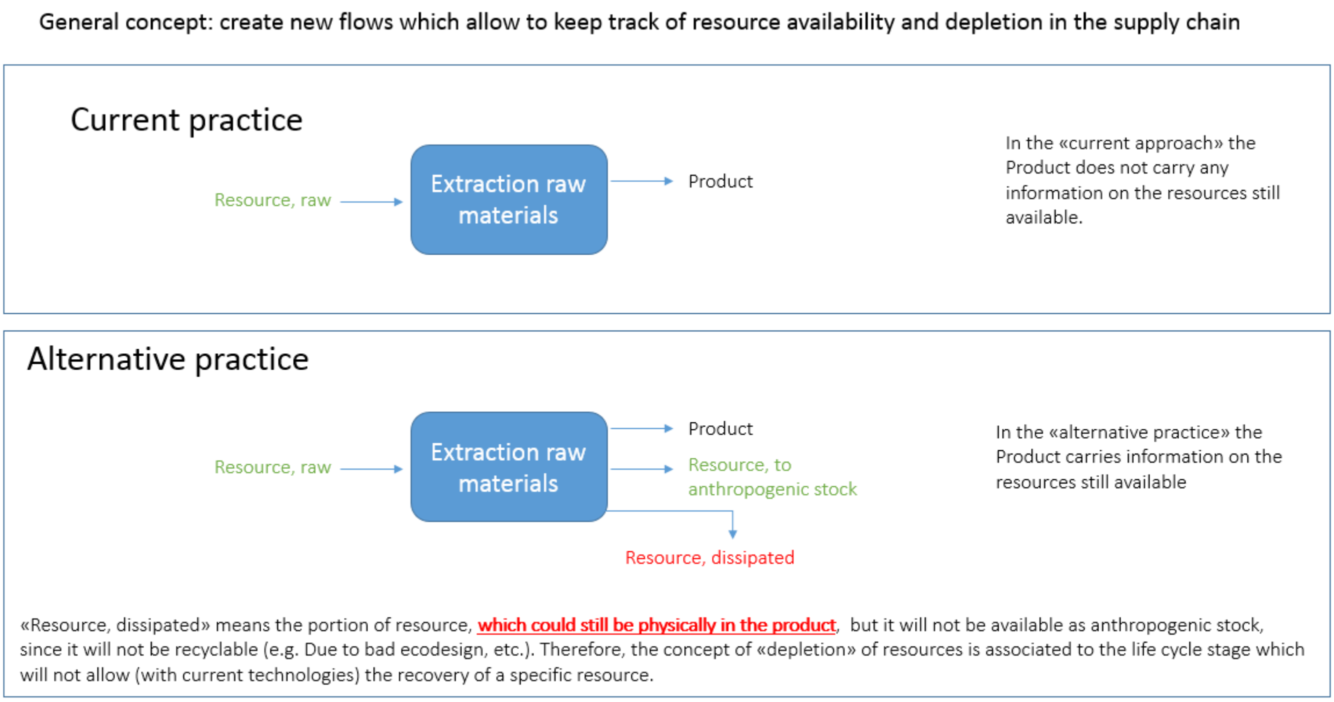


Figure 8. Resource Depletion: possible way forward. Re-thinking the Life Cycle Inventory.

2) Associate a characterization model to the new built inventories

This example was built with the use of Characterization Factors with 0-1 values expressed as Arbitrary Units (AU), to show the underlying concept of how the rationale of the proposed way forward. Therefore the use of 0-1 values is to be intended as oversimplification to show the conceptual basis of the suggested way forward. Different characterization models could be used, also building on existing ones, or new characterization models could be elaborated. Consistency with perspectives identified in Dewulf et al. (2015) is recommended[35].

[35] E.g. If perspective 1 is used, the method will treat the "Asset of Natural Resources" as safeguard subject. According to perspectives 2-5 of Dewulf et al. (2015), Natural Resources are treated – to varying degrees - as Natural Capital generating use values in the form of Ecosystem Services or economic building blocks

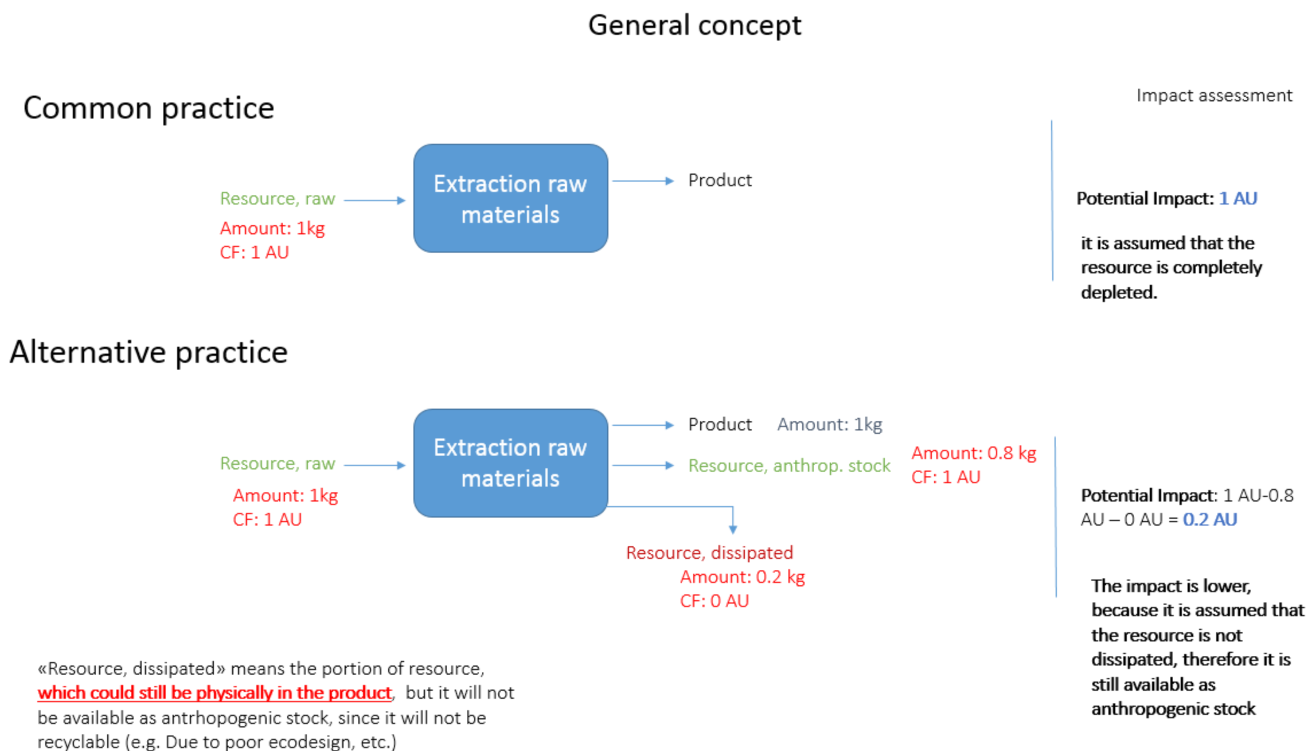


Figure 9. Resource Depletion: possible way forward. Characterization factors to be associated to the newly created flows.

3) Examples of a complete life cycle

In Examples A and B, we chose to show the case of a resource which is not recovered at end-of-life: the resource is used in a product, which is not recovered at end-of-life due to a poor eco-design. The example does not pretend to depicts reality and it is only an illustration to show how the methodology works over a complete life-cycle.

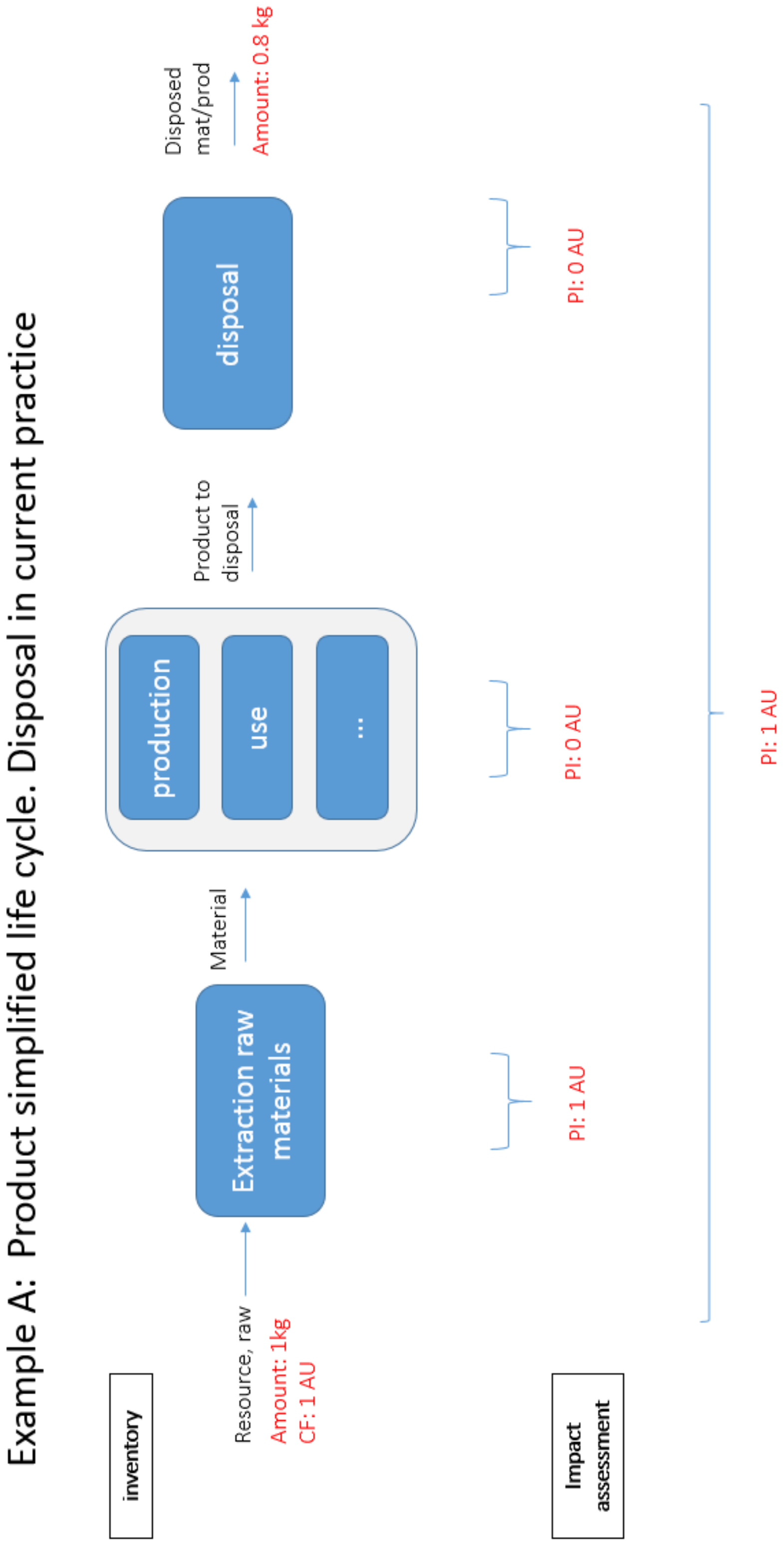


Figure 10. Resource Depletion: possible way forward. Example of a full life cycle in the current practice. Disposal.

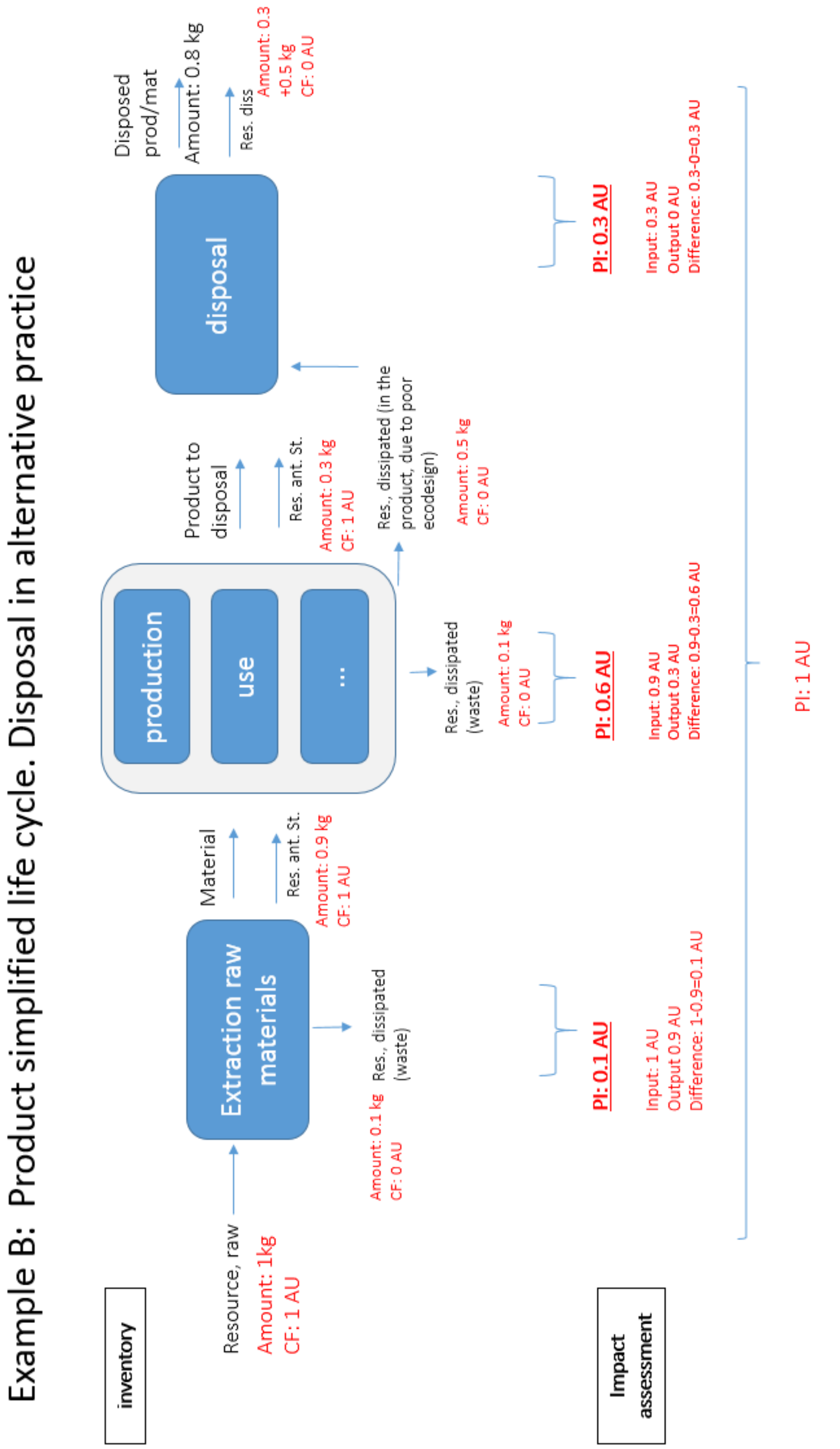


Figure 11. Resource Depletion: possible way forward. Example of a full life cycle in the alternative practice. Disposal.

As it can be seen by comparing Examples A and B:

- Impacts over the full life cycle are the same: PI = 1 Arbitrary Unit in both cases

- Example A associates all burdens of depletion of resources to the “extraction of raw materials”: at that stage the resource could be used in a product with good eco-design, therefore recovered at end-of-life through a recycling process or lost due to bad eco-design. The resource is the same, the product different, but the “hotspot” process remains the same. No indication for improving the process can be extracted from this analysis.

- Example B associates burdens of depletion of resources to those life cycle stages which prevent the recovery of the resource or to those life cycle stages which physically lose part of the resource (e.g. process losses). The “Production, Use, …” life cycle stage becomes the “hotspot” of the life cycle, meaning that an improvement in this area is needed to keep resources in the loop.

The above example shows the general framework, however industry and modelling experts should support the refinement of the model. For example, looking at example B, “resource dissipation (waste)” from the “Extraction” stage has to be carefully considered and defined. Key aspects will include difference between materials contained within the waste and materials leached or run-off from the waste, etc. A realistic and reasonable definition of “dissipation” is required as well as a realistic and reasonable boundary between Anthropogenic Stock (or stocks) and Losses.

Another example can be built taking into account recycling at End-of-Life. Example C illustrates how recycling would be dealt with the current practice, while Example D shows the alternative modelling. Examples C and D are built to be compared with A and B.

When comparing A and C, burdens are always associated only with “Extraction of raw materials”, while processes occurring between this life cycle stage and the end-of-life (disposal or recycling) are always burden free, while they could actually influence the end-of-life destiny of the product. When comparing B and D a more accurate depicting of resource flows is inventoried and the impacts associated to the different life cycle stages actually allow to focus where improvement is needed.

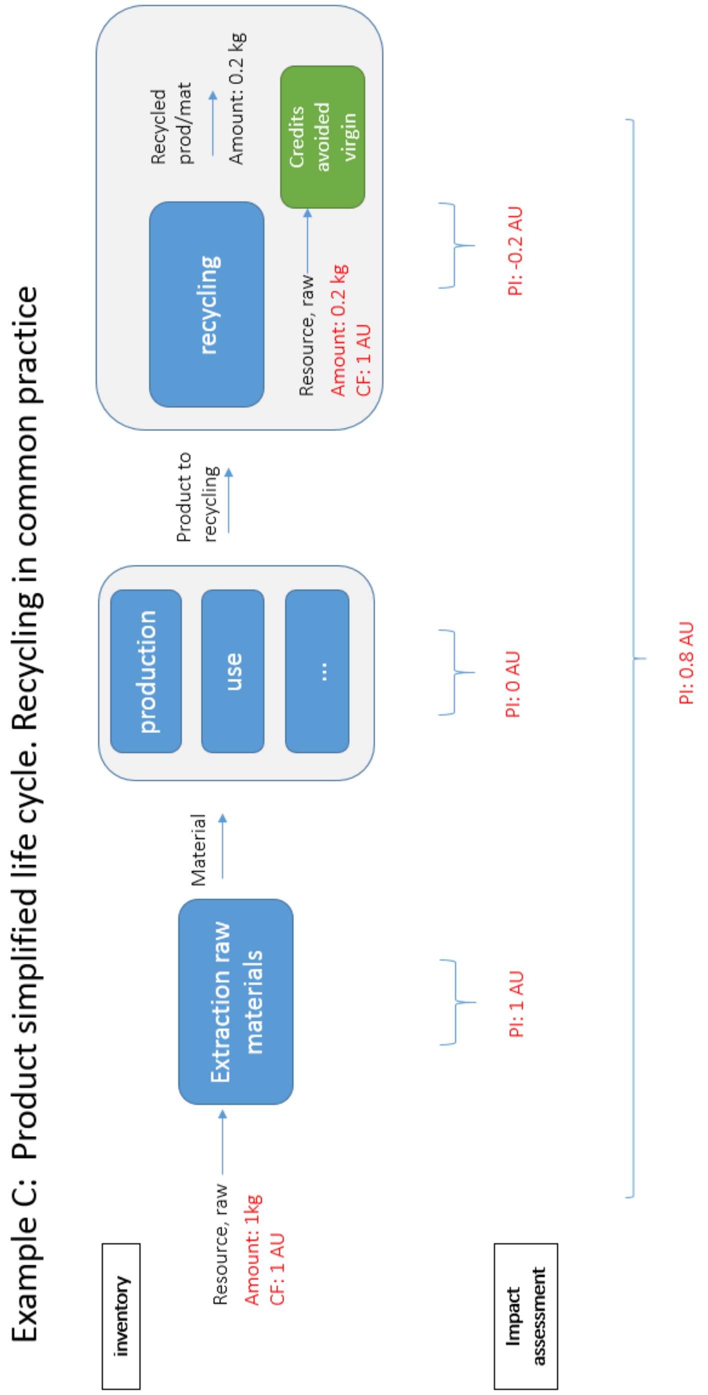


Figure 12. Resource Depletion: possible way forward. Example of a full life cycle in the current practice. Recycling.

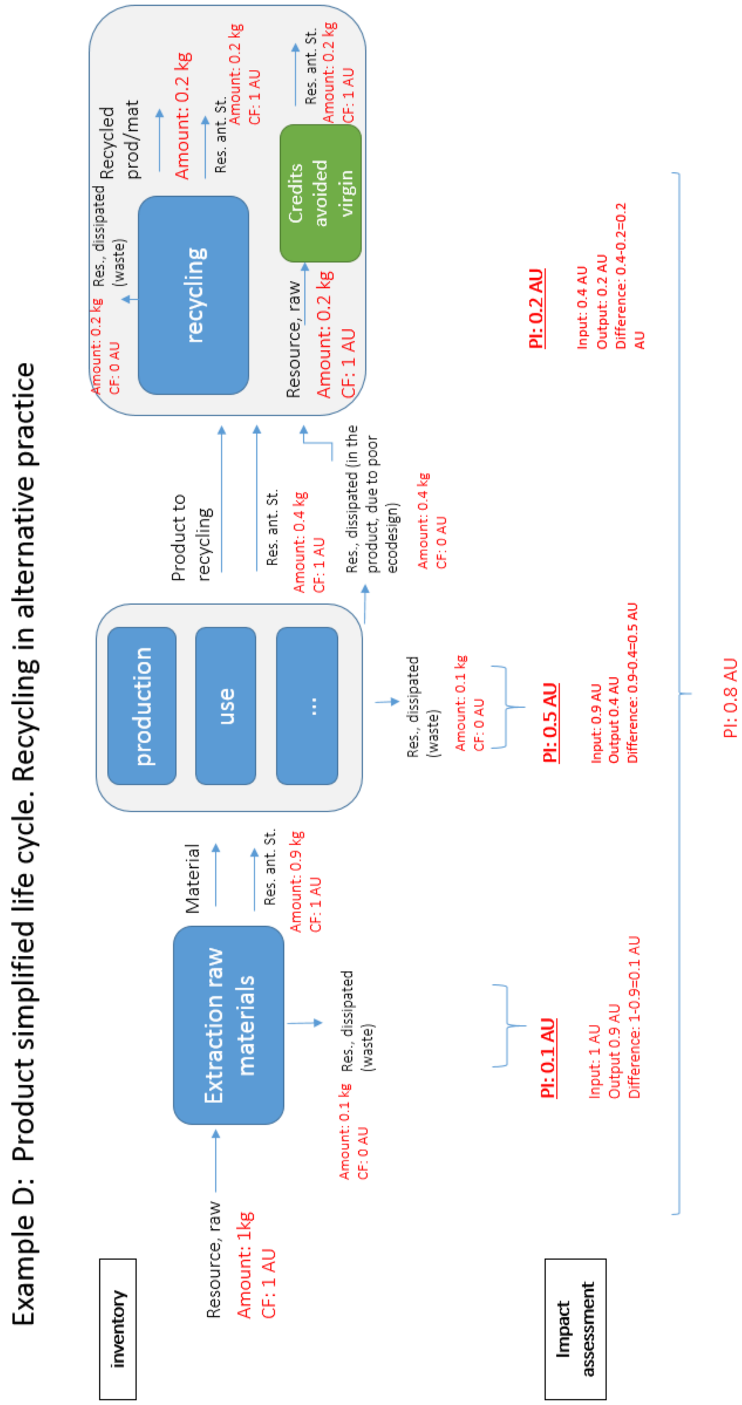


Figure 13. Resource Depletion: possible way forward. Example of a full life cycle in the alternative practice. Recycling.

References

- Dewulf J., et al. - Rethinking the Area of Protection "Natural Resources" in Life Cycle Assessment. Environmental Science and Technology 2015, 49, 5310–5317

- Drielsma J.A., et al. – Mineral resources in life cycle impact assessment – defining the path forward. International Journal of Life Cycle Assessment, 2016, 21 (1), 85-105.