Organisation Environmental Footprint Sector Rules –

Copper production

- The sector for which the OEFSR is valid: Copper production
- Version number: 3.1
- Date of publication: February 2020 (original publication date: April 2018)
- Time validity: until 31st December 2021

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Acronyms

AF	Allocation Factor
AR	Allocation Ratio
B2B	Business to Business
B2C	Business to Consumer
BoC	Bill of Components
BoM	Bill of Materials
BREF	Best Available Techniques Reference Document
CF	Characterization Factor
CFF	Circular Footprint Formula
CFF-M	Circular Footprint Formula – Modular form
CMWG	Cattle Model Working Group
CPA	Classification of Products by Activity
DC	Distribution Centre
DMI	Dry Matter Intake
DNM	Data Needs Matrix
DQR	Data Quality Rating
EA	Economic Allocation
EC	European Commission
EF	Environmental Footprint
EI	Environmental Impact
EoL	End-of-Life
FU	Functional Unit
GE	Gross Energy intake
GR	Geographical Representativeness (AD suffix stands for Activity Data, EF suffix stands for Elementary Flow, SD suffix stands for Secondary Dataset)
GHG	Greenhouse Gas
GWP	Global Warming Potential
HD	Helpdesk
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	Joint Research Centre
LCDN	Life Cycle Data Network
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LT	Lifetime
MWEI	Management of Waste from the Extractive Industries
NACE	Nomenclature Générale des Activités Economiques dans les Communautés Européennes
NDA	Non Disclosure Agreement
NFM	Non Ferrous Metals industries
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile compounds
OEF	Organisation Environmental Footprint
OEFSR	Organisation Environmental Footprint Sector Rule
P	Precision (AD suffix stands for Activity Data, EF suffix stands for Elementary Flow, SD suffix stands for Secondary Dataset)
PCR	Product Category Rules

PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PGM	Platinum Group Metals
PP	Product Portfolio
RF	Reference Flow
RO	Representative Organisation
SB	System Boundary
SC	Steering Committee
SS	Supporting study
TAB	Technical Advisory Board
TeR	Technological Representativeness (AD suffix stands for Activity Data, EF suffix stands for Elementary Flow, SD suffix stands for Secondary Dataset)
TiR	Time Representativeness (AD suffix stands for Activity Data, EF suffix stands for Elementary Flow, SD suffix stands for Secondary Dataset)
TS	Technical Secretariat
UUID	Universally Unique Identifier

Definitions

For all terms used in this OEFSR and not defined below, please refer to the most updated version of the Organisation Environmental Footprint (OEF) Guide, OEFSR Guidance, ISO 14025:2006, ISO 14040-44:2006.

Activity data - This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the OEF Guide it is also called "non-elementary flows". 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 a process (See **Figure 1**). 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 equipment is operated, distance travelled, floor area of a building, etc. In the context of OEF the amounts of ingredients from the bill of material (BOM) shall always be considered as activity data.

Aggregated dataset - This term is defined as a life cycle inventory of multiple unit processes (e.g. material or energy production) or life cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level. Aggregated datasets are also called "LCI results", "cumulative inventory" or "System processes" datasets. The aggregated dataset can have been aggregated horizontally and/or vertically. Depending on the specific situation and modelling choices a "unit process" dataset can also be aggregated. See Figure 1.

Application specific - it refers to the generic aspect of the specific application in which a material is used. For example, the average recycling rate of PET in bottles.

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 an end product.

[1] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004).

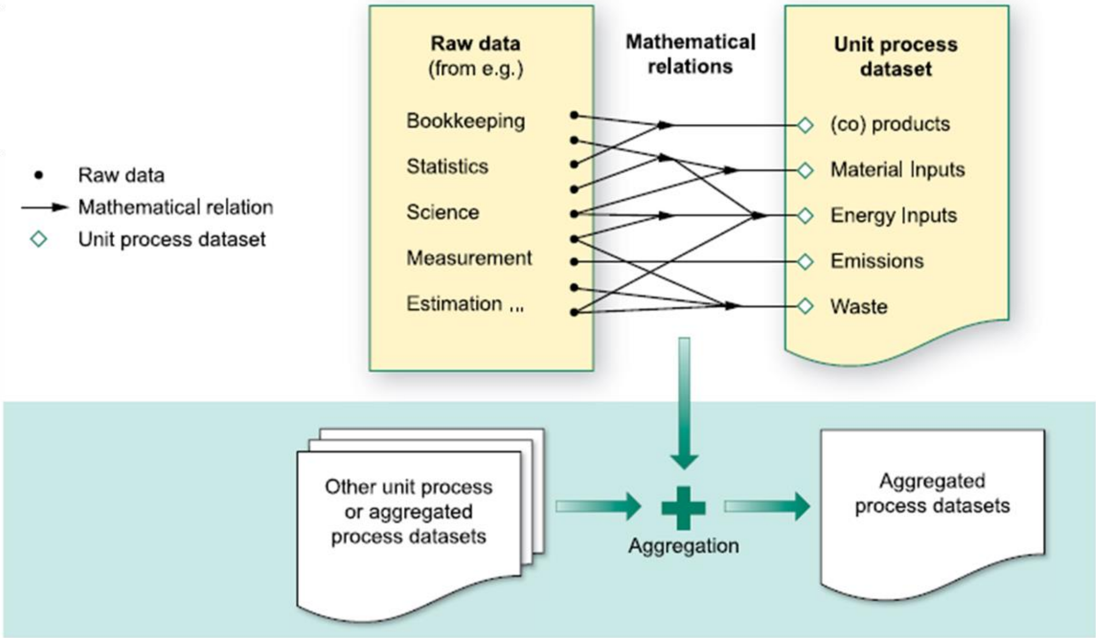

Figure 1. Definition of a unit process dataset and an aggregated process dataset (Source: UNEP/SETAC "Global Guidance Principles for LCA Databases")

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. According to ISO 14025:2006, a consumer is defined as "an individual member of the general public purchasing or using goods, property or services for private purposes".

Company-specific data – it refers to directly measured or collected data representative of activities at a specific facility or set of facilities. It is synonymous to "primary data".

Comparative assertion – environmental claim regarding the superiority or equivalence of one organisation versus a competing organisation that operates in the same sector, based on the results of an OEF study and supporting OEFSRs.

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more organisations/production sites/time frames based on the results of an OEF study, and supporting OEFSRs. Comparing production sites or time frames within the same company falls under this definition and is not a comparative assertion.

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.

Direct elementary flows - All emissions and resource use (also named elementary flows) that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite. See **Figure 2**.

Disaggregation - The process that breaks down an aggregated dataset into smaller unit process datasets (horizontal or vertical). The disaggregation can 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

Electricity tracking[2] **-** Electricity tracking is the process of assigning electricity generation attributes to electricity consumption.

Elementary flow - 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.

EMAS - Eco-Management and Audit Scheme (REGULATION (EC) No 1221/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS). EMAS is a premium management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance. EMAS is open to every type of organisation and spans all economic and service sectors and is applicable worldwide.

EMAS Sectoral Reference Documents (EMAS SRDs) – documents developed according to Art. 46 of the EMAS Regulation3, which contain best environmental management practice, environmental performance indicators for specific sectors and, where appropriate, benchmarks of excellence and rating systems identifying environmental performance levels.

Environmental aspect – element of an organization's activities or products or services that interacts or can interact with the environment (ISO 14001:2015)

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

Input flows – product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products (ISO 14040:2006).

Intermediate product - an intermediate product is a product that requires further processing before it is saleable to the final consumer.

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[2] https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii
[3] Regulation (EC) No 1221/2009

Life Cycle Inventory (LCI) - The combined set of exchanges of elementary, waste and product flows in an 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.

Material-specific - it refers to a generic aspect of a material. For example, the recycling rate of PET.

Output flows – product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases (ISO 14040:2006).

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 be reported.

OEF screening – a preliminary study carried out on the representative organisation, and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories, data quality needs, and any other major requirement to be part of the final OEFSR.

OEFSR Supporting study – the OEF study done on the basis of a draft OEFSR. It is used to confirm the decisions taken in the draft OEFSR before the final OEFSR is released.

Organisation - a company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private. For the purpose of calculating the OEF, the function of the organisation is defined as the provision of products (i.e. goods and services) over a specified reporting interval, thus it is defined with reference to its Product Portfolio.

Organisational claims – Any form of communication regarding an organisation's environmental performance, such as reports, responses to questionnaires, declarations and press releases. Herein claims refer exclusively to those based on a life cycle assessment (LCA-based claims).

Organisation Environmental Footprint Sector 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 whilst reducing costs in comparison to a study based on the comprehensive requirements of the OEF Guide. OEFSRs are defined primarily with reference to the activities characteristic of the sector, as represented in a typical Product Portfolio.

Partially disaggregated dataset - A dataset with an LCI that contains elementary flows and activity data, and that only in combination with the complementing aggregated datasets that represent the activities yields a complete aggregated LCI data set. We refer to a partially disaggregated dataset at level 1 in case the LCI contains elementary flows and activity data, while at least some of the complementing sub-processes are in their aggregated form (see an example in **Figure 2**). The underlying sub-processes should be based on EF-compliant secondary datasets (if available).

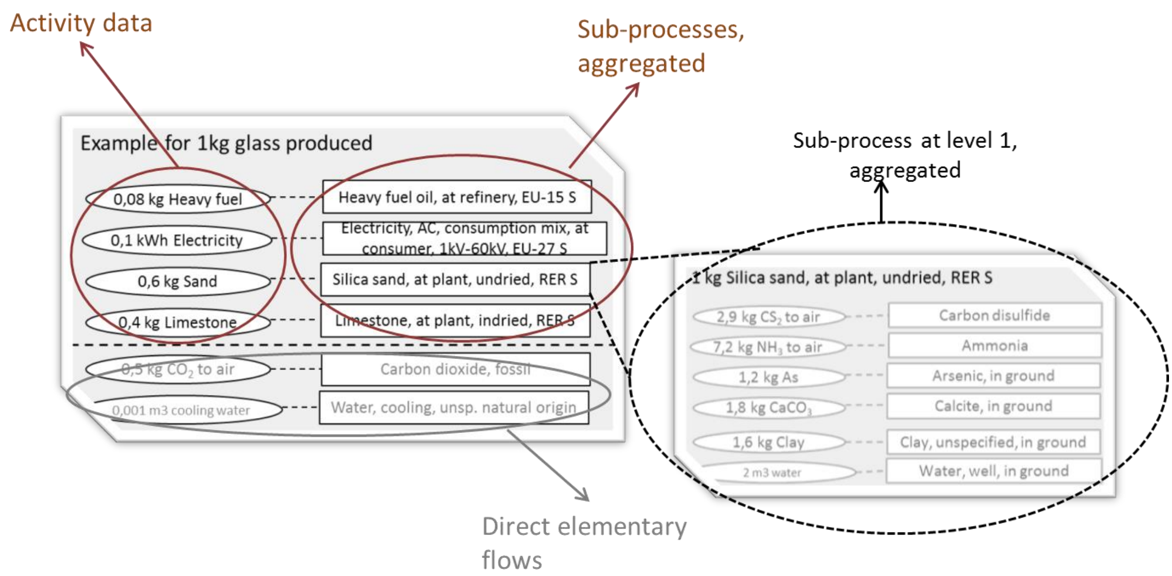

Figure 2. An example of a partially aggregated dataset, at level 1 with its activity data and direct elementary flows (to the left), and the complementing sub-processes in their aggregated form (to the right). The grey text indicates elementary flows.

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

Primary data[4] - This term refers to data from specific processes within the supply-chain of the company applying 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 a 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 company applying the OEFSR. In this Guidance, primary data is synonym of "company-specific data" or supply-chain-specific data".

Product Portfolio - The Product Portfolio refers to the amount and nature of goods and services provided by the Organisation over the reporting interval, which should be one year.

[4] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004).

Refurbishment - 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.

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

Representative organisation (model) - The "representative organisation" is a real or fictive organisation that is typical for the given sector and Product Portfolio. Especially when technologies and the composition of Production Portfolios within a sector are varied, the "representative organisation" can be a virtual (non-existing) organisation, built, for example, with the average EU sales-weighted characteristics of all technologies used, using the Product Portfolio as a reference. If appropriate, an OEFSR might include more than one representative organisation (business unit).

Sample - A sample is 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[5] - refers to data not from specific process within the supply-chain of the company applying the OEFSR. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third-party life-cycle-inventory 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 can 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.

Sector – A sector is defined with reference to the characteristic sectorial Product Portfolio, defined using NACE codes (i.e. in line with the Nomenclature générale des Activités Economiques dans les Communautés Européennes NACE Rev. 2).

Sub-population - In this document this term indicates any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study that constitutes an homogenous sub-set of the whole population. Sometimes the word "stratum" can be used as well.

Sub-sample - In this document this term indicates a sample of a sub-population.

[5] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004)

Sub-processes - those processes used to represent the activities of the level 1 processes (=building blocks). Sub-processes can be presented in their (partially) aggregated form (see **Figure 2**).

Supply-chain - refers to all of the upstream and downstream activities associated with the operations of the company applying the OEFSR, 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 can produced by a specific company.

Type III environmental declaration – An environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information (ISO 14025:2006). The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044.

Unit process dataset - Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 14040:2006). In LCA practice, both physically not further separable processes (such as unit operations in production plants, then called "unit process single operation") and also whole production sites are covered under "unit process", then called "unit process, black box" (ILCD Handbook).

1 Introduction

The Organisation Environmental Footprint (OEF) Guide provides detailed and comprehensive technical guidance on how to conduct an OEF study. OEF studies may be used for a variety of purposes, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this OEFSR the applicant shall refer to the documents this OEFSR is in conformance with (see chapter 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 organization	*Type of organization*	*Name of the members*
European Commission – Joint Research Centre	Government	Luca Zampori Rana Pant
Aurubis	Industry	Daniela Cholakova Karin Hinrichs-Petersen Jorn Muehlenfeld
Outotec	Industry	Ilkka Kojo Susanna Horn Markus Reuter
KGHM	Industry	Pawel Feret Daniel Glowacki Damian Krol Oskar Filipowski

2.2 Consultations and stakeholders

The process of creating a new OEFSR requires the involvement of interested stakeholders in physical and virtual consultations.

The first virtual stakeholder consultation was launched on 26 February 2014 up to 31 March 2014. The aim of the consultation was to provide comments on two documents:

- Scope of the OEFSR and Representative Organisation
- Overview of existing product category rules, sector guidance and relevant documents and comparisons with key requirements for the OEFSR on copper production.

Documents are available at the following web-link:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production

A physical stakeholder meeting was organized in Brussels on 10 March 2014.

No stakeholder attended the meeting nor provided comments.

The documents were approved by the Steering Committee (SC) in May 2014. The TS submitted a request to the SC to broaden the list of products included in the Product Portfolio: this request was approved during the SC meeting held in December 2014.

The second stakeholder consultation was launched on 4 May 2015 up to 1 June 2015. The aim of the consultation was to provide comments on two documents:

- OEF screening
- 1st Draft OEFSR

Comments were provided by the EF Helpdesk (7 comments on the OEFSR), Environment Agency Austria + Quantis + Carrefour (48 comments on the OEFSR, 7 on the OEF screening), private citizen (these last comments were not provided via the official wiki page).

The screening study is available upon request to the TS coordinator (e-mail: luca.zampori@ec.europa.eu) that has the responsibility of distributing it with an adequate disclaimer about its limitations.

The 1st draft OEFSR was approved by the EF Steering Committee (SC) in July 2015. Upon request of some SC members, the TS committed to introduce some changes to be implemented in the final OEFSR:

- the copper OEF commits to further test an alternative method for resources in addition to the baseline abiotic resource depletion (ARD)
- to further tailor the document towards an OEFSR, include organisational elements in detail in the supporting studies.
- The option of including energy efficiency or physical efficiency as mandatory supporting information was raised by the SC. The pilot explained that it took into account overall physical efficiency and further investigate this aspect in the supporting studies.

The last stakeholder consultation was launched on 24 June 2016 up to 22 July 2016. The aim of the consultation was to provide comments on the final OEFSR. A total of 123 stakeholders were registered in the wiki-pages. Comments were received from: Belgium – Federal Public Service – Health, Food chain safety and Environment (12 comments); European Commission (37 comments); Employers Organisation of Polish Copper (5 comments); Euromines / Metal sheet Pilot Eurometaux (4 comments).

Documents are available at:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production

2.3 Review panel and review requirements of the OEFSR

Name of the member	*Affiliation*	*Role*
Ugo Pretato	Studio Fieschi e Soci srl	Panel Chair
Ladji Tikana	Deutsches Kupferinstitut BV	Panel member
Anna Lewandowska	Poznan University of Economics and Business	Panel member

The reviewers have verified that the following requirements have been fulfilled:

- *The OEFSR has been developed in accordance with the requirement provided in the OEFSR Guidance* [indicate the version the OEFSR is in conformance with], *and where appropriate in accordance with the requirements provided in the most recent approved version of the OEF Guide, and supports creation of credible and consistent OEF profiles,*
- *Functional unit, allocation and calculation rules are adequate for the sector under consideration,*
- *Company-specific and secondary datasets used to develop this OEFSR are relevant, representative, and reliable,*
- *The selected LCIA indicators and additional environmental information are appropriate for the sector under consideration and the selection is done in accordance with the guidelines stated in the OEFSR Guidance version 6.3 and the most recent approved version of the OEF Guide,*
- *Both LCA-based data and the additional environmental information prescribed by the OEFSR give a description of the significant environmental aspects associated with the sector.*
- The OEFSR takes into account requests from the Steering Committee when approving the draft OEFSR (cfr. Minutes 9th SC meeting);
- The OEFSR takes into account comments from the last stakeholder consultation (24 June 2016 up to 22 July 2016).
- The information provided in the supporting studies are sufficiently taken into account in the OEFSR.

The detailed review report is provided in Annex 3 of this OEFSR.

2.4 Review statement

This OEFSR has been developed in compliance with Version 6.3 of the OEFSR Guidance, and with the OEF Guide adopted by the Commission on 9 April 2013.

The representative product portfolio correctly describes the average sector 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 under the prescribed conditions (see chapter on limitations).

The panel members confirm that they have sufficient knowledge and experience of the industrial sector involved and of the relevant methods and guidance to carry out this review and that they have performed the review tasks at the best of their capacity.

The panel members confirm that they have been independent in their role as reviewers, they have not been involved in the development of the OEFSR and they do not have conflicts of interest regarding this review.

2.5 Geographic validity

This OEFSR is valid for the EU + EFTA.

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):

- *OEFSR Guidance 6.3*
- *Organisation Environmental Footprint (OEF) Guide; Annex III to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, 4 May 2013*

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 (cfr. Scope document, page 13, for further details, available at:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production).

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 should 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 3**. A detailed description of the Representative Organisation is available at the following link:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production

The screening study is available upon request to the TS coordinator (e-mail: luca.zampori@ec.europa.eu) that has the responsibility of distributing it with an adequate disclaimer about its limitations.

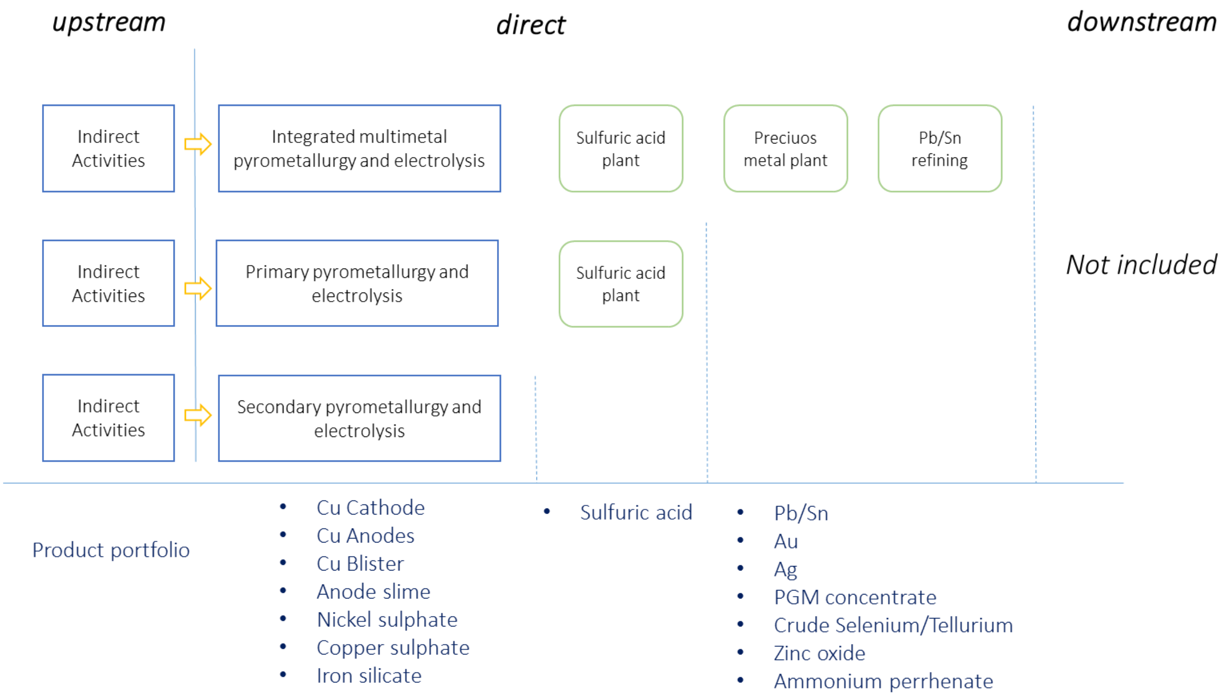

Figure 3 – Model of the Representative Organisation

3.3 Reporting unit and product portfolio

The reporting unit 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.

In **Table 1** the aspects and details of the typical product portfolio are reported.

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 OEFSR Guidance 6.3 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 - Product Portfolio

Aspect	**Detail**
[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 **$NiSO_4$, $CuSO_4$, 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 **All metals are associated with copper production and exclude production of these metals from other different sources**

[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 should be provided.[6]
[YEAR]	Specify year of reporting.
[REPORTING INTERVAL]	1 year

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.

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

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

- A - Primary smelting and converting (in two process steps or in one process step)
- B - Secondary smelting and converting
- C - Fire refining and copper electrolysis
- D - Recovery of Pb/Sn/zinc oxide
- E - Recovery of precious metals, crude selenium and/or tellurium, ammonium perrhenate
- F- Slag cleaning (and iron converting)
- G- Sulfuric acid plant products (Acid and liquid SO_2 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:

i) processes which are necessary to contribute to providing the Product Portfolio over the reporting interval,

ii) processes which are not necessary to provide the PP over the reporting interval. Such processes shall be reported separately. 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

- 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
- Smelting
- Converting

- Sulfuric acid production
- Slag cleaning
- 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 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
- 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.

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 anodes and blister copper
- Transport of raw materials (copper concentrate, scrap, purchased anodes and blister) in vehicles not owned by the organisation
- Etc.

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 7.2). 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 4**. 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.

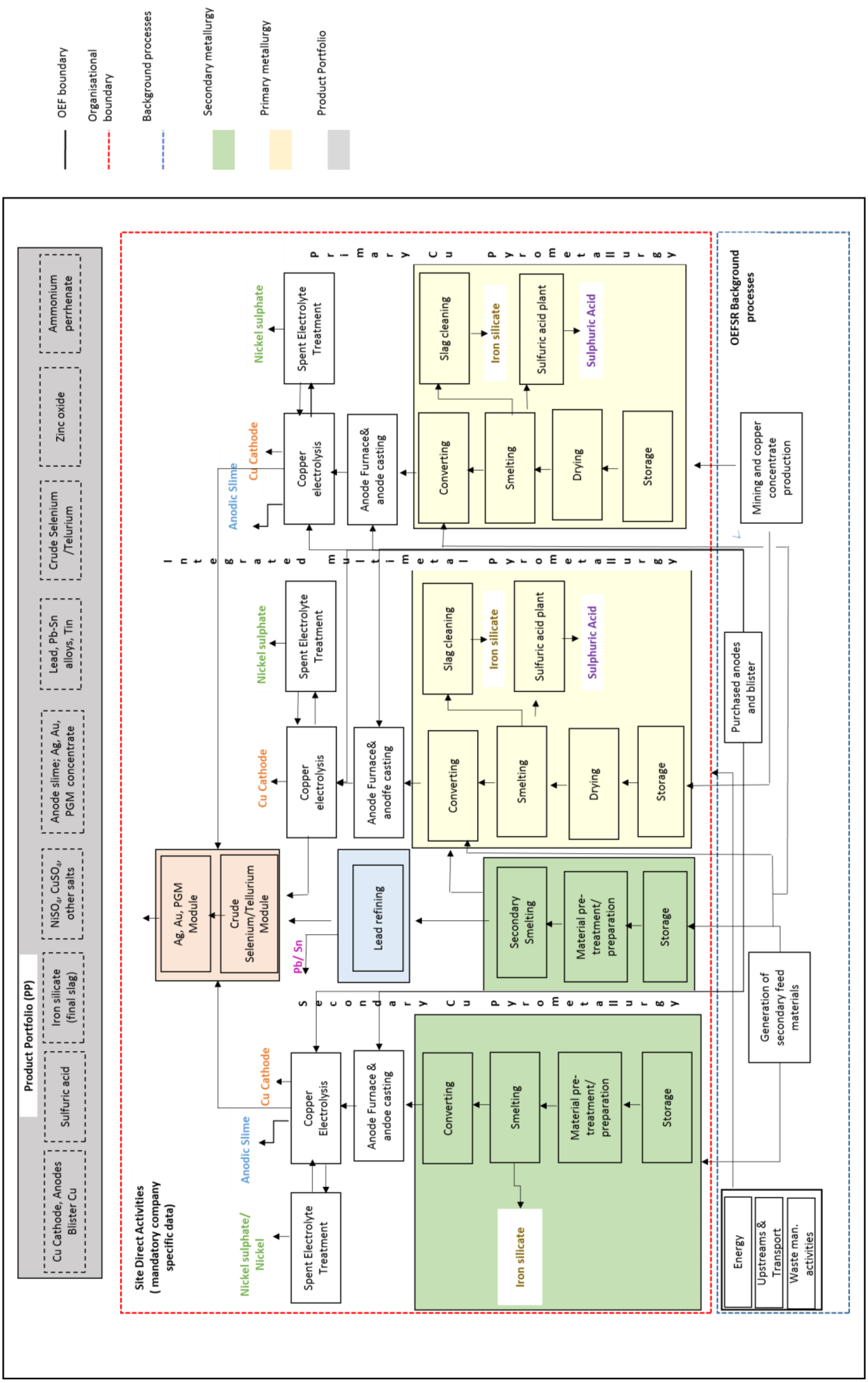

Figure 4 – System diagram reporting OEF and Organisational boundaries. An organization may be composed of all, one or two routes.

The following life cycle stages and processes shall be included in the system boundary:

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. **including collection, sorting and mechanical pre-treatment (e.g. shredding) of scrap.*
Manufacturing	• Upstreams (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 Fire refining. 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.

[7] The relevance of processes subject to cut-off was evaluated in the OEF supporting studies, available at https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production

3.5 EF Impact assessment

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

Table 3 List of 16 impact categories to be used to calculate the OEF profile.

Impact category	Indicator	Unit	Recommended default LCIA method
Climate change	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2 eq	Baseline model of 100 years of the IPCC (based on IPCC 2013)
- ~~**Climate change-biogenic**~~ [8]			
- ~~**Climate change – land use and land transformation**~~			
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 eq	Steady-state ODPs 1999 as in WMO assessment
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Human toxicity, non- cancer*	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Particulate matter	Impact on human health	disease incidence	UNEP recommended model (Fantke et al 2016)
Ionising radiation, human health	Human exposure efficiency relative to U235	kBq U^{235} eq	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOCeq	LOTOS-EUROS (Van Zelm et al, 2008) as implemented in ReCiPe
Acidification	Accumulated Exceedance (AE)	mol H+ eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P eq	EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N eq	EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe
Ecotoxicity, freshwater*	Comparative Toxic Unit for ecosystems (CTUe)	CTUe	USEtox model, (Rosenbaum et al, 2008)

[8] 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.

Impact category	Indicator	Unit	Recommended default LCIA method
Land use	• Soil quality index[9] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production[10] • kg soil • m^3 water • m^3 groundwater	• Soil quality index based on LANCA (EC-JRC)[11] • LANCA (Beck et al. 2010) • LANCA (Beck et al. 2010) • LANCA (Beck et al. 2010) • LANCA (Beck et al. 2010)
Water use⁺	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq.}$	Available WAter REmaining (AWARE) Boulay et al., 2016
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{-eq}$	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002

*****Long-term emissions (occurring beyond 100 years) shall be excluded from the toxic impact categories. Toxicity emissions to this sub-compartment have a characterisation factor set to 0 in the EF LCIA (to ensure consistency). If included by the applicant in the LCI modelling, the sub-compartment 'unspecified (long-term)' shall be used.*

⁺The results for water use might be overestimated and shall therefore be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR/OEFSR include inconsistencies in the regionalization and elementary flow implementations. This problem has nothing to do with the impact assessment method or the implementability of EF methods, but occurred during the technical development of some of the datasets. The PEFCR/OEFSR remains valid and usable. The affected EF datasets will be corrected by mid-2019. At that time it will be possible to review this PEFCR/OEFSR accordingly, if seen necessary.

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 (EC-JRC, 2017a) is available at this link http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml.

[9] This index is the result of the aggregation, performed by JRC, of the 4 indicators provided by LANCA model as indicators for land use

[10] This refers to occupation. In case of transformation the LANCA indicators are without the year (a)

[11] Forthcoming document on the update of the recommended Impact Assessment methods and factors for the EF

3.6 Limitations

In a cradle-to-gate OEF context, ADP 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 7.2).

Resource Depletion – fossil, mineral, 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[12]. 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.

3.6.1 Comparisons

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 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[13].

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

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

[13] 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.

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 7.2 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 7.2 of this OEFSR.

Comparisons of different organisations[14]

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[15].

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

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

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.

- Compare and report results both of the OEF boundaries and the Organisational boundaries
- Compare and report OEF profiles based on both EU-28 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 7.2 of this OEFSR.
- Rules for interpreting results of the OEF studies shall be followed.

Even when the above conditions are met, no comparative assertions[16] 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

[16] 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.

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
Use of primary or secondary data to model electricity	Yes	Yes

Each European copper smelter has its own specificities, related to factors listed in **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

4 Summary of most relevant impact categories, life cycle stages, processes

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

- Primary route: Resource use – mineral; climate change, particulate matter/respiratory inorganics
- Secondary route: Resource use – mineral; climate change, particulate matter/respiratory inorganics
- Integrated route: Resource use – mineral; climate change, particulate matter/respiratory inorganics

Resource Depletion – fossil, mineral, 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[17]. 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.

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

- Primary route: raw material acquisition and pre-processing; manufacturing
- Secondary route: raw material acquisition and pre-processing; manufacturing
- Integrated route: raw material acquisition and pre-processing; manufacturing

The most relevant processes and elementary flows (direct emissions) for the sector in scope of this OEFSR are the following: not applicable.

Table 5. List of the most relevant processes– Primary route

Impact category	***Processes***
Resource use - Mineral	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)
Climate change	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)
	· Energy (from life cycle stage: Manufacturing)
Particulate matter / respiratory inorganics	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)

[17] 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***
Resource use - Mineral	· Purchased anodes and blister copper (from life cycle stage: Raw material acquisition and pre-processing)
Climate change	· Purchased anodes and blister copper (from life cycle stage: Raw material acquisition and pre-processing)
	· Site Direct Activities (from life cycle stage: Manufacturing)
	· Energy (from life cycle stage: Manufacturing)
Particulate matter / respiratory inorganics	· Purchased anodes and blister copper (from life cycle stage: Raw material 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***
Resource use - Mineral	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)
	- Purchased anodes and blister copper (from life cycle stage: Raw material acquisition and pre-processing)
Climate change	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)
	- Purchased anodes and blister copper (from life cycle stage: Raw material acquisition and pre-processing)
	· Energy (from life cycle stage: Manufacturing)
Respiratory inorganics / Particulate matter	· Mining and Copper concentrate production (from life cycle stage: Raw material acquisition and pre-processing)
	- Purchased anodes and blister copper (from life cycle stage: Raw material acquisition and pre-processing)

5 Life cycle inventory

All newly created processes shall be EF-compliant.

5.1 List of mandatory company-specific data

. Mandatory activity data to be collected are:

- 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. 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 Guidance 6.3 shall be applied (Par 7.14.2."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

<u>Process: Site direct activities</u>

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 products (work in progress);

- 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)
- 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);
- GHG inventory calculations and reports under EU Emission Trading Scheme (ETS);
- 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);
- Reports on waste;
- 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[18].
- 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

[18] 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).

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– Life Cycle Inventory". Sub-processes and activity data not listed in the Annex "Copper OEFSR_3.0 - Life Cycle Inventory" and belonging within the Organisational boundaries needed to produce the Product 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[19].

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 5.6 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_3.0 - 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.

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

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. 5.9 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_3.0 - 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***	***Default DQR***
High quality (Copper /copper alloy scrap)	Yearly	*kg*	*EU-28+EFTA Recycling of copper from clean scrap*	http://lcdn.thinkstep.com/Node/	*23a1a30f-e160-45bd-b586-ce56e46d4537*	*2*
Medium quality (Shredder material)	Yearly	*kg*	*EU-28+EFTA Recycling of copper from clean scrap*	http://lcdn.thinkstep.com/Node/	*23a1a30f-e160-45bd-b586-ce56e46d4537*	*2*
Low quality (Electronic scrap and	Yearly	*kg*	*EU-28+EFTA Recycling of copper from clean*	http://lcdn.thinkstep.com/Node/	*23a1a30f-e160-45bd-b586-ce56e46d4*	*2*

residues)			*scrap*		*537*	
Very low quality (Waste / residues)	Yearly	*kg*	*EU-28+EFTA Recycling of copper from clean scrap*	http://lcdn.thinkstep.com/Node/	*23a1a30f-e160-45bd-b586-ce56e46d4537*	*2*
Oxygen	Yearly	*kg*	*Not applicable (produced internally - included in electricity)*	-	-	-
Fuel (Oil, natural gas, ..)	Yearly	*kg*	*EU-28+3 Heavy fuel oil at refinery*	http://lcdn.thinkstep.com/Node/	*ccd71a68-0fd9-4104-ad2c-6caedd1c4228*	*1.5*
Steam (including for heating of buildings)	Yearly	*MJ*	*EU-28+3 Process steam from natural gas*	http://lcdn.thinkstep.com/Node/	*2e8bee44-f13b-4622-9af3-74954af8acea*	*1.5*
Electricity (including for oxygen production)	Yearly	*kWh*	*Electricity grid mix 1kV-60kV*	http://lcdn.thinkstep.com/Node/	*34960d4d-af62-43a0-aa76-adc5fcf57246*	*1.5*

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*	-	-	-

Elementary flows to assess the land use impact category shall be collected: they are not listed below, as they are related to the whole site and not specifically to a uniqe metallurgical operation. Both “transformation” and “occupation” type of elementary flows shall be collected, considering the area occupied by the site, roads, etc.

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_3.0 - Life Cycle Inventory.

Emissions/resources	***Elementary flow***	***Frequency of measurement***	***Default measurement method***[20]	***Remarks***
Emissions to air			Measurement requirements of emissions are described in the main text in this section.	

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

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		
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		

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– 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. 5.9 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_3.0 - 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***	***Default 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	yearly	*kWh*	*Electricity grid mix 1kV-60kV*	*http://lcdn.thinkstep.com/Node/*	*34960d4d-af62-43a0-aa76-adc5fcf57246*	*1.5*

Fuels	Yearly	*kg*	EU-28+3 Heavy fuel oil at refinery	http://lcdn.thinkstep.com/Node/	ccd71a68-0fd9-4104-ad2c-6caedd1c4228	*1.5*
Explosives	Yearly	*kg*	*Data gap*			
In-situ Ore	Yearly	*kg*	*Elementary flow*			
Steel for rock bolting	Yearly	*kg*	EU-28+EFTA Steel cast part alloyed	http://lcdn.thinkstep.com/Node/	366a0afd-88e4-45dc-999a-8acc20fd0ead	*2.6*
Concrete	Yearly	*kg*	Concrete C20/25 (Ready-mix concrete) technology mix production mix, at plant C20/25	http://lcdn.thinkstep.com/Node/	0b1047d1-87c5-4ada-8a1f-dc1222b78d5d	
Sand	Yearly	*kg*	RER silica sand production	http://ecoinvent.lca-data.com/	573168e4-8f9e-46a3-a684-6187deeea33d	
Tires	Yearly	*kg*	*Follow rules in section 5.6*			

Oils and lubricants	Yearly	*kg*	*Follow rules in section 5.6*			
Outputs						
Mined ore	Yearly	*Kg*	*Internal flow*			
Waste rock	Yearly	*Kg*	*Follow rules in section 5.6*			
Overburden	Yearly	*Kg*	*Follow rules in section 5.6*			*Applicable for underground mine*
Other waste	Yearly	*Kg*	*Follow rules in section 5.6*			*Applicable for open pit mine*
Salt (NaCl)	Yearly	*kg*	*Follow rules in section 5.6*			
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_3.0 - Life Cycle Inventory".

Emissions/resources	Elementary flow	Frequency of measurement	Default measurement method[21]	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		
As	256c7700-d975-4e38-b8cf-baa4cd9a2a9b	Yearly		
Cd	08a91e70-3ddc-11dd-	Yearly		

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

	9674-0050c2490048			
Pb	4d9a8790-3ddd-11dd-91dc-0050c2490048	Yearly		
Hg	fe0acd60-3ddc-11dd-a8c4-0050c2490048	Yearly		

See excel file named "Copper OEFSR_3.0 - Life Cycle Inventory" for the list of all processes and sub-processes to be expected in situation 1.

5.3 Data gaps

- Purchased blister copper. Own produced blister copper may be used as a proxy also for externally supplied blister copper[22]: 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.

- Natural gas mix. There is currently no EF-compliant dataset for natural gas, therefore the ILCD-compliant proxy shall be used, until an EF-compliant dataset is available (EU-27 Natural gas mix; uuid: ab21687e-9afb-45e4-b789-6700543038c1). Details are available in the Excel file “Copper OEFSR_3.0 - Life Cycle Inventory”).

- Electrodes (no proxy currently available).

Proxies to fill in data gaps may also be found in the Excel file “Copper OEFSR - Life Cycle Inventory” in the “remarks” column.

[22] In case blister copper and anodes used to produce copper cathodes are produced by the organisation, data shall be collected following rules under “Site Direct Activities” and the data collection template available in the *excel file named* "[Copper OEFSR – Life Cycle Inventory], filled in only for those sub-processes which are needed to produce blister copper and copper anodes

5.4 Data quality requirements

In this section the applicant of the OEFSR finds data quality requirements for mandatory processes (chapter 5.4.1), processes in situation 1 (chapter 5.5.1), processes in situation 2 (chapter 5.5.2) and processes in situation 3 (chapter 5.5.3).

- 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:

$$DQR = \frac{TeR+GR+TiR+P}{4}$$ [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.

5.4.1 Company-specific datasets

The score of criterion P cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (the DQR score shall be ≤1.6). 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 sub-processes and direct elementary flows 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.

2) Calculate the DQR criteria TeR, TiR, GR and P for each most relevant process and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table 12.

2.a) Each most relevant elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, evaluate the 4 DQR criteria named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF} in Table 12. It shall be evaluated for example, the timing of the flow measured, for which technology the flow was measured and in which geographical area.

2.b) Each most relevant process is a combination of activity data and the secondary dataset used. For each most relevant process, the DQR is calculated by the applicant of the PEFCR *as a combination of the 4 DQR criteria for activity data and the secondary dataset: (i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}) and (ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary dataset used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}SD}$ and $G_{R\text{-}SD}$). As Ti_R is evaluated twice, the mathematical average of $Ti_{R\text{-}AD}$ and $Ti_{R\text{-}SD}$ represents the Ti_R of the most relevant process.*

3) Calculate the environmental contribution of each most-relevant process and elementary flow to the total environmental impact of all most-relevant processes and elementary flows, in % (weighted using 13 EF impact categories, with the exclusion of the 3 toxicity-related ones). For example, the newly developed dataset has only two most relevant processes, contributing in total to 80% of the total environmental impact of the dataset:

- *Process 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).*
- *Process 1 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 Te_R, Ti_R, G_R and P criteria of the newly developed dataset as the weighted average of each criterion of the most relevant processes and direct elementary flows. The weight is the relative contribution (in %) of each most relevant process and direct elementary flow calculated in step 3.

5) The applicant of the PEFCR shall the total DQR of the newly developed dataset using the equation B.2, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ are the weighted average calculated as specified in point 4).

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

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 parameter for the processes for which company specific values are used.

	P_{EF} and P_{AD}	Ti_{R-EF} and Ti_{R-AD}	Ti_{R-SD}	Te_{R-EF} and Te_{R-SD}	G_{R-EF} and G_{R-SD}
1	*Measured/calculated <u>and</u> externally verified*	*The data refers to < = 3 years old*	*The EF report publication date happens within the time validity of the dataset*	*The elementary flows and the secondary dataset reflect exactly the technology of the newly developed dataset*	*The data(set) 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 3-5 years old*	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The elementary flows and the secondary dataset is a proxy of the technology of the newly developed dataset*	*The data(set) 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 5-10 years old*	*Not applicable*	*Not applicable*	*Not applicable*
4-5	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

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.

5.5 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific shall be evaluated using the DNM (see ***Error! Reference source not found.***

Table 14. How to assign the values *to* parameters in the DQR formula when secondary datasets are used.*). The DNM shall be used by the OEFSR applicant to evaluate which data is needed and shall be used within the modelling of its OEF, depending on the level of influence the applicant (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)[23]. *Disaggregated datasets shall be used

Situation	Option	Most relevant process	Other process
Situation 1: process run by the company applying the OEFSR	Option 1	Provide company-specific data (as requested in the OEFSR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criteria + total)	
	Option 2		Use default secondary dataset in OEFSR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process not run by the company applying the OEFSR but with access to (company-)specific information	Option 1	Provide company-specific data (as requested in the OEFSR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criteria + total)	
	Option 2	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	
	Option 3		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). Re-evaluate the DQR criteria within the product specific context
Situation 3: process not run by the company applying the OEFSR and without access to (company)-specific information	Option 1	Use default secondary dataset, in aggregated form (DQR ≤3.0). Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary dataset in OEFSR, in aggregated form (DQR ≤4.0) Use the default DQR values

5.5.1 Processes in situation 1

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

- *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);*

[23] The options described in the DNM are not listed in order of preference

- *The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 2).*

<u>Situation 1/Option 1</u>

For all processes run by the company and where the company applying the PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section 5.4.1.

Situation 1/Option 2

For the non-most relevant processes only, if the applicant decides to model the process without collecting company-specific data, then the applicant 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 applicant of the OEFSR shall take the DQR values from the metadata of the original dataset.

5.5.2 Processes in situation 2

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

- *The company applying the OEFSR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[24] (Option 1);*
- *The company has some supplier-specific information and want to make some minimum changes (Option 2).*
- *The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 3).*

Situation 2/Option 1

For all processes run by the company and where the company applying the OEFSR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section *5.4.1*.

<u>Situation 2/Option 2</u>

Company-specific activity data for transport are used and the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets are substituted 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.

[24] The review of the newly created dataset is optional

The applicant of the OEFSR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R and Ti_R, using the table(s) provided. The criteria G_R shall be lowered by 30%[25] and the criteria P shall keep the original value.

Situation 2/Option 3

Company-specific activity data for transport are used and the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets are substituted starting from the default secondary dataset provided in the OEFSR.

In this case, the applicant of the OEFSR shall recalculate the DQR for the processes by taking the DQR values from the dataset and lowering the parameter G_R by 30%.

Table 14. How to assign the values to parameters in the DQR formula when secondary datasets are used.

	TiR	***TeR***	***G_R***
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 **Error! Reference source not found.** substitute the criteria provided inTable 14.

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

[25] In situation 2, option 2 it is proposed to lower the parameter G_R by 30% in order to incentivize 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.

	TiR	*TeR*	*GR*[26]
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.*

5.5.3 Processes in situation 3

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

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[26] 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 in the list of most relevant processes (situation 3, option 1)*
- *It is not in the list of most relevant processes (situation 3, option 2)*

Situation 3/Option 1

In this case, the applicant of the OEFSR shall make the DQR values of the dataset context-specific by re-evaluating Te_R, Ti_R and G_r using the table(s) provided. The criteria P shall keep the original value.

Situation 3/Option 2

For the non-most relevant processes, the applicant shall use 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 applicant of the OEFSR shall take the DQR values from the metadata of the original dataset.

5.6 Which datasets to use?

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*
  - *https://lcdn.quantis-software.com/PEF/*
  - *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.*

5.7 How to calculate the average DQR of the study

In order to calculate the average DQR of the EF study, the applicant shall calculate separately the TeR, TiR, GR and P for the EF study as the weighted average of all most relevant processes, based on their relative environmental contribution to the total single score (excluding the 3 toxicity-related ones). The calculation rules explained in chapter 5.4 shall be used.

5.8 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 (e.g. using dataset EU-28+3 Process steam from natural gas; UUID 2e8bee44-f13b-4622-9af3-74954af8acea), see process M10 in Excel file "OEFSR Copper – Life Cycle Inventory"

5.9 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:

(i) Supplier-specific electricity product shall be used if:
- *(a) available, and*
- *(b) the set of minimum criteria to ensure the contractual instruments are reliable is met.*

(ii) The supplier-specific total electricity mix shall be used if:
- *(a) available, and*
- *(b) the set of minimum criteria that to ensure the contractual instruments are reliable is met.*

(iii) *As a last option the 'country-specific residual grid mix, consumption mix' shall be used (available at http://lcdn.thinkstep.com/Node/). Country-specific means the country in which the life cycle stage occurs. This may be an EU country or non-EU country. The residual grid mix characterizes the unclaimed, untracked or publicly shared electricity. This prevents double counting with the use of supplier-specific electricity mixes in (i) and (ii).*

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 minimal criteria to ensure contractual instruments from suppliers:

A supplier-specific electricity product/mix may only be used when the applicant ensures that any contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then 'country-specific residual grid mix, consumption mix' shall be used in the modelling.

A contractual instrument used for electricity modelling shall:

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 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.*
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).*
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, per energy type, per country and per voltage have been purchased by the European Commission and are available in the dedicated node (http://lcdn.thinkstep.com/Node/).

In case the necessary dataset is not available, an alternative dataset shall be chosen according to the procedure described in section above. If no dataset is available, the following approach may 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 combined 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*
    - *Distribution losses*
    - *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).
- *Available LCI datasets per fuel technologies in the node. The LCI datasets available are generally specific to a country or a region in terms of:*
    - *Fuel supply (share of resources used, by import and / or domestic supply),*
    - *Energy carrier properties (e.g. element and energy contents)*
    - *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.

On-site electricity generation:

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

- *No contractual instruments have been sold to a third party: the own electricity mix (combined with LCI datasets) shall be modelled.*
- *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 can be seen as a multifunctional situation. The system will provide two functions (e.g. product + electricity) and the following rules shall be followed:

- *If possible, apply subdivision.*
- *Subdivision applies both to separate electricity productions or to a common electricity production where you can 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 wind mill on its production site and export 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the OEF study.*
- *If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[27].*
- *Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.*

5.10 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 (CO_2, CO and CH_4) 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 the foreground emissions. Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. When 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 of each product of the product portfolio (physical content and allocated content) shall be reported as 'additional technical information'.

3. C*limate change – land use and land transformation: This sub-category accounts for carbon uptakes and emissions (CO_2, CO and CH_4) originating from carbon stock changes caused by*

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

[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.

land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (incl. 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 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:

[29] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2).

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

- *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 be modelled, calculated and reported as additional environmental information: NO.

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

The sub-category 'Climate change-biogenic' shall be reported separately: NO

The sub-category 'Climate change-land use and land transformation' shall be reported separately: NO

5.11 Modelling of wastes and recycled content

The waste 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 gives guidelines on how to model the End-of-Life of products as well as the recycled content.

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

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 shqll be set to zero for all OEF studies.*

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

Qs_{out}: *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.*

***EER:** specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …).*

$E_{SE,heat}$ 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.*

<u>How to apply the Circular Footprint Formula in an OEF context</u>

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 Guidance 6.3 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 5). 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_3.0 - Life Cycle Inventory):
    - Secondary blister (Erec) – Primary blister (Ev)
    - Copper scrap (Erec) – Primary blister (Ev)
  - Electrolysis (sub-process M11 in Excel file "Copper OEFSR_3.0 - 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	*EU-28+EFTA Recycling of copper from clean scrap*
Secondary Blister copper	1	1	1	*Check data gap procedure (Chapter 5.3)*
Secondary Copper anodes	1	1	1	*Check. data gap procedure (Chapter 5.3)*

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 7.2):

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_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:

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

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

Table 18 Raw material acquisition and processing

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*	*GLO Copper Concentrate (Mining, mix technologies)*	*http://lcdn.thinkstep.com/Node/*	*beacade4-7521-4844-a79d-1872414284 2f*	*2*	*1*	*3*	*1*	*Y*
Copper scrap	*ton*	*1*	*Company specific*	*EU-28+EFTA Recycling of copper from*	*http://lcdn.thinkstep.com/Node/*	*23a1a30f-e160-45bd-b586-ce56e*	*2*	*2*	*2*	*2*	*N*

				clean scrap		*46d45 37*					
PURCHASED ANODES AND BLISTER	*ton*	*0*	*Company specific*	*See rules at chapter 5.3*							*Y*

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

The applicant shall report the DQR for all the datasets used for the most relevant processes, the new ones created, and other processes in situation 1 of the DNM.

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_3.0 - Life Cycle Inventory". The user shall check and adapt the utilisation factor.

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 Guidance 6.3 shall be applied (Par 7.14.2. ”From supplier to factory”)

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_Life Cycle Inventory) and an example is given in Table 19.

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

- Rules at chapter 5.9 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 19 . Manufacturing – Example. Full list available in Excel file "Copper OEFSR_Life Cycle Inventory"

Process name	***Unit of measurement (output)***	***Default amount per RU***	***Default dataset***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant process [Y/N]***
						P	*TiR*	*GR*	*TeR*	
Site Direct Activities	*Product Portfolio*	*Company specific*	*Mandatory company-specific data*	-	-	-	-	-	-	*Y*
Electricity	*kWh*	*Company specific (as specified in the process "Site Direct Activities)*	*Electricity grid mix 1kV-60kV*	*http://lcdn.thinkstep.com/Node/*	*34960d4d-af62-43a0-aa76-adc5fcf57246*	*2*	*1*	*1*	*1*	*Y*
Check Excel file "Copper OEFSR Life Cycel Inventory" for full list										

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

7 OEF results

7.1 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-28 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 Guidance 6.3 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.

7.2 Additional technical information

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- *The recycled content (R_1) shall be reported.*
- *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

   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.

2) In addition to the OEF profile calculated using the default requirements for electricity modelling, the OEF profile shall also be calculated using the EU-28 electricity grid mix, related to electricity used as input to the organization (i.e. electricity activity data in excel file “Copper OEFSR - 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.

3) Potential impacts associated to fugitive emissions, if this information is available, shall be calculated and reported separately.

Recommended Additional technical information

1) 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 Guidance 6.3.

- 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 Guidance 6.3 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 5). 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_3.0 - Life Cycle Inventory):
            - Secondary blister (Erec) – Primary blister (Ev)
            - Copper scrap (Erec) – Primary blister (Ev)
        - ▪ Electrolysis (M11 in Excel file "Copper OEFSR_3.0 - 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; copper scrap smelting and refining; single route, at plant; 8.92 g/cm3 (uuid: 08ee08dd-1eaf-4f99-8af4-4acc8bf32ef2).[31]
- The dataset to be used to model E*v is: primary copper cathode (664b08b1-9025-4d25-acab-eb138575848f). This is a gate-to-gate process to be complemented with GLO copper concentrate (Mining, mix technologies) (uuid: beacade4-7521-4844-a79d-18724142842f)).
- The datasets to model Ed (landfilling) are available at: http://lcdn.thinkstep.com/Node/.
- 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.

[31] The dataset cannot be currently used, because it is modelled using the previous 50-50 EoL formula, described in the Annex V of the OEF Guide. The modeling of the EoL of copper cathode, will therefore be possible only when the dataset will be corrected following requirements in line with the application of the Circular Footprint Formula (CFF).

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.

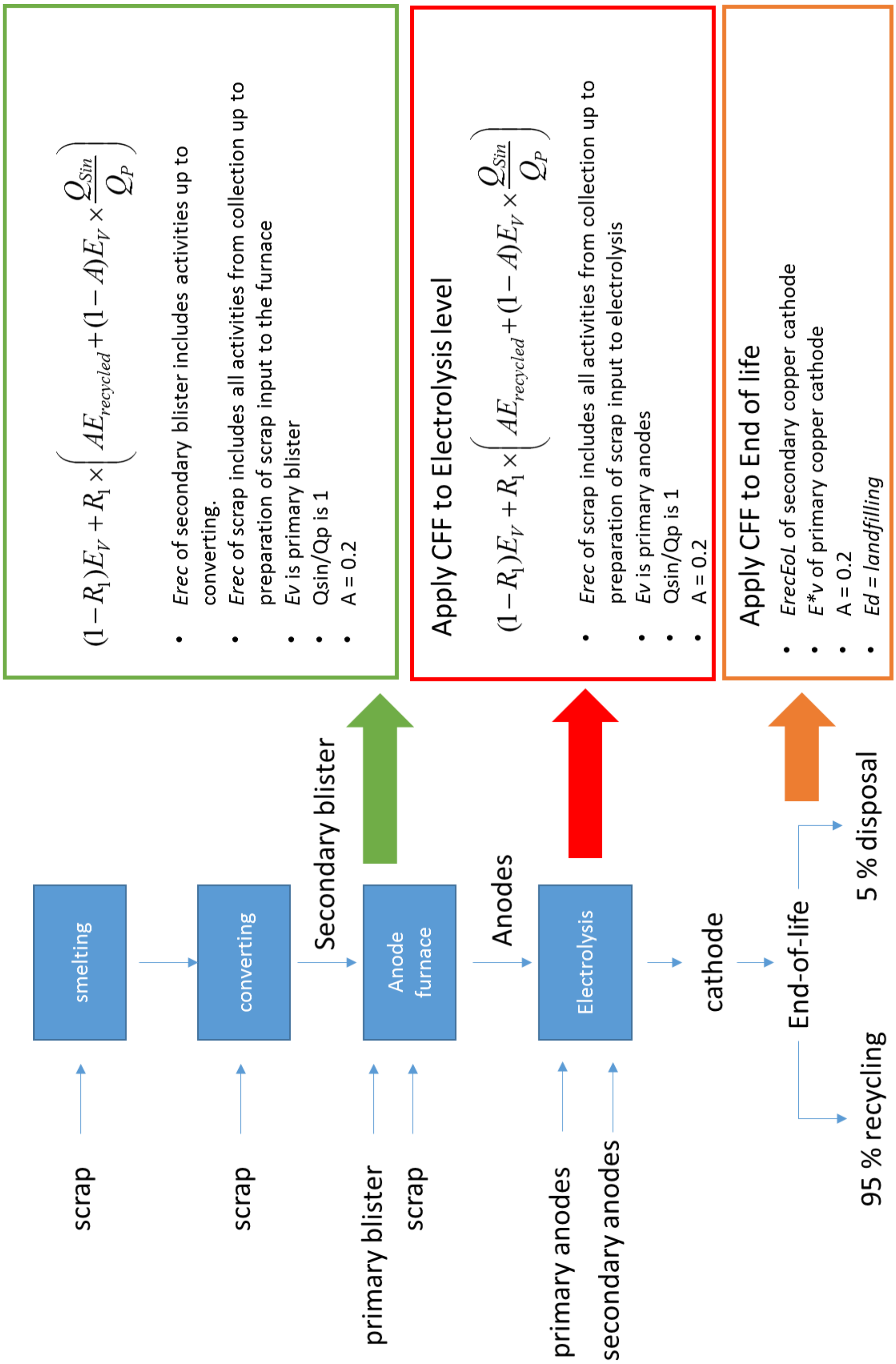

Figure 5 Example on how to model virgin and secondary input in the CFF when calculating the profile of copper cathode for Additional Environmental Information, using Option 1 (Recommended in this OEFSR).

- Anode level: model primary and secondary flows, as in **Figure 6**

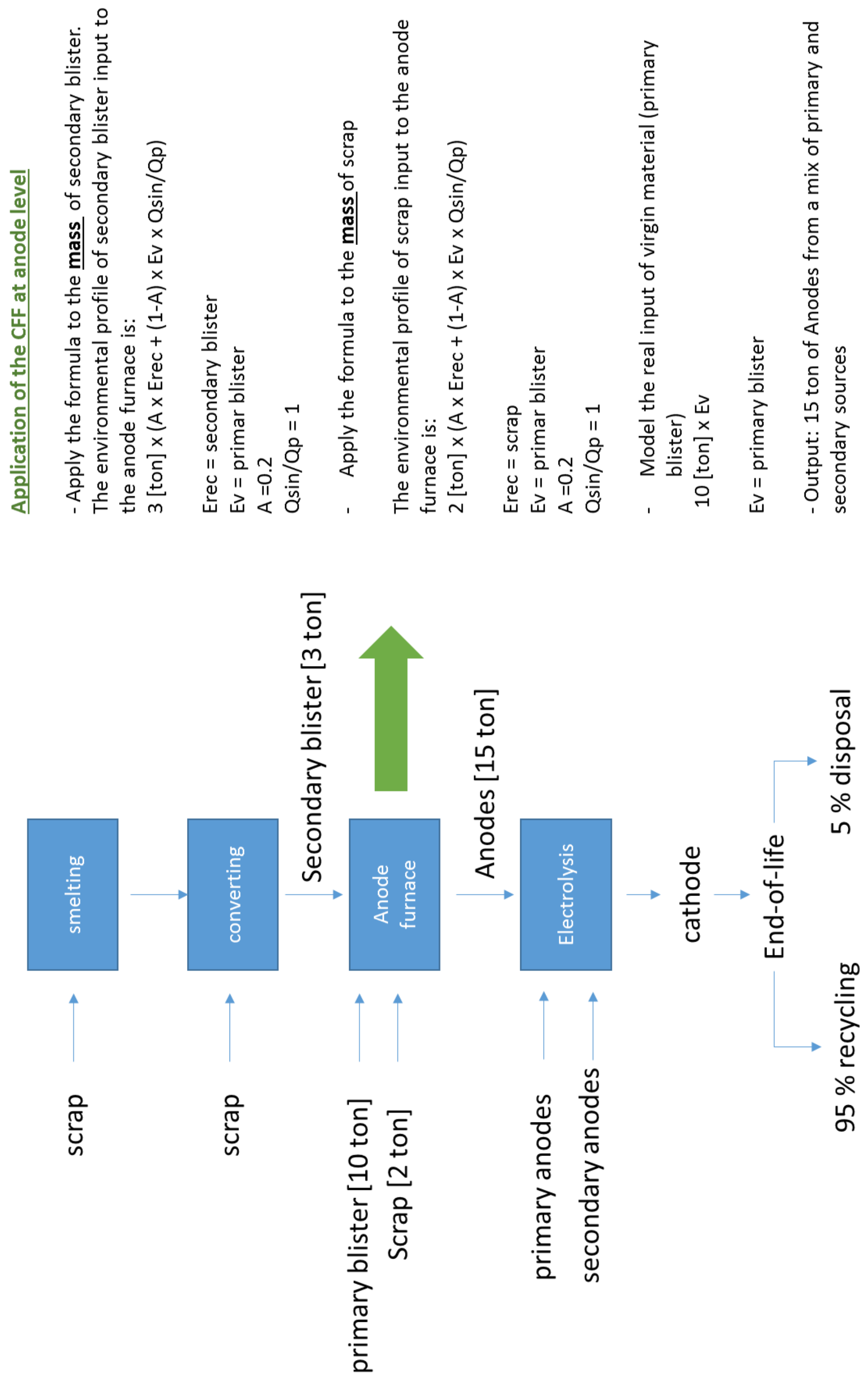

Figure 6 –Example of application of the CFF to Anode level.

- Electrolysis: model primary and secondary flows, as in **Figure 7**

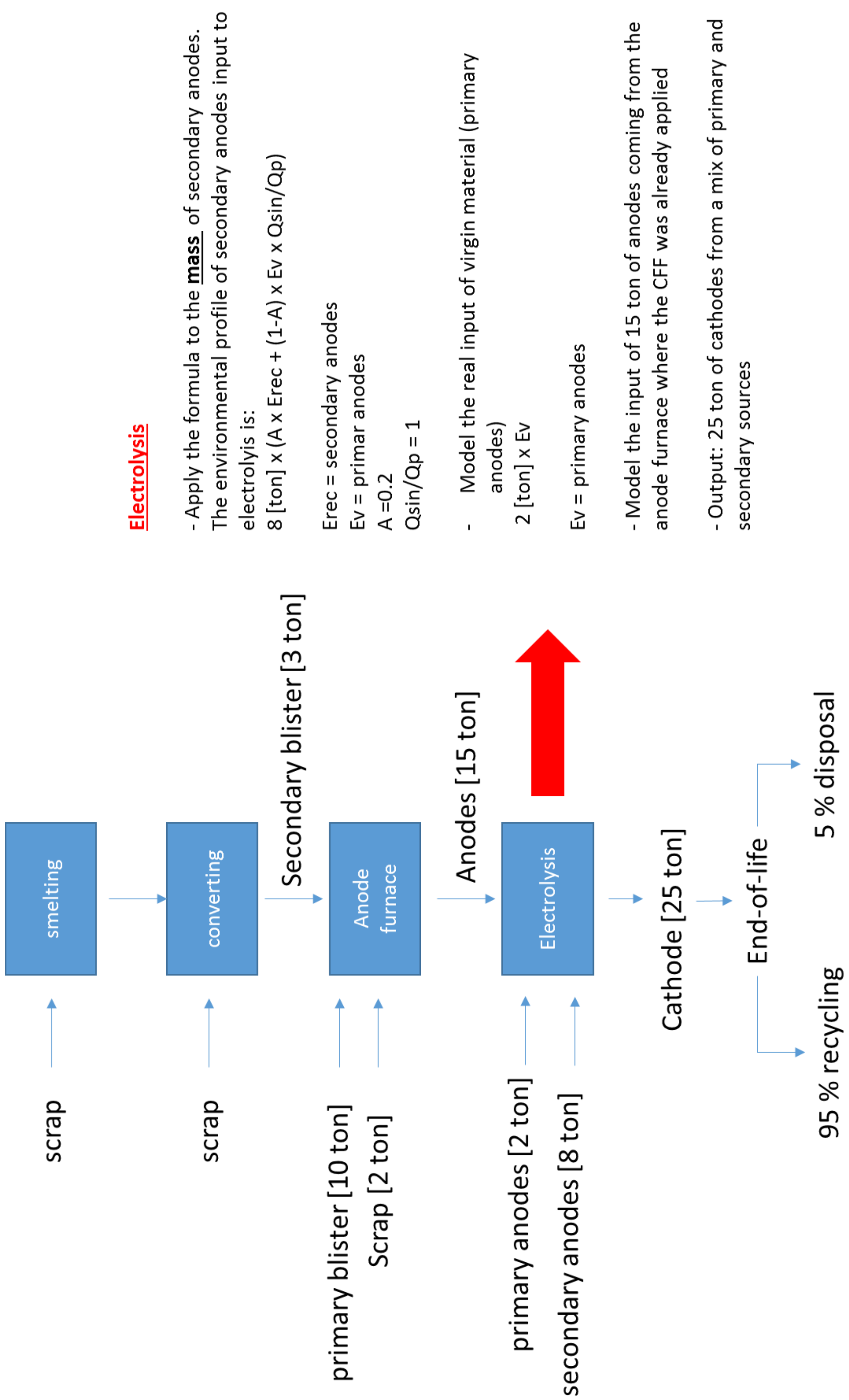

Figure 7 – Example of application of the CFF to Electrolysis.

- End of life: model as in **Figure 8**

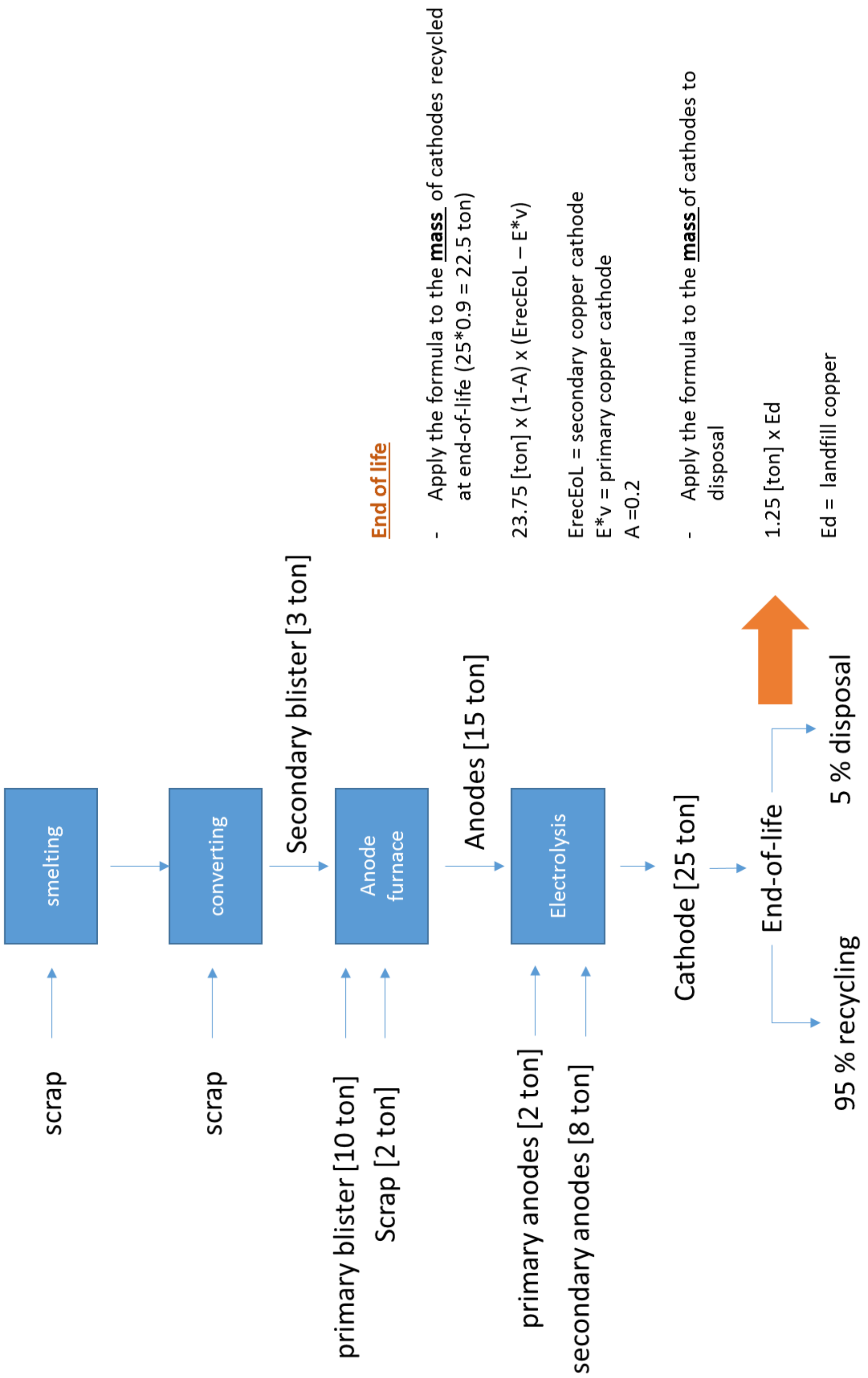

Figure 8 – Example of application of the CFF to End-of-Life.

7.3 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).

8 Verification

The verification of an EF study/report carried out in compliance with this OEFSR shall be done according to all the general requirements included in Section 8 of the latest version of the OEFSR Guidance and the requirements listed below.
The verifier(s) shall verify that the EF study is conducted in compliance with the most recent version of this OEFSR.
These requirements will remain valid until an EF verification scheme is adopted at European level or alternative verification approaches applicable to EF studies/report are included in existing or new policies.

8.1 Specific requirements for the verification

The verification of an EF study/report carried out in compliance with this OEFSR shall be done according to all the general requirements included in Section 8 of the OEFSR Guidance [enter version number] *and the requirements listed below.*

The verifier(s) shall verify that the EF study is conducted in compliance with this OEFSR.
These requirements will remain valid until an EF verification scheme is adopted at European level or alternative verification approaches applicable to EF studies/report are included in existing or new policies.

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:

- *the verifier shall check if the correct version of all impact assessment methods was used. For each of the most relevant impact categories, at least 50% of the characterisation factors (for each of the most relevant EF impact categories) shall be verified, while all normalisation and weighting factors of all ICs shall be verified. In particular, the verifier shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with[32];*
- *all the newly created datasets shall be checked on their EF compliancy (for the meaning of EF compliant datasets refer to Annex H of the Guidance). All their underlying data (elementary flows, activity data and sub processes) shall be validated;*
- *for at least 70% of the most relevant processes in situation 2 option 2 of the DNM, 70% of the underlying data shall be validated. The 70% data shall including all energy and transport sub processes for those in situation 2 option 2;*
- *for at least 60% of the most relevant processes in situation 3 of the DNM, 60% of the underlying data shall be validated;*
- *for at least 50% of the other processes in situation 1, 2 and 3 of the DNM, 50% of the underlying data shall be validated.*
- 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 OEFSR Guidance 6.3 to evaluate hotspots, most relevant life cycle stages, processes and elementary flows.
- 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_3.0 - Life Cycle Inventory”. Sub-processes and activity data not listed in the Annex “Copper OEFSR_3.0 - Life Cycle Inventory” and belonging within the Organisational boundaries needed to produce the Product 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, it shall be verified for the selected processes if the DQR of the process satisfies the minimum DQR as specified in the DNM.

The selection of the processes to be verified for each situation shall be done ordering them from the most contributing to the less contributing one and selecting those contributing up to the identified percentage starting from the most contributing ones. In case of non-integer numbers, the rounding shall be made always considering the next upper integer.

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

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

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 possible subject of check.

The verification of the EF report shall be carried out by randomly checking enough information to provide reasonable assurance that the EF report fulfils all the conditions listed in section 8 of the OEFSR Guidance.

9 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 Commission (2013). "Annex III: Organisation Environmental Footprint (OEF) Guide to the Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (2013/179/EU)."

- European Commission, DG Environment (2018) Organisation Environmental Footprint Sector Rules Guidance – version 6.3.

- 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. https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production
- 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. https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+OEFSR+pilot+Copper+production
- 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	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Climate change	kg CO_2 eq	5.35E+13	7.76E+03	I	II	I	
Ozone depletion	kg CFC-11 eq	1.61E+08	2.34E-02	I	III	II	
Human toxicity, cancer	CTUh	2.66E+05	3.85E-05	II/III	III	III	
Human toxicity, non-cancer	CTUh	3.27E+06	4.75E-04	II/III	III	III	
Particulate matter	disease incidence	4.39E+06	6.37E-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, human health	kBq U^{235} eq	2.91E+13	4.22E+03	II	II	III	
Photochemical ozone formation, human health	kg NMVOC eq	2.80E+11	4.06E+01	II	III	I/II	
Acidification	mol H+ eq	3.83E+11	5.55E+01	II	II	I/II	
Eutrophication, terrestrial	mol N eq	1.22E+12	1.77E+02	II	II	I/II	
Eutrophication, freshwater	kg P eq	1.76E+10	2.55E+00	II	II	III	

Eutrophication, marine	kg N eq	1.95E+11	2.83E+01	II	II	II/III	
Land use	pt	9.20E+15	1.33E+06	III	II	I I	The NF is built by means of regionalised CFs.
Ecotoxicity, freshwater	CTUe	8.15E+13	1.18E+04	II/III	III	III	
Water use	m^3 world eq	7.91E+13	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
Resource use, fossils	MJ	4.50E+14	6.53E+04	III	I	II	
Resource use, minerals and metals	kg Sb eq	3.99E+08	5.79E-02	III			

Weighting factors for Environmental Footprint

	Aggregated weighting set	Robustness factors	Calculation	**Final weighting factors**
	(50:50)	(scale 1-0.1)		
WITHOUT TOX CATEGORIES	A	B	C=A*B	C scaled to 100
Climate change	15.75	0.87	13.65	**22.19**
Ozone depletion	6.92	0.6	4.15	**6.75**
Particulate matter	6.77	0.87	5.87	**9.54**
Ionizing radiation, human health	7.07	0.47	3.3	**5.37**
Photochemical ozone formation, human health	5.88	0.53	3.14	**5.1**
Acidification	6.13	0.67	4.08	**6.64**
Eutrophication, terrestrial	3.61	0.67	2.4	**3.91**
Eutrophication, freshwater	3.88	0.47	1.81	**2.95**
Eutrophication, marine	3.59	0.53	1.92	**3.12**
Land use	11.1	0.47	5.18	**8.42**
Water use	11.89	0.47	5.55	**9.03**
Resource use, minerals and metals	8.28	0.6	4.97	**8.08**
Resource use, fossils	9.14	0.6	5.48	**8.92**

ANNEX 2 – Check-list for the OEF study

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 - Critical review report of the OEFSR

Excel File "OEFSR copper review – FINAL_Panel" – Available at: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

ANNEX 4 – Excel file "Copper OEFSR_3.0 - Life Cycle Inventory"

Excel file "Copper OEFSR_3.0 – *Life Cycle Inventory*" - Available at: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

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).

Possible way forward

According to the current LCA practice, depletion of resources[33] 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 tecnosphere, 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 tecnosphere. 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 tecnosphere.

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

[33] *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.

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

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

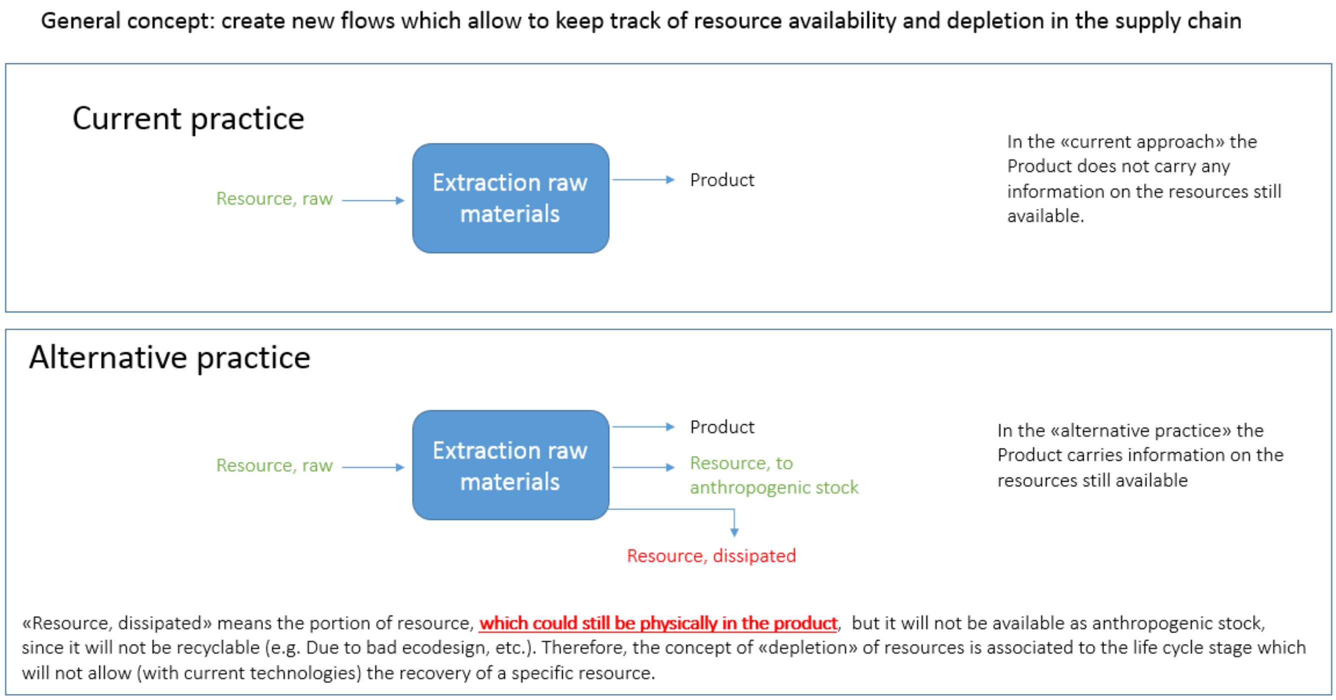

Figure 9 Resource Depletion: possible way forward. Re-thinking the Life Cycle Inventory

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[34].

[34] 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

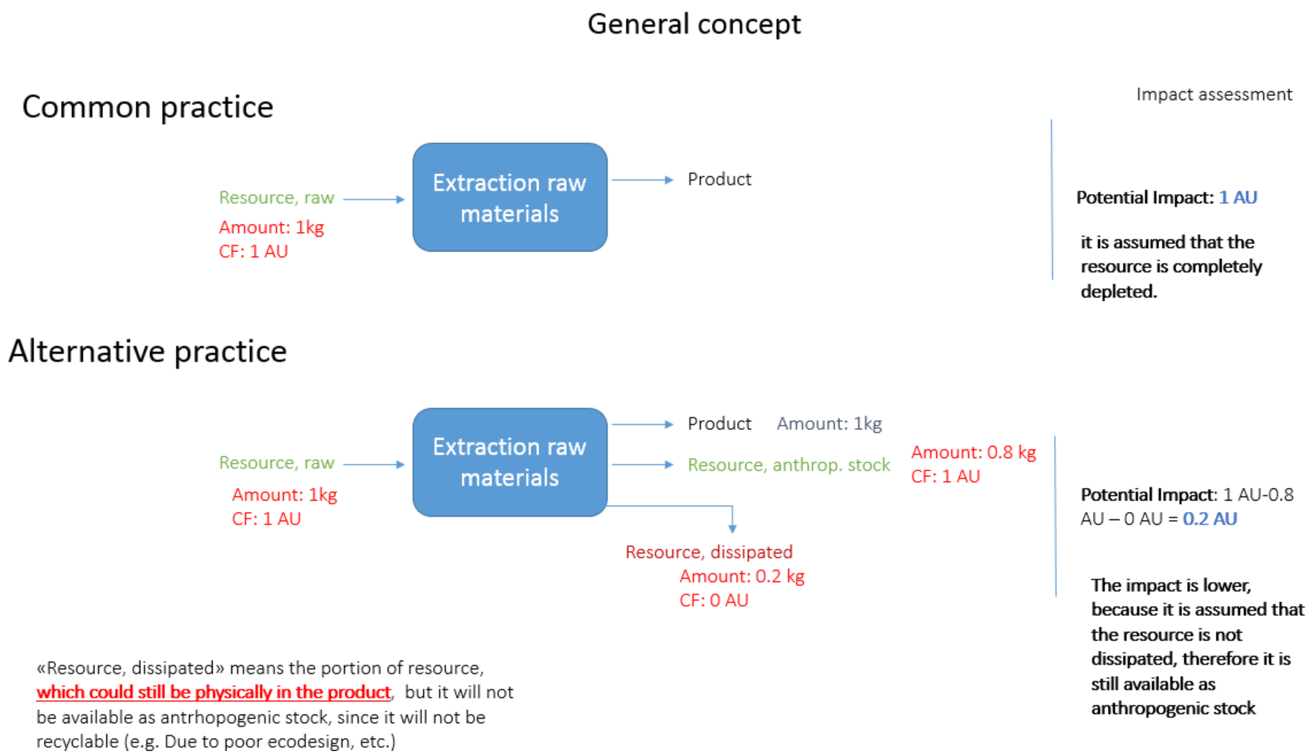

Figure 10 Resource Depletion: possible way forward. Characterization factors to be associated to the newly created flows.

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.

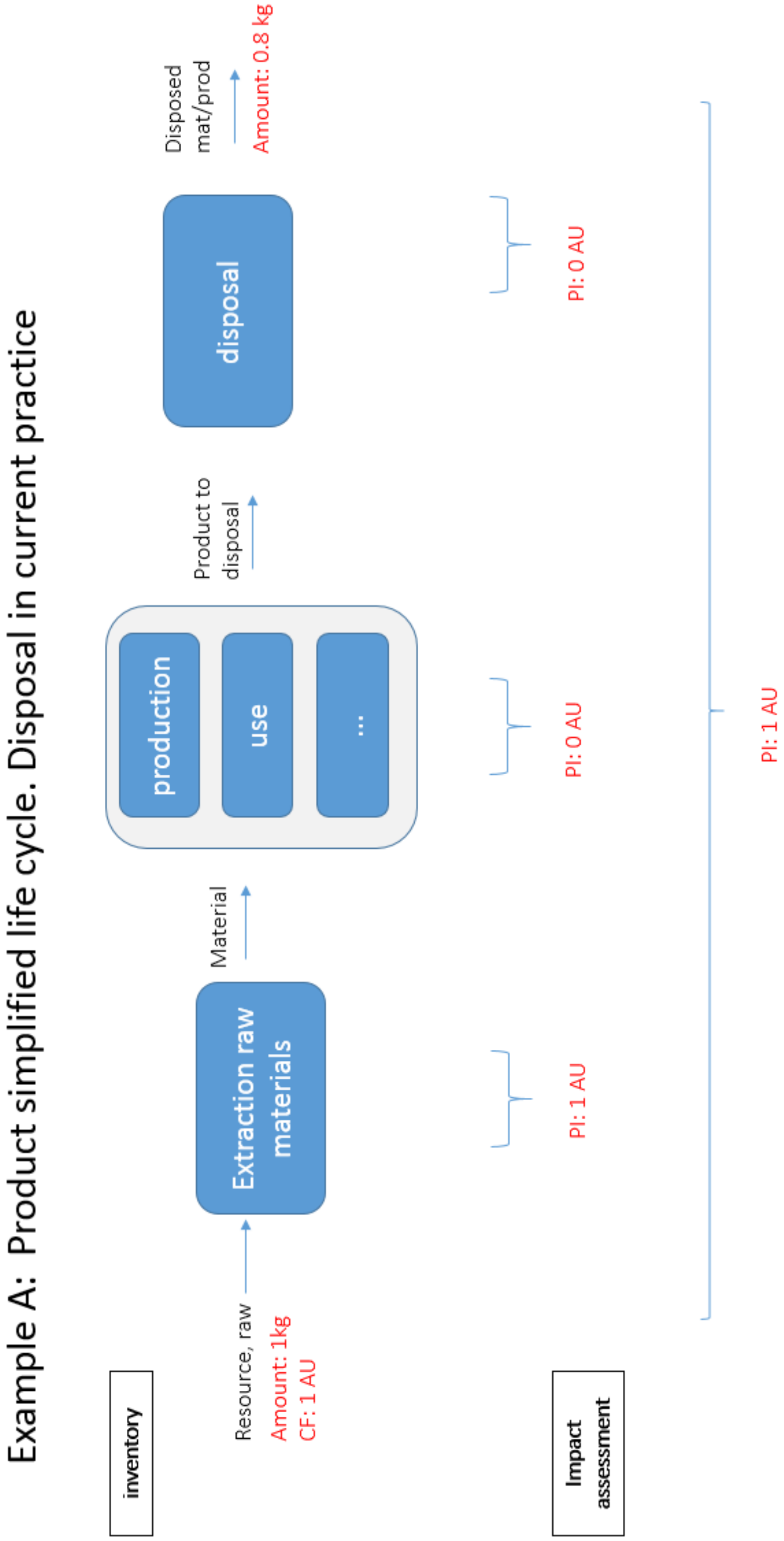

Figure 11 Resource Depletion: possible way forward. Example of a full life cycle in the current practice. Disposal.

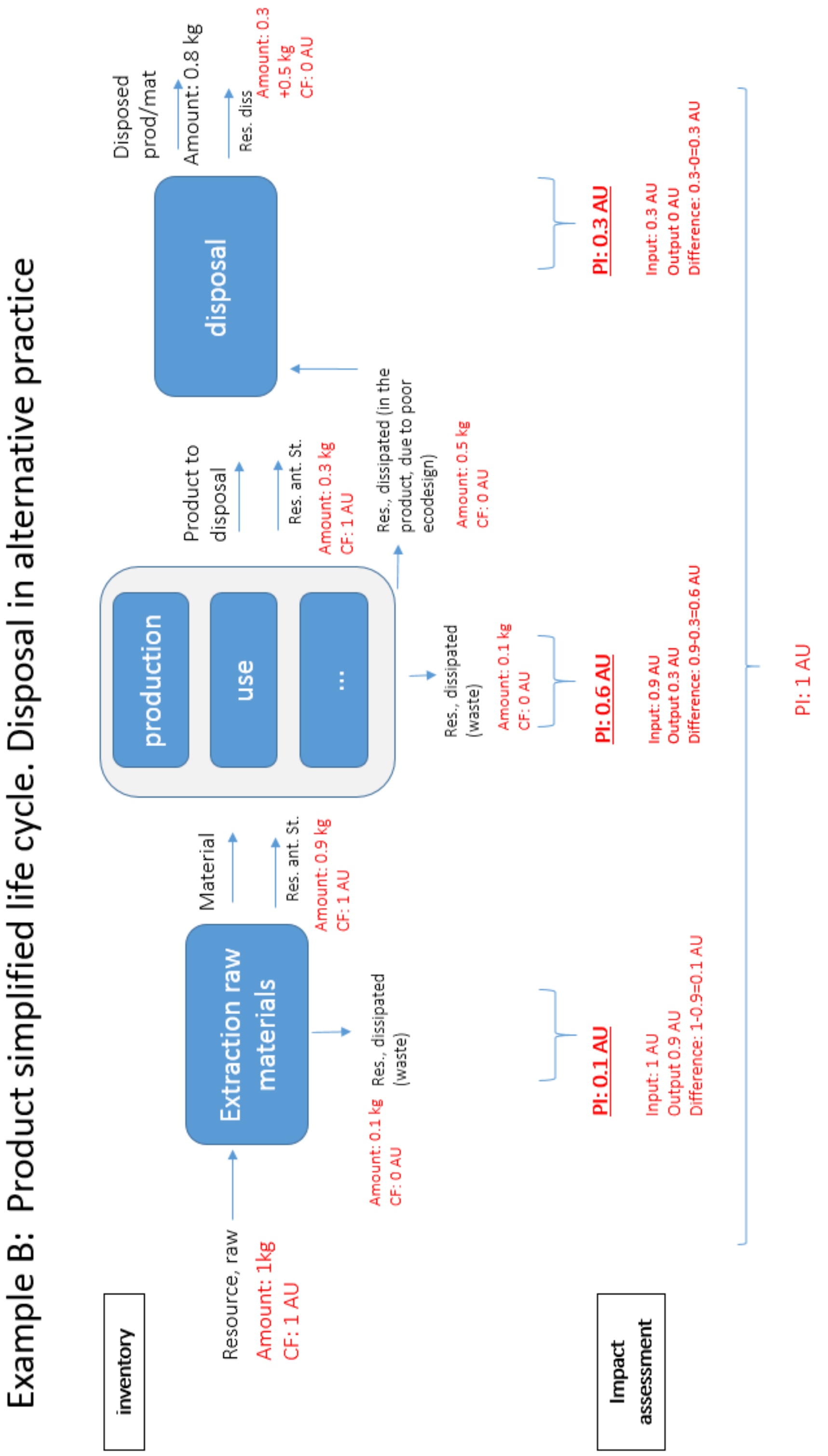

Figure 12 Resource Depletion: possible way forward. Example of a full life cycle in the alternative practice. Disposal.

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.

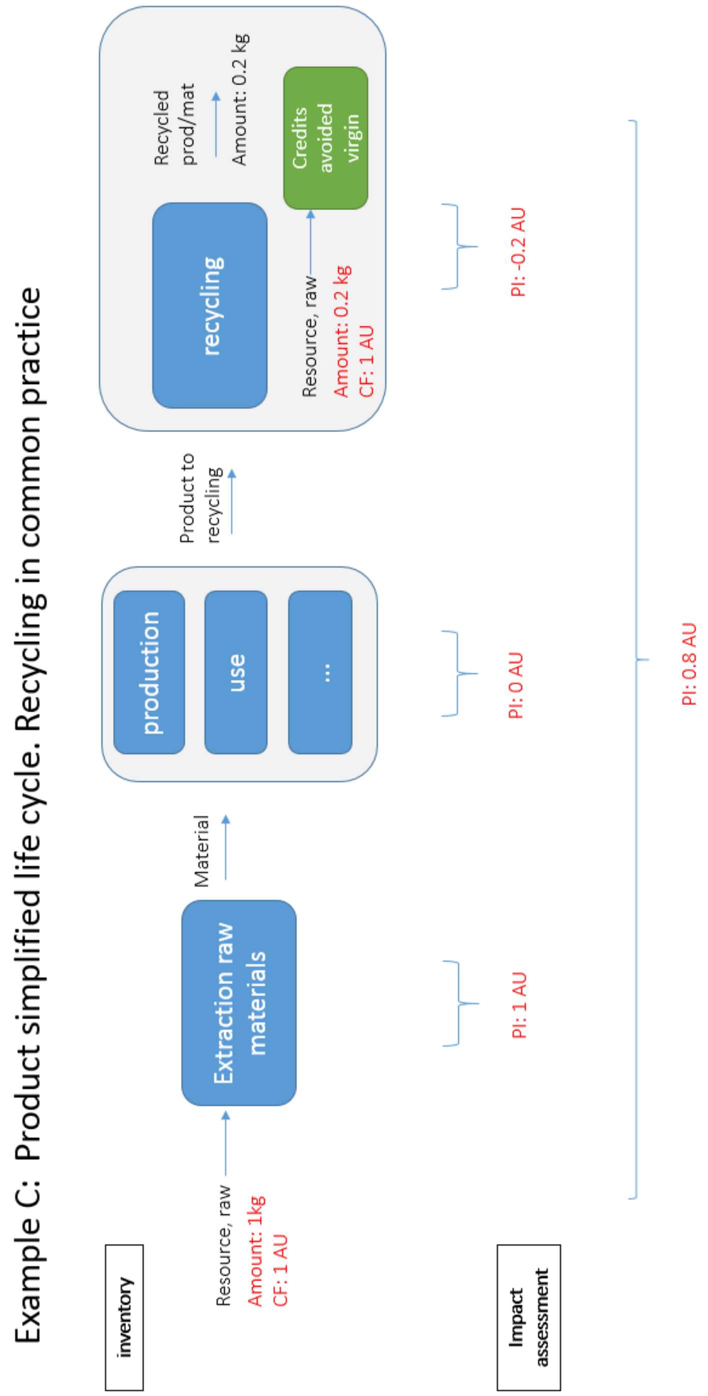

Figure 13 Resource Depletion: possible way forward. Example of a full life cycle in the current practice. Recycling.

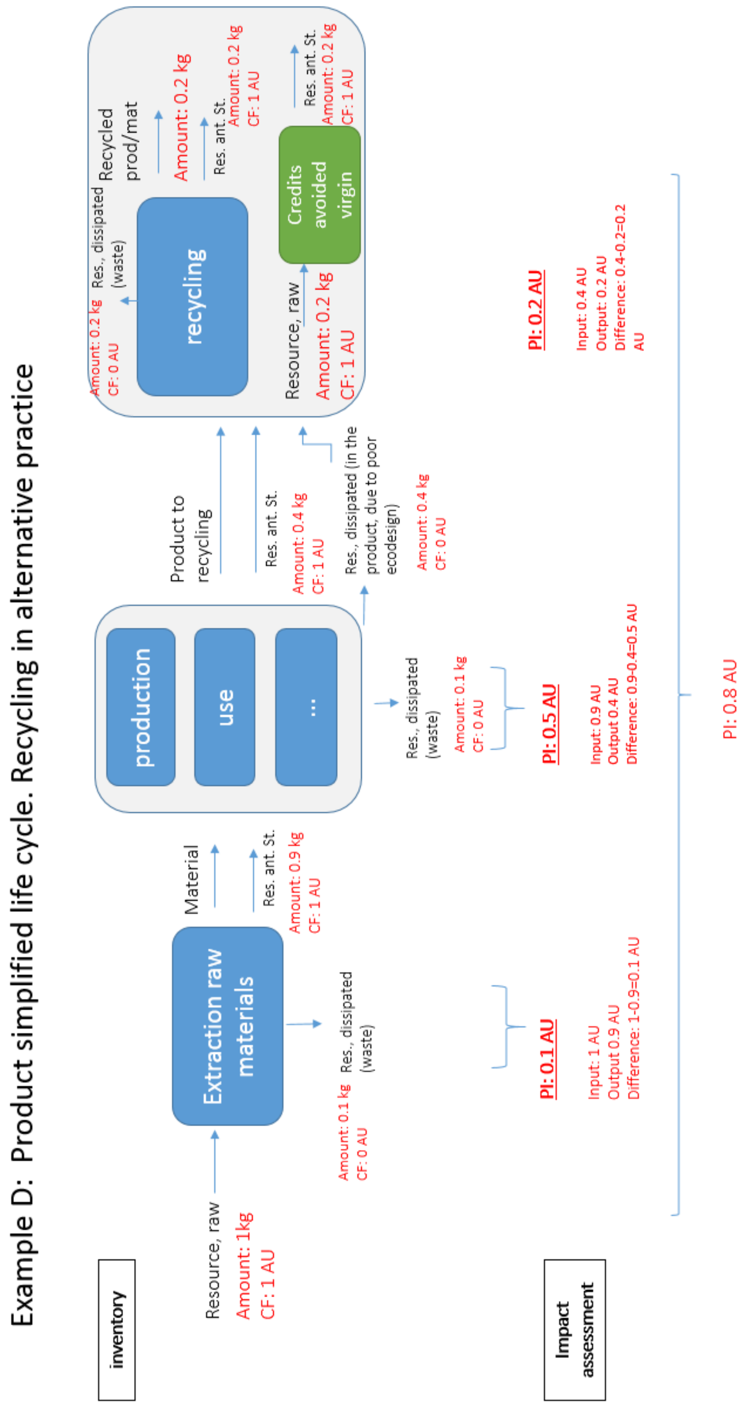

Figure 14 Resource Depletion: possible way forward. Example of a full life cycle in the alternative practice. Recycling.

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