Eurometaux

Product Environmental Footprint Category Rules (PEFCR) for Metal Sheets for Various Applications

Version: 28/06/2019

Time validity: 31/12/2021

Based on the template from the PEFCR Guidance ver. 6.3 (May 2018)

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Acronyms

ADP	Abiotic Depletion Potential
AF	Allocation Factor
AP	Acidification Potential
AR	Allocation Ratio
B2B	Business to Business
B2C	Business to Consumer
BoC	Bill of Components
BOF	Basic oxygen furnace
BoM	Bill of Materials
BP	Bonne Pratique (Eng. : best practice)
CF	Characterization Factor
CFF	Circular Footprint Formula
CFF-M	Circular Footprint Formula – Modular form
CML	Centre of Environmental Science at Leiden
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
EAF	Electric Arc Furnace
EC	European Commission
EF	Environmental Footprint
EI	Environmental Impact
ELCD	European Life Cycle Database
EoL	End-of-Life
FU	Functional Unit
GE	Gross Energy intake
GHG	Greenhouse Gas
GR	Geographical Representativeness
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
LCA	Life Cycle Assessment
LCDN	Life Cycle Data Network

LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LT	Lifetime
NACE	Nomenclature statistique des activités économiques dans la Communauté Européenne (French for nomenclature of economic activities in the European Union)
NDA	Non-Disclosure Agreement
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile compounds
ODP	Ozone Depletion Potential
P	Precision
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PSR	Product Specific Rules
RF	Reference Flow
RP	Representative Product
SB	System Boundary
SC	Steering Committee
SMRS	Sustainability Measurement & Reporting System
SS	Supporting study
TAB	Technical Advisory Board
TeR	Technological Representativeness
TiR	Time Representativeness
TS	Technical Secretariat
UNEP	United Nations Environment
UUID	Universally Unique Identifier
VOC	Volatile Organic Compound

Definitions

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

Activity data – This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF 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 that process (see Figure 1).

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

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 PEF, 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[2].

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.

Benchmark – A standard or point of reference against which any comparison can be made. In the context of PEF, the term 'benchmark' refers to the average environmental performance of the representative product sold in the EU market. A benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.

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.

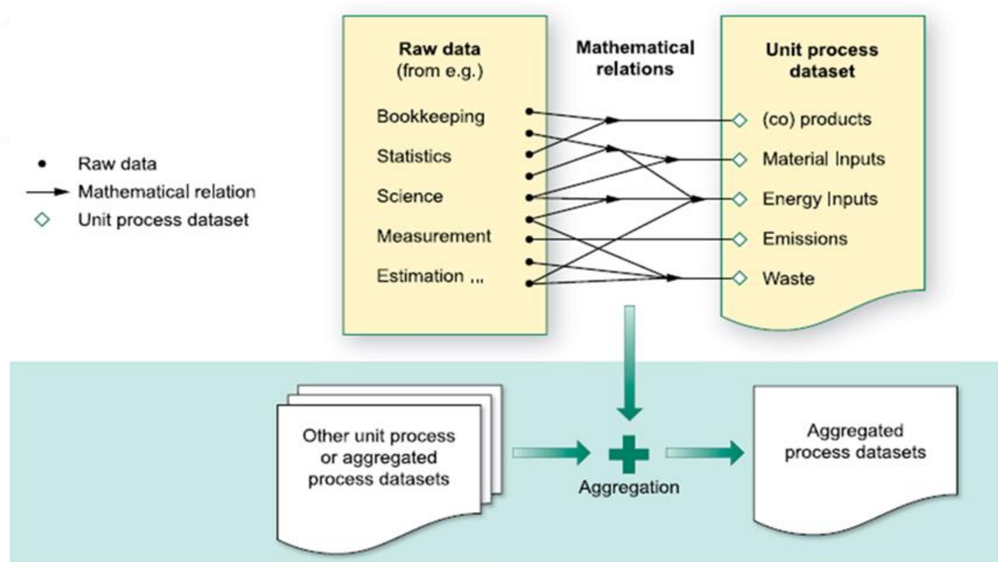

Figure 1: Definition of a unit process dataset and an aggregated process dataset

[2] Source: UNEP/SETAC 'Global Guidance Principles for LCA Databases'

Billet – A cast refinery shape of circular cross-section, used for the production of tube, rod, bar, profiles or forgings [Murray, S., 1978].

Cathode – A rough flat refinery shape made by electrolytic deposition and normally used for remelting [Murray, S., 1978].

Commissioner of the EF study – Organisation (or group of organisations) that finances the EF study in accordance with the EF Guide, EF Guidance and the relevant PEFCR, if available (definition adapted from ISO 14071/2014, point 3.4).

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

Comparative assertion – An environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (adapted from ISO 14025:2006).

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of a PEF study and supporting PEFCRs or the comparison of one or more products against the benchmark, based on the results of a PEF study and supporting PEFCRs.

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

EF communication vehicles – It includes all the possible ways that can be used to communicate the results of the EF study to the stakeholders. The list of EF communication vehicles includes, but it is not limited to, label, environmental product declarations, green claims, website, infographics, etc.

EF report – Document that summarises the results of the EF study. For the EF report the template provided as annex to the PECFR Guidance shall be used. In case the commissioner of the EF study decides to communicate the results of the EF study (independently from the communication vehicle used), the EF report shall be made available for free through the commissioner's website. The EF report shall not contain any information that is considered as confidential by the commissioner, however the confidential information shall be provided to the verifier(s).

EF study – Term used to identify the totality of actions needed to calculate the EF results. It includes the modelisation, the data collection, and the analysis of the results.

Electricity tracking[3] – 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.

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

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

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

Independent external expert – Competent person, not employed in a full-time or part-time role by the commissioner of the EF study or the practitioner of the EF study, and not involved in defining the scope or conducting the EF study (adapted from ISO 14071/2014, point 3.2).

Ingot – A cast refinery shape in a form suitable only for remelting. Note – 'ingots' are sometimes called 'ingot bars' [Murray, S., 1978].

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.

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

[3] http://www.e-track-project.org/

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).

Partially disaggregated dataset – A dataset with an LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying aggregated datasets that 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 all complementing underlying dataset are in their aggregated form (see an example in Figure 2 where the activity data and direct elementary flows are to the left, and the complementing sub-processes in their aggregated form are to the right. The grey text indicates elementary flows).

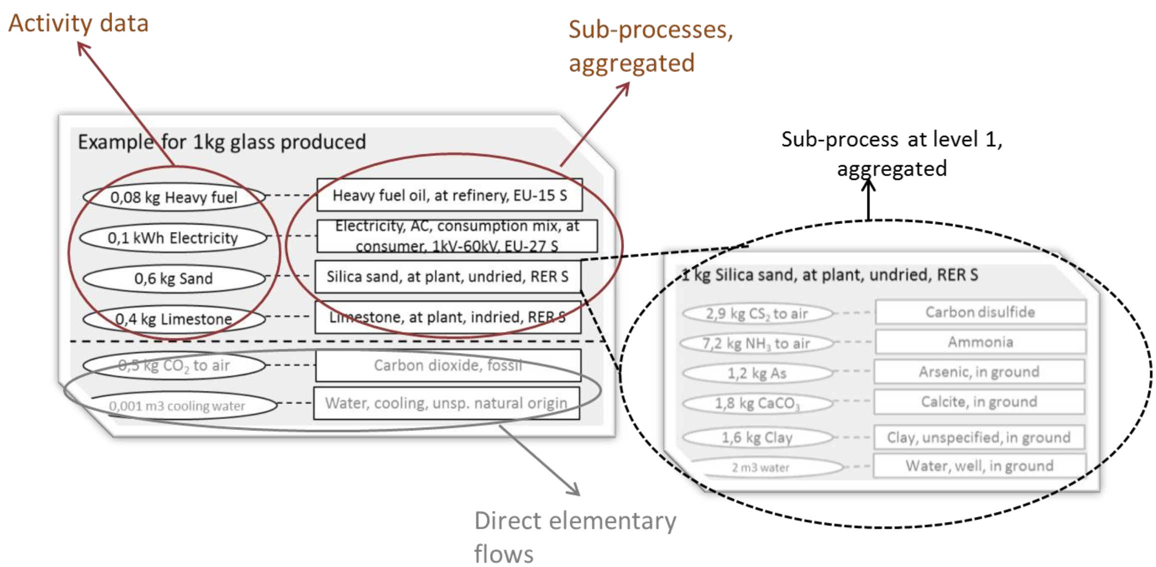

Figure 2: An example of a partially aggregated dataset, at level 1

PEF Profile – The quantified results of a PEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to be reported.

PEF screening – A preliminary study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the product category/sub-categories in scope, and any other major requirement to be part of the final PEFCR.

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

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

Practitioner of the EF study – Individual, organisation or group of organisations that performs the EF study in accordance with the PEF Guide, PEFCR Guidance and the relevant PEFCR if available. The practitioner of the EF study can belong to the same organisation as the commissioner of the EF study (adapted from ISO 14071/2014, point 3.6).

Primary data[4] – This term refers to data from specific processes within the supply-chain of the company applying the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply-chain-specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the company applying the PEFCR. In this Guidance, primary data is synonym of 'company-specific data' or 'supply-chain specific data'.

Primary Raw-Materials – Primary Raw-Materials are the basic (naturally occurring) materials from which a product is made. In LC terms it means those basic (naturally occurring) materials that are introduced into the boundaries of the studied system.

Product category – Group of products (or services) that can fulfil equivalent functions (ISO 14025:2006).

Product Environmental Footprint Category Rules (PEFCRs) – Product category-specific, life-cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF guide.

Refurbishment – 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.

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

Representative product (model) – The 'representative product' may or may not be a real product that one can buy on the EU market. Especially when the market is made up of different technologies, the 'representative product' can be a virtual (non-existing) product built, for example, from the average EU sales-weighted characteristics of all technologies around. A PEFCR may include more than one representative product if appropriate.

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.

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.

Scrap – Metal fragments, materials or components containing metal that can be used as starting material for metal recycling. In the metal industry, metallic scrap is recycled to produce metal. Any scrap produced along the fabrication chain is called pre-consumer scrap while metallic scrap collected at the end of life stage is classified as post-consumer scrap. In the metals industry, it is the common example of secondary raw material.

Scrap pool – The scrap pool is a concept that represents the metallic scrap that is available for recycling. It can also be considered as a sink/receptor for metal scrap generated at end of life stage or during fabrication stages. This pool can be composed of different types of scrap which can be classified under various categories determined by composition, physical form or content of alloying elements.

Secondary data[5] – refers to data not from specific process within the supply-chain of the company applying the PEFCR. 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.

Secondary Raw-Material – Secondary Raw-Materials are the basic materials recovered from previous use or waste from which a product is made. In LC terms it means those basic materials recovered from previous use or waste that are introduced into the boundaries of the studied system.

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

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

Slab – A cast refinery shape of rectangular cross-section, generally used for rolling into plate, sheet, strip or profiles [Murray, S., 1978].

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 a homogenous sub-set of the whole population. Sometimes the word 'stratum' can be used as well.

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).

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

Supply-chain – refers to all of the upstream and downstream activities associated with the operations of the company applying the PEFCR, 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 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 whole production sites are covered under 'unit process', then called 'unit process, black box' (ILCD Handbook).

Verification report – Documentation of the verification process and findings, including detailed comments from the *Verifier(s)*, as well as corresponding responses from the *commissioner of the EF study.* This document is mandatory, but it can be confidential. However, it shall be signed, electronically or physically, by the *verifier or in case of a* verification panel, by the lead verifier.

Validation statement – Conclusive document aggregating the conclusions from the *verifiers* or the verification team regarding the EF study. This document is mandatory and shall be electronically or physically signed by the *verifier or in case of a* verification panel, by the lead verifier.

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

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

1. Introduction

The Product Environmental Footprint (PEF) Guide provides detailed and comprehensive technical guidance on how to conduct a PEF study. PEF 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 PEFCR the applicant shall refer to the documents this PEFCR is in conformance with (see Section 2.7).
The compliance with the present PEFCR is optional for PEF in-house applications, whilst it is mandatory whenever the results of a PEF study or any of its content is intended to be communicated.

Terminology: shall, should and may
This PEFCR uses precise terminology to indicate the requirements, the recommendations and options that could be chosen when a PEF study is conducted.

- *The term 'shall' is used to indicate what is required in order for a PEF study to be in conformance with this PEFCR.*
- *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 PEF study and made transparent.*
- *The term 'may' is used to indicate an option that is permissible. Whenever options are available, the PEF study shall include adequate argumentation to justify the chosen option.*

2. General information about the PEFCR

This PEFCR provides Product Environmental Footprint Category Rules (PEFCRs) for developing Product Environmental Footprints for metal sheets made of aluminium, copper, lead and steel.
It provides a structure to ensure that all Product Environmental Footprints (PEF) for metal sheets are derived, verified and presented in a harmonised way.
Metal sheets are products which may require further transformation for their final application. This PEFCR becomes a 'module' to be used for the development of a PEF for products further down the supply chain.
Metal sheet is an intermediate product which can be used for different purposes. Today different LCA methodologies and tools are used to measure the environmental contribution of this component to the overall product environmental profile, e.g. MEErP, the eco-design methodology or EN15804 for building products. These methodologies are not harmonised and equivalent. As a result, the contribution of the same metal sheet in the ecodesign context, e.g. a washing machine, or in the context of a building, a metal sheet

for cladding, are pretty different due to non-harmonised methodology. Through this PEFCR on metal sheet, the metal industry aims at developing a harmonised methodology which can be used across various applications.

The PEFCR of the metal sheet for various applications will provide the necessary guidance for the PEF studies being undertaken for the final applications to help guarantee that the consistent information is used as input into the PEF study of the final application. The intention is that this PEFCR will inform downstream users of metal sheets, including other PEFCRs, on how to treat metals in their emissions profiles.

Note: The structure of this document follows the 'Template for Product Environmental Footprint Category Rules' (PEFCR Guidance ver. 6.3, May 2018).

2.1 Technical secretariat

Organisation name	***Type of organization***	***Participation since***
Eurometaux *(Coordinator)*	Non-ferrous metals association	23/01/2014
ArcelorMittal	Steel and mining company	23/01/2014
Aurubis Group	Manufacturing and processing of copper and other non-ferrous metals (company)	23/01/2014
EAA (European Aluminium Association)	Metal sector association for aluminum	23/01/2014
ECI (European Copper Institute)	Metal sector association for copper	23/01/2014
ELSIA (European Lead Sheet Industry Association)	Lead Sheet in Construction Sector association	23/01/2014
Euromines (European Association of Mining Industries, Metal Ores & Industrial Minerals)	Mining association	23/01/2014
KME	Copper products company	23/01/2014
TataSteel	Steel company	23/01/2014
thinkstep AG	Sustainability consulting	23/01/2014

2.2 Consultations and stakeholders

This PEFCR was prepared by members of the Technical Secretariat.
The following physical meetings with stakeholders and consultation periods were integral part of the development of this PEFCR:

- **Physical stakeholder meeting on 7 March 2014**
  Borschette Conference Centre, Rue Froissart 36, Brussels

28 participants from these 25 organizations/companies:

Participating companies/organisations	
1. ArcelorMittal	14. FOD
2. BASF	15. IMA-Europe
3. CECED (as of 03/2018 APPLiA)	16. Jernkontoret
4. Daikin Europe	17. LKAB
5. Digital Europe	18. MPE
6. ELSIA	19. Nickel Institute
7. Eurofer	20. PE International (currently thinkstep AG)
8. Eurometaux	21. TEPPFA
9. Euromines	22. Umicore
10. European Aluminium Association (EAA)	23. VITO
11. European Commission - DG ENV	24. Wieland Werke
12. European Commission-JRC	25. WirtschaftsVereinigung Metalle (WVM)
13. European Copper Institute (ECI)	

Link to the wiki page:
https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+PEFCR+pilot+Metal+sheets?preview=%2F61837447%2F74973302%2F2014+03+07+stakeholders+meeting+PEF+project+-+meeting+report.doc

- **Virtual consultation on the 1st draft of the PEFCR, 29 April – 2 June 2015**

31 comments from the following seven persons/companies/organizations:

- Catalina Giraldo-CAV+S Chile
- Quentin de Hults, BASF
- Bo Weidema, 2.-0 LCA Consultance, Denmark
- Karl Downey, CEMBUREAU
- Lisa Mohr, ThyssenKrupp Steel Europe AG
- Norbert Hatscher, Stahlinstitut VDEh

- Hanna Schreiber, EAA
- Gwendolyn Bailey, Carrefour
- Sebastien Humbert, Quantis

Link to the wiki page:
https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+PEFCR+pilot+Metal+sheets?preview=%2F61837447%2F74973302%2F2014+03+07+stakeholders+meeting+PEF+project+-+meeting+report.doc

- **Virtual consultation of the draft final PEFCR, 15 June – 15 July 2016**

The first draft of the Metals Sheet PEFCR was approved by the EF Steering Committee in July 2015. This has been proceeded by the virtual consultation.

71 comments were received from the following four organizations:

- European Commission
- CEMBUREAU
- EURIMA
- Polish Steel Association

Link to the wiki page:
https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Stakeholder+workspace%3A+PEFCR+pilot+Metal+sheets?preview=%2F61837447%2F74973302%2F2014+03+07+stakeholders+meeting+PEF+project+-+meeting+report.doc

After the consultation periods, all the received comments have been addressed and part of them have been implemented in the document.

2.3 Review panel and review requirements of the PEFCR

The PEFCR panel consists of the following experts:

Name of the member	***Affiliation***	***Role***
Ugo PRETATO	Studio Fieschi & soci Srl Corso Vittorio Emanuele II, 18 I-10123 Torino Italy Tel.: +39 0116599677	Chairperson of the review panel

Name of the member	***Affiliation***	***Role***
	pretato@studiofieschi.it	
Peter SALING	BASF SE, ZZS/S - C 104, 67056 Ludwigshafen am Rhein, Germany Tel.: +49 621 60-58146 peter.saling@basf.com	Reviewer Director Sustainability Methods BASF
Karolien PEETERS	VITO NV Boeretang 200 2400 Mol Belgium Tel.: +32 14 33 59 66 kristel.boonen@vito.be	Reviewer LCA expert – Units Smart Energy and Built Environment

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

- *The PEFCR has been developed in accordance with the requirement provided in the PEFCR Guidance ver. 6.3 (May 2018), and where appropriate in accordance with the requirements provided in the most recent approved version of the PEF Guide, and supports creation of credible and consistent PEF profiles.*
- *The functional unit, allocation and calculation rules are adequate for the product category under consideration.*
- *Company-specific and secondary datasets used to develop this PEFCR are relevant, representative, and reliable.*
- *The selected LCIA indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in the PEFCR Guidance ver. 6.3 (May 2018) and the most recent approved version of the PEF Guide.*
- *Both LCA-based data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product.*
- The information provided in the supporting studies on copper and steel sheets have been considered to secure that this PEFCR is applicable for all metals covered by this PEFCR (as described in Section 3.6).

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

2.4 Review statement

This PEFCR has been developed in compliance with version 6.3 of the PEFCR Guidance (May 2018), and with the PEF Guide; Annex II to the Recommendation 2013/179/EC adopted by the Commission on 9th April 2013 (published in the Official Journal of the European Union, Volume 56, 4 May 2013).

The representative product(s) correctly describe the average product(s) sold in Europe for the product group in scope of this PEFCR.

The panel members (listed in Section 2.3) confirm that the reviewed PEFCR on Metal Sheets have not established any relevant deviations to the above-referenced PEFCR Guidance with respect to the requirements identified in the review scope.

The panel members confirm that have been independent in our roles as reviewers, that they have not been involved in the preparation of the PEFCR or related supporting studies and they do not have conflicts of interest regarding this review.

2.5 Geographic validity

This PEFCR is valid for products in scope sold in the European Union + EFTA.
Each PEF study shall identify its geographical validity listing all the countries where the product object of the PEF study is sold with the relative market share. In case the information on the market for the specific product object of the study is not available, Europe +EFTA shall be considered as the default market, with an equal market share for each country.

2.6 Language

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

2.7 Conformance to other documents

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

- *PEFCR Guidance, ver. 6.3 (May 2018);*
- *Product Environmental Footprint (PEF) Guide; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the Official Journal of the European Union, Volume 56, 4 May 2013.*

Additional requirements on top of the PEFCR Guidance ver. 6.3 (May 2018) for intermediate products have been added to the DQR criteria for Situations 2 and 3 and to Sections 3.4, 5.11, 6.6, and 7.4 to report End-of-Life as mandatory additional information. Justification can be found in the relevant sections of the PEFCR.

3. PEFCR scope

3.1 Product classification

The Classification of Products by Activity (CPA) codes for the products included in this PEFCR are:

Material	CPA
Steel	C24.1
Lead	C24.4.3
Copper	C24.4.4
Aluminium	C24.4.2

Table 1. Classification of Products by Activity (CPA)

3.2 Representative product(s)

Considering the specificity of the production route for each metal sheet, the following list of representative intermediate products has been selected in order to illustrate different applications:

For the subcategory construction:

- Copper sheet
- Lead sheet
- Aluminium sheet
- Steel sheet

For the subcategory appliances:

- Aluminium sheet
- Steel sheet

A metal sheet is an intermediate product that can be used in many different end applications. The grade of metal, thickness of the sheet and the surface finish will be dependent on the specific end use. Examples are given in this PEFCR of 'representative products', but it should be stressed that these examples do not specify exact technical parameters, and these examples should not be used as criteria for benchmarking.

An 'intermediate' metal sheet is typically subject to additional manufacturing steps in order to be transformed into the final product (e.g. metal sheets undergo machine or manual working operations such as forming, bending, seaming, joining, welding to make a building's roof or façade element). Those manufacturing steps are not covered by this PEFCR.

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

3.3 Functional unit and reference flow

This document provides Product Environmental Footprint Category Rules (PEFCRs) for product environmental footprints (PEFs) for metal sheets as intermediate products.

A metal sheet is a product manufactured at an industrial site with specific properties (e.g. mechanical properties, surface properties, conductivity etc.). It is typically an intermediate product that requires further transformation to an end-use product within the following application sectors (non-exhaustive list):

- building and construction applications;
- transport;
- appliances;
- packaging;
- engineering.

Any surface treatment or finishing of the intermediate product is included in the scope and depends on the individual specification of the product as it will be sold on the market.
The function of a metal sheet within an end-use product is usually multiple. Examples of these functions are (non-exhaustive list): structural integrity, weather protection, physical separation, shaping, sealing and aesthetics.

This PEFCR is developed in the context of a PEF pilot project covering aluminium, steel, copper and lead sheets, referring to buildings or appliances as example end applications. This PEFCR is not intended to apply to other metals. Due to the widespread use of metal sheets only two typical examples of application fields are covered explicitly by this PEFCR for an intermediate product. The validity of this PEFCR for other application fields has to be cross-checked case-by-case.

It is the opinion of the TS that this PEFCR applies to all four metals mentioned notwithstanding the fact that only supporting studies have been executed for copper and steel. The four metals have been studied extensively during the screening phase and the results of the screening are implemented in this PEFCR. It was shown that the basic principles of all the metal sheets can be considered as equal.

Depending on the application, the metal sheet may be composed of almost 100% pure metal (e.g. copper or lead) or an alloy (e.g. steel or aluminium). For some specific applications, the metal sheet may also be coated with a metallic or a non-metallic coating. The intentionally added alloying elements and coatings shall be included in the assessment. This PEFCR is applicable for pure metal sheets (in the case of copper and lead) and sheets that include low level of alloying elements and /or coatings (in the case of aluminium and steel.).

The composition of the low alloyed sheets depends on the application. This PEFCR is unconditionally applicable to the alloys listed in Annex 4.

To cover the variation of chemical composition of the metal sheet, modelling shall be done as described below. Alloying elements which are added intentionally shall be considered in the PEF calculation, except when they are originating from secondary material input. The corresponding LCI datasets for the alloying elements shall be selected in order to model the sheet production. The model for metal sheet production shall then consider the true fraction of these alloying elements added intentionally. The rest of the mass of the sheet (pure metal and impurities) is then considered as being a pure metal. Where secondary material is used that contains alloying elements that are retained in the new product then they shall not be modelled as primary alloys additions. In practice the yield takes into account any loss of alloying elements in the process.

For a metal sheet made of an alloy which is beyond the composition limits of Annex 4, a sensitivity analysis shall be performed to assess the relevance of the other elements composing the alloy and/or the coating. If the sensitivity analysis does not change the identified most relevant processes and most relevant life cycle stages, then this PEFCR may be applied, provided that mandatory company-specific data for the alloying elements are complemented with any additional regulated direct emissions. The contribution of these other elements to the analysis shall be documented and provided to the verifier.

The FU is metal sheet (1m^2) with the key aspects defined in the following table:

Table 2. Key aspects of the Functional Unit (FU)

What?	The **functional unit** includes a non-exhaustive list e.g. structural integrity, weather protection, physical separation, shaping, sealing, aesthetics, etc. to the level required by the most relevant, international, regional, national or technical standards to a **reference extent of 1m²**.
How much?	The extent of the function expressed in the reference flow is defined as **1m²** of metal sheet.
How well?	Metal sheets can be used in a very wide variety of applications. For metal sheets as an intermediate product to be used in final applications, the 'how well' strongly depends on the downstream application and its specific requirements and cannot be generalized. The 'how well' is specified by the product standard. A non-exhaustive list of applicable product standards for metal sheets is provided in Annex 4. Specific product standards and technical properties of a specific metal sheet PEF shall be declared in the PEF documentation.
How long?	The life-time of the metal sheet ('how long'?) is determined by its specific application. The use phase and the related life time are not relevant for the PEFCR for the

	intermediate state of the metal sheets but will be required for all final products PEFs. Therefore, a typical use phase scenario shall be defined for the various applications in a final product application.

The reference flow *is the amount of product needed to fulfil the defined function. All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.*

Example how to calculate the reference flow:

Metal: aluminium
Specific mass (W): 2700 kg/m^3
Thickness (T): 0,0007 m
Grammage (WxT): 1,9 kg/m^2
The functional unit of 1m^2 of aluminium corresponds to 1,9 kg of reference flow.

Table 3. Representative product(s) specification

		Representative Products (N.)					
Parameter	Unit	1.	2.	3.	4.	5.	6.
Metal		Steel	Steel	Aluminium	Aluminium	Copper	Lead
Exemplary application		Buildings	Appliances	Buildings	Appliances	Buildings	Buildings
Composition		See Tables in Annex 4	See Table s in Annex 4	See Tables in Annex 4	See Tables in Annex 4	99,9% Cu	99% Pb
Thickness	mm	1	0,60	0,70	1,00	0,60	1,70
Grammage	kg/m²	7,8	4,68	1,90	2,71	5,30	19,20
R_1[6]		0,18	0,18	0 (*)	0 (*)	0,79	1
Share of $E_{recycled,1}$ (= $R_{1,1}$; tech. description) (**)	%	100 (18; sec. billet)	100 (18; sec. billet)	100 (0; sec. slab)	100 (0; sec. slab)	30 (23,7; sec. cathode)	80 (80; battery recycling)
Share of $E_{recycled,2}$ (= $R_{1,2}$; tech. description) (**)	%	N/A	N/A	N/A	N/A	70 (55,3; clean scrap)	20 (20; clean lead scrap recycling)
R_2[7]		0,95	0,90	0,95	0,90	0,95	0,95
Share of $E_{recycledEoL,1}$ (= $R_{2,1}$; tech. description)	%	100 (95; clean scrap)	100 (90; clean scrap)	100 (95; clean scrap)	100 (90; clean scrap)	100 (95; clean scrap)	100 (95; clean scrap)
Share of $E_{recycledEoL,2}$ (= $R_{2,2}$; tech. description)	%	N/A	N/A	N/A	N/A	0 (0)	0 (0)

(*) no specific figure is available. Thus, zero is used as a default value.
(**) In some cases, for example in copper and lead, there may be different types of scrap which require different processing and require differentiation in the modelling, i.e. $R_{1,1}$, $R_{1,2}$.

The above values were used for the modelling of the representative products. However, for specific PEF studies using this PEFCR, the actual values for the product in question shall be used.

[6] **R_1:** it is the proportion of material in the input to the production that has been recycled from a previous system (see Section 5.11 Modelling of wastes and recycled content).

[7] **R_2:** it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system (see Section 5.11 Modelling of wastes and recycled content).

3.4 System boundary

The following life cycle stages and processes shall be included in the system boundary.
The system boundary for a PEF of metal sheets includes the life cycle stages as shown in the Figure 3 and Table 4.

Figure 3. Product flow sheet and system boundaries

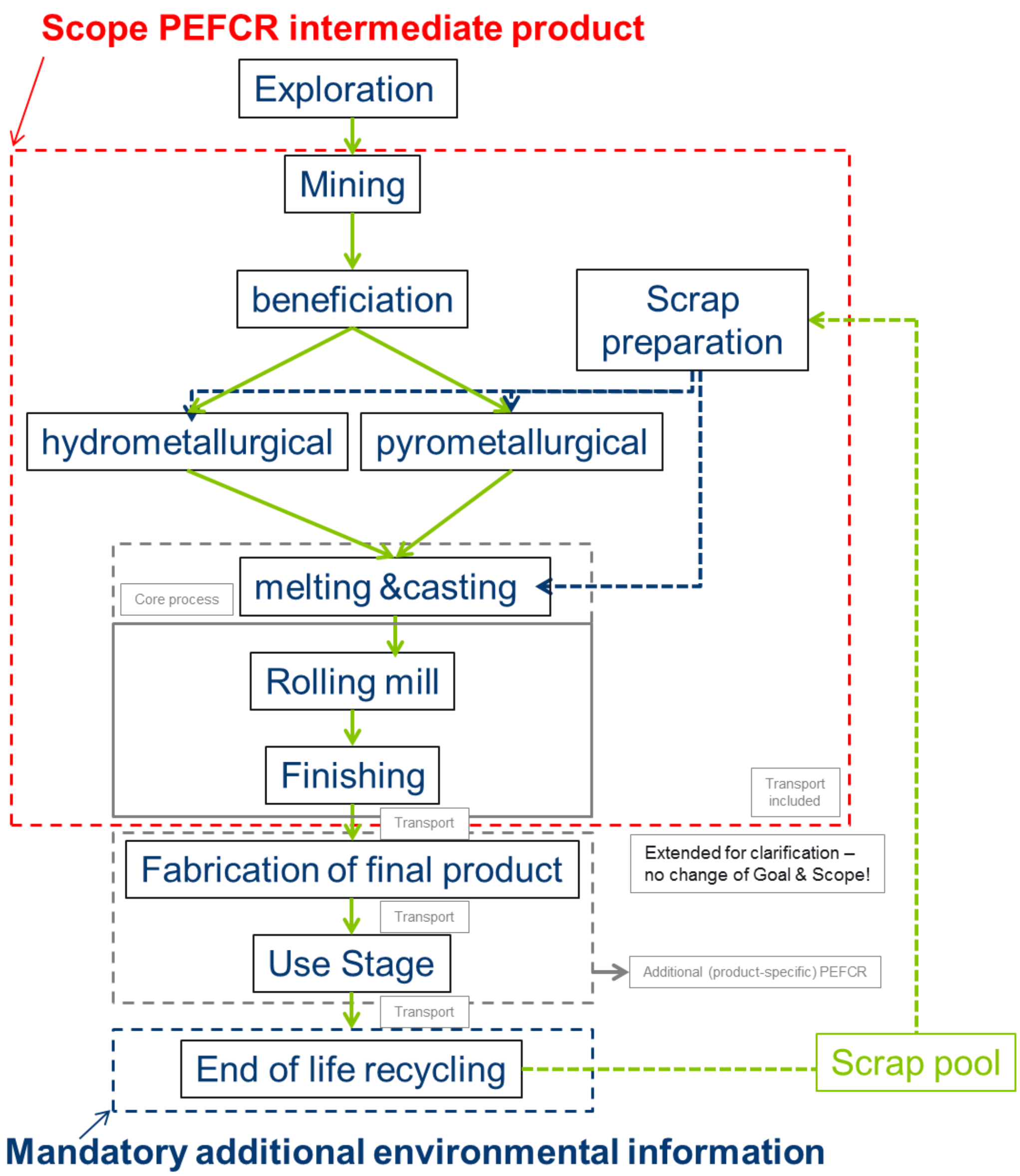


Table 4 provides details about the various processes to be considered per type of metal.

Table 4. Life cycle stages and corresponding processes for the four metal sheets

(Legend: not covered – **orange,** background processes – **grey**, foreground processes - **green**)

Life Cycle Stages	Description of Generic Process Steps (as in Fig. 3)	Description of Specific Process Steps			
		Aluminium	Copper	Steel	Lead
Raw Material Acquisition (incl. Metal Production)	**Exploration**	Not covered	Not covered	Not covered	Not covered
	Mining (incl. downstream transport)	Mining	Mining	Mining	Mining
	Beneficiation (incl. downstream transport)	Alumina Refining	Beneficiation/ Flotation	Beneficiation	Beneficiation /Flotation
	Hydro- or Pyro-metallurgy (incl. downstream transport)*	Smelting*	Solvent Extract. / Smelting* / Refining*	BOF / EAF*	Smelting* / Refining *
Metal Sheet Production	**Melting & Casting***	Casting*	Melting & Casting*	Casting*	Melting & Casting*
	Rolling	Hot and cold rolling	Rolling	Rolling	Rolling
	Finishing, incl. Surface Treat.	Finishing	Finishing	Finishing	Finishing
	Fabrication	Not covered	Not covered	Not covered	Not covered
Use	**Use**	Not covered	Not covered	Not covered	Not covered
End-of-Life	**Collection, transport & scrap preparation**	Collection, transport, shredding & sorting	Collection, transport, shredding & sorting	Collection, transport, shredding & sorting	Collection, transport, shredding & sorting

* can be fed by primary or secondary raw materials

A more detailed explanation of the Production and End-of-Life (EoL) stage can be found in Annex 5.

For the most relevant processes analysis, the processes indicated as 'not covered' shall be excluded. Processes with an asterisk (*) can be fed by primary or secondary raw materials, i.e. with metal scrap. Section 5.11 and Annex 5 provide a more detailed flow diagram.

The declaration of the EoL stage is part of the mandatory additional environmental information and details are given in Section 5.11.

Any surface treatment or finishing of the intermediate product is included in the scope and depends on the individual specification of the product as it will be sold on the market.

Figure 3 depicts an overview of the lifecycle of a typical metallic sheet. The dotted lines indicate which processes and life cycle stages are included and which are excluded from this PEFCR. Exploration, fabrication and use are out of scope.
Exploration is excluded from the scope of this PEFCR because there are currently no models of the exploration phase available for use in LCIA or PEF. It is explicitly illustrated in Figure 3 since it is the life cycle stage that is known empirically to have the most significant effect on 'availability of abiotic resources for human use' [8]. For the moment, PEFCR Guidance ver. 6.3 (May 2018) specifies the use of ADP ultimate reserves, which is a temporary recommendation, which estimates impacts on total environmental stocks rather than availability for human use and which is not significantly influenced by Exploration.

All energetic inputs to the process stages are to be recorded, including fuels, electricity, steam and compressed air. Processes that have been cut-off according to criteria in PEF Guidance 6.3 are listed in the Life Cycle Inventory Excel files.

It shall be noted that the transport of the metal sheet for the final product fabrication is outside of the scope of this PEFCR. Metal sheets in the scope of this document are considered as an intermediate product. However, for a final product, transportation to fabrication shall be assessed under the specific PEF rules for this product.

Each PEF study done in accordance with this PEFCR shall provide in the PEF study 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 (DNM).

3.5 EF impact assessment

This PEFCR is applicable to metal sheets as intermediate and therefore all impact category indicators shall be transferred to the user of the information in the compilation of the PEF profile of the final product produced from the intermediate metal sheet.

[8] For relevant background, see European Commission Joint Research Centre (2016): Environmental Footprint – Update of Life Cycle Impact Assessment methods, prepared by S Sala, L Benini, V Castellani, B Vidal-Legaz and R Pant

Each PEF study carried out in compliance with this PEFCR shall calculate the PEF-profile including all PEF impact categories listed in the Table below.

Table 5. List of the impact categories to be used to calculate the PEF 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)*
Ozone depletion	*Ozone Depletion Potential (ODP)*	*kg CFC-11eq*	*Steady-state ODPs 1999 as in WMO assessment*
*Human toxicity, cancer**	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model (Rosenbaum et al, 2008)*
*Human toxicity, non-cancer**	*Comparative Toxic Unit for humans (CTU_h)*	*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 U^{235}*	*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 $NMVOC_{eq}$*	*LOTOS-EUROS model (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} equivalent*	*EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe*
*Ecotoxicity, freshwater**	*Comparative Toxic Unit for ecosystems (CTU_e)*	*CTUe*	*USEtox model, (Rosenbaum et al, 2008)*
Land use	• *Soil quality index*[9] • *Biotic production* • *Erosion resistance* • *Mechanical filtration*	• *Dimensionless (pt)* • *kg biotic production*[10] • *kg soil/(m^2*a)* • *m^3 water* • *m3 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)*

[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

Impact category	Indicator	Unit	Recommended default LCIA method
	• Groundwater replenishment		• 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, energy carriers	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:
http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtm

3.6 Limitations

1) Limitations derived from the supporting studies

Supporting studies have been performed at the early stage of the PEF pilot phase for steel and copper.
For lead and aluminium sheets, no supporting studies have been performed. The members of the Technical Secretariat representing lead and aluminium have analysed and integrated the remarks and recommendations from the supporting studies on copper and steel sheets as well as the reviewers' requests:

- For aluminium sheets, the main concern was the absence of consideration of the alloying elements in the composition of the aluminium sheet. The adaptations introduced in the final version of the PEFCR as well as the activity data for aluminium sheet cope with the aspects of alloying elements. Various primary and secondary aluminium alloys have been included in the PEF background datasets. In particular, the 'Aluminium ingot-magnesium main solute' (f7b7e0ff-b423-4e9d-b921-10c81872eacb) can be considered as good proxy for EN-AW 5182 or 5754 alloy series which are typically used for building or appliance applications covered in this PEFCR. European Aluminium (representing more than 90% of the Aluminium sheet produced in Europe) and its members confirm that the updated PEFCR is applicable to aluminium sheets for building or appliance applications.

- For lead sheets, ELSIA (representing more than 80% of the European lead sheet market) has studied all comments and recommendations and concluded that the final version of the PEFCR is applicable to lead sheet for building applications.

Hence, the PEFCR is also applicable to lead and aluminium sheets.

2) Limitations resulting from indicator uncertainty

Resource depletion – fossil, mineral has been found to be a dominating impact category for different metals, such as primary and secondary copper production and zinc production, when applying the current method 'ADP ultimate reserves' for assessing minerals and metals and current normalisation factors. This outcome shall be interpreted with caution. The ADP ultimate reserve is considered as an intermediate recommendation. The EU Commission in cooperation with industry intends to develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources.

3) Limitations resulting from the intermediate product scope

A metal sheet is an intermediate product that can be used in many different end applications. The grade of metal, thickness of the sheet and the surface finish are defined according to the specific end use. Examples are given in this PEFCR of 'representative products', but it should be stressed that these examples do not specify exact technical parameters, and these examples should not be used as criteria for benchmarking.

Each representative product has its own environmental footprint at the intermediate level and cannot be compared to any of the other representative products at this level. Only when a function is well-defined and the life cycle assessment is performed on the entire life cycle of this final function (including the use phase and the end of life stage), benchmarking and comparison could be performed.
If benchmarking is to be performed on the final product, it should be conducted with data collected with consistent and comparable system boundaries.

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

The most relevant impact categories, life cycle stages and processes for the different product groups in scope of this PEFCR are presented in the Tables 6, 7, 8 and 9. The first column of each table shows the most relevant impact category. The second column contains the most relevant life cycle stage/process in the considered impact category. The third column contains the contribution of the process to the considered impact category.

For the UUID information related to datasets in tables 6-9 see the Excel Life Cycle Inventory files.

Table 6. List of the most relevant processes for aluminium

Impact category	***Life Cycle Stage/Processes***	***Contribution of most relevant processes (%)***
Climate change	Raw material acquisition: EU-28+3: Aluminium ingot (magnesium main solute)	97,2%
Particulate matter	Raw material acquisition: EU-28+3: Aluminium ingot (magnesium main solute)	96,9%
Resource use, energy carriers	Raw material acquisition: EU -28+3: Aluminium ingot (magnesium main solute)	97,0%
Acidification terrestrial and freshwater	Raw material acquisition: EU-28+3: Aluminium ingot (magnesium main solute)	98,0%

Table 7. List of the most relevant processes for copper

Impact category	**Life Cycle Stage/Processes**	***Contribution of most relevant processes* (%)**
Resource use, mineral	Raw material acquisition and pre-processing: Copper Concentrate (Mining. mix technologies)	99,0%
Climate change	Raw material acquisition and pre-processing: EU-28+EFTA: Copper billet/slab* (smelting and refining to produce primary copper cathode)	17,2%
	Raw material acquisition and pre-processing: EU-28+EFTA: Secondary Copper Cathode	16,8%
	Raw material acquisition and pre-processing: Copper Concentrate (Mining. mix technologies)	37,6%

	Production of the main product (sheet): EU-28: Copper sheet making	12,7%
Particulate matter	Raw material acquisition and pre-processing: EU-28+EFTA: Copper billet/slab* (smelting and refining to produce primary copper cathode)	15,6%
	Raw material acquisition and pre-processing: EU-28+EFTA: Secondary Copper Cathode	38,4%
	Raw material acquisition and pre-processing: Copper Concentrate (Mining. mix technologies)	43,6%

*The name of the process should be 'copper cathode'. This will be corrected in the transition phase

Table 8. List of the most relevant processes for lead

Impact category	***Life cycle stage/Processes***	***Contribution of most relevant processes (%)***
Resource use, mineral	Raw material acquisition: EU-28+EFTA: Secondary lead	97,0%
Climate change	Raw material acquisition: EU-28+EFTA: Secondary lead	59,1%
	Raw material acquisition: EU-28+EFTA: Recycling of lead into lead scrap	9,6%
	Metal sheet production: EU-28+3: Thermal energy from natural gas	17,0%
Resource use, energy carriers	Raw material acquisition: EU-28+EFTA: Secondary lead	58,4%
	Metal sheet production: EU-28+3: Thermal energy from natural gas	21,2%
	Metal sheet production: EU-28+3: Electricity grid mix 1kV-60kV	9,1%
Water scarcity	Raw material acquisition: EU-28+EFTA: Secondary lead	95,9%

Table 9. List of the most relevant processes for steel

Impact category	**Life Cycle Stage/Processes**	***Contribution of most relevant processes* (%)**
Climate change	Raw material acquisition and pre-processing: EU: 1 kg BF Slab (theoretical 100% primary)	72,7%

	Production of the main product: EU: 1 kg BF Slab (theoretical 100% primary) - Credit for Rolling Scrap	8,6%
Particulate matter	Raw material acquisition and pre-processing: EU: 1 kg BF Slab (theoretical 100% primary)	70,9%
	Production of the main product: EU: 1 kg BF Slab (theoretical 100% primary) - Credit for Rolling Scrap	8,3%
	Production of the main product: GLO: Zinc	7,9%
Resource use, mineral*	Production of the main product: GLO: Zinc	97,6%
Resource use, energy carriers	Raw material acquisition and pre-processing: EU: 1 kg BF Slab (theoretical 100% primary)	65,5%
	Production of the main product: EU-27: Natural gas mix	10,1%
	Production of the main product: EU: 1 kg BF Slab (theoretical 100% primary) - Credit for Rolling Scrap	7,7%

* Refer to the limitations of this impact category escribed in Chapter 3.6.

The detailed analysis including relative contributions of the most relevant impact categories and life cycle stages can be found in the respective Excel Life Cycle Inventory files.
Resource Depletion – fossil, mineral, is the dominating impact category for primary and secondary copper production and zinc production when applying the current method (‘ADP 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 ultimate reserves is considered as an intermediate recommendation[12]. The EU Commission in cooperation with industry intends to develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources.

5. Life cycle inventory

All newly created processes shall be EF-compliant. The data collection shall be from all the plants without performing any sampling.
The core process even in cases where this core process is not one of the most relevant processes shall be modelled with the company specific data (see Tables 6-9).

5.1 List of mandatory company-specific data

The mandatory core processes to be modelled with company-specific data are:

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

- For Al and steel: rolling and finishing;
- For Cu and Pb: melting, casting, rolling and finishing.

For the following parameters, the specific data shall be used:

- Type of metal
- Density
- Melting point
- Thickness
- Grammage
- R_1 (recycled content of the input material for sheet production)

If a company producing the metal sheet is supplied with an external feedstock material and no data on R1 is provided, it shall be assumed to be primary production (R_1 is on zero – worst case scenario). For copper and lead, there are two recycling routes / two types of secondary materials which require different processing and differentiation in the modelling, i.e. $R_{1,1,}$ $R_{1,2,}$

The DQR of mandatory company specific data shall be ≤1.6, where the score of P (Precision) cannot be higher than 3 while the score for TiR (Time Representativeness), TeR (Technological Representativeness), and GR (Geographical Representativeness) cannot be higher than 2 (see Section 5.4 on Data Quality Requirements).

As guidance beyond the DQR descriptions, the following requirements shall be applied for collection of the specific data:

- The data shall be collected in accordance with the applied technology and the expected material and energy flows as well as expected burdens of the processes,
- The data shall include minimum all inputs and outputs listed in the Life Cycle Inventory Excel files,
- Information on the source of data (example direct measurements) and methodology used for calculations shall be provided.
- The data collection shall cover 12 months that are representative for the metal sheet produced.

This PEFCR shows aluminium as an example in terms of data collection requirements for mandatory process. All the below listed input and output data shall be collected (no cut-off allowed). See Table 10.
The collection requirement for other metals are in the respective Excel Life Cycle Inventory files.

Table 10. Data collection requirements for mandatory process – Example of Aluminium: rolling and finishing

Requirements for data collection purposes			**Requirements for modelling purposes**								**Remarks**
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***	***TiR***	***TeR***	***GR***	***P***	***DQR***	
Inputs:											
Nitrogen gaseous [Inorganic intermediate products]	Annual Consumption	kg	Nitrogen gas production	http://ecoinvent.lca-data.com/	66ff464f-6471-4f6e-9d34-e657924fae89	1	2	1	2	2	
Oil, cold rolling [Custom PEF Flows]	Annual Consumption	kg	Crude oil mix	http://lcdn.thinkstep.com/Node/	03bcbe8f-b957-43dc-9c9e-020836c954a6	Not ev.	Not ev.	Not ev.	Not ev.	Not ev.	Proxy
Other energy source (propane) [Custom PEF Flows]	Annual Consumption	MJ	Thermal energy from LPG	http://lcdn.thinkstep.com/Node/	ade98dea-0c74-4ebb-94ef-f9686eb0ddc5	1	1	1	2	1	Proxy
Paper & cardboard for packaging [Custom PEF Flows]	Annual Consumption	kg	Kraft paper, bleached	https://lcdn.quantis-software.com/PEF/	b5e2916f-cd5d-40da-8b5f-29e4997fc087	3	2	2	2	2	
Plastic for packaging [Custom PEF Flows]	Annual Consumption	kg	Plastic shrink, wrap	http://lcdn.thinkstep.com/Node/	017de0d2-c8f8-4208-b1b5-357a815f2dd8	2	2	2	2	2	

Purchased electricity [Custom PEF Flows]	Annual Consumption	MJ	Electricity grid mix 1kV-60kV	http://lcdn.thinkstep.com/Node/	34960d4d-af62-43a0-aa76-adc5fcf57246	1	1	1	2	1	
Steel for packaging [Custom PEF Flows]	Annual Consumption	kg	Steel cold rolled coil	http://lcdn.thinkstep.com/Node/	3e5ff637-ffc2-4920-9051-11055b1d2d18	3	2	2	2	2	Proxy
Thermal energy from natural gas (MJ) [Thermal energy]	Annual Consumption	MJ	Thermal energy from natural gas	http://lcdn.thinkstep.com/Node/	81675341-f1af-44b0-81d3-d108caef5c28	1	1	1	2	1	
Unscalped rolling ingots [Custom PEF Flows]	Annual Consumption	kg	Aluminium ingot mix (high purity), Secondary aluminium ingot (magnesium main solute)	http://lcdn.thinkstep.com/Node/	#NV	#NV	#NV	#NV	#NV	#NV	Proxy
Water (cooling water) [Operating materials]	Annual Consumption	kg	Water, completely softened	https://lcdn.quantis-software.com/PEF/	5acdcd80-9e9a-46fb-8da7-791a13bfd831	2	2	2	2	2	
Water (process water) [Operating materials]	Annual Consumption	kg	Water, completely softened	https://lcdn.quantis-software.com/PEF/	5acdcd80-9e9a-46fb-8da7-791a13bfd831	2	2	2	2	2	

Wood for packaging [Custom PEF Flows]	Annual Consumption	kg	Sawn Soft Wood	http://lcdn.thinkstep.com/Node/	008412a6-515a-46e8-a89f-dff0ddf22b8f	2	2	2	2	2	Proxy
Nitrogen gaseous [Inorganic intermediate products]	Annual Consumption	kg	Nitrogen gas production	http://ecoinvent.lca-data.com/	66ff464f-6471-4f6e-9d34-e657924fae89	1	2	1	2	2	
Oil, cold rolling [Custom PEF Flows]	Annual Consumption	kg	Crude oil mix	http://lcdn.thinkstep.com/Node/	03bcbe8f-b957-43dc-9c9e-020836c954a6	Not evaluated / unknown	Not evaluated / unknown	Not evaluated / unknown	Not evaluated / unknown	Not evaluated / unknown	Proxy
Other energy source (propane) [Custom PEF Flows]	Annual Consumption	MJ	Thermal energy from LPG	http://lcdn.thinkstep.com/Node/	ade98dea-0c74-4ebb-94ef-f9686eb0ddc5	1	1	1	2	1	Proxy
Outputs:											
Finished cold rolled strip [Custom PEF Flows]	Annual production	kg	#N/A		#N/A						
Clean scrap [Material recycling]	Annual production	kg	#N/A		#N/A						
Hazardous waste for incineration [Hazardous waste for disposal]	Annual production	kg	Waste incineration of hazardous waste	http://lcdn.thinkstep.com/Node/	fa158634-c471-4b0e-afef-407d1073b086	1	2	1	2	1	

Hazardous waste for land-filling [Hazardous waste for disposal]	Annual production	kg	Landfill of polluted inorganic waste	http://lcdn.thinkstep.com/Node/	749b650d-aa86-4027-95a1-f20f712a5631	2	2	2	2	2	
Hazardous waste for recycling or further processing [Custome PEF Flows]	Annual production	kg	Landfill of polluted inorganic waste	http://lcdn.thinkstep.com/Node/	749b650d-aa86-4027-95a1-f20f712a5631	2	2	2	2	2	Proxy
Metal scrap for recycling, excluding aluminium [Custome PEF Flows]	Annual production	kg	Landfill of inert (ferro metals)	http://lcdn.thinkstep.com/Node/	d1b67ec3-daf6-4978-ac86-c30bc6cd88c3	2	2	2	2	2	Proxy
Non-haz. waste for incineration [Custome PEF Flows]	Annual production	kg	Waste incineration of non-ferro metals, aluminium, more than 50µm	http://lcdn.thinkstep.com/Node/	f2c7614e-a50c-4f77-b49c-76472649acd6	1	2	1	2	1	
Non-haz. waste for land-filling [Custome PEF Flows]	Annual production	kg	Landfill of inert material (other materials)	http://lcdn.thinkstep.com/Node/	448ab0f1-4dd6-4d85-b654-35736bb772f4	2	2	2	2	2	
Non-hazardous waste for recycling or further processing [Custome PEF Flows]	Annual production	kg	Landfill of inert material (other materials)	http://lcdn.thinkstep.com/Node/	448ab0f1-4dd6-4d85-b654-35736bb772f4	2	2	2	2	2	Proxy

Table 11. Direct elementary flow collection requirements for mandatory process – Example of Aluminium: rolling and finishing

Emissions/resources	Elementary flow	Frequency of measurement	Unit	Default measurement method[13]	Remarks
Emissions	Chlorine [Inorganic emissions to air]	Annual emission (data collected according to BREF)	kg		
Emissions	Dust (PM10) [Particles to air]	Annual emission (data collected according to BREF)	kg		
Emissions	Hydrogen chloride [Inorganic emissions to air]	Annual emission (data collected according to BREF)	kg		
Emissions	Nitrogen dioxide [Inorganic emissions to air]	Annual emission (data collected according to BREF)	kg		
Emissions	Processed water to groundwater [Other emissions to fresh water]	Annual emission (data collected according to BREF)	kg		
Emissions	Sulphur dioxide [Inorganic emissions to air]	Annual emission (data collected according to BREF)	kg		
Emissions	Total organic carbon [Other emissions to air]	Annual emission (data collected according to BREF)	kg		

5.2 List of processes expected to run by the company

Some companies may also run upstream process related to raw material acquisition (including the metal production). Thus, this section covers:

- for steel: slab production;
- for copper: copper cathode production;
- for aluminium: ingot/slab production;
- for lead: ingot production.

[13] Unless specific measurement methods are foreseen in a country specific legislation. Methods taken from ROM - JRC Reference Report on Monitoring of emissions to air and water from IED installations (Update Final Draft July 2017)

The above processes and sub-processes are illustrated in the system boundary diagram Figure 3. Some companies may directly operate the above processes listed and sub-processes depending on their local situation. Two cases can be distinguished:

CASE 1: processes run by the company applying the PEFCR

In this case, according to the Data Needs Matrix, specific data shall be collected following the example of slab production for steel sheets in the respective Excel file – Life Cycle Inventory.
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 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 PEFCR 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 PEFCR regarding electricity.

R_1 (input of scrap) shall be modelled with company-specific data. Please refer to the Life Cycle Inventory Excel files.

CASE 2: processes not run by the company (see Sections 5.5.2 and 5.5.3)

This PEFCR has identified that slab/ingot production is also a most relevant process and therefore the DNM emphasises the need for those datasets to be representatives of the specific supply chain. Sheet producers that source slab from external sources shall follow the rules below and the requirements of the DNM:

- If primary sets are available (situation 2, option 1 of the DNM) use dataset for the relevant share of input it represents. Demonstrate that the data set represents the profile of technology and material input to the sheet production. Evidence shall be provided in the report.

- If primary data are not available, use the default dataset identified/provided in the PEFCR and apply the requirements of situation 2 option 2 or situation 3 option 1 of the DNM according to the specific situation and demonstrate that the data set represents the profile of the technology and material input for sheet production.

- If the actual 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 PEF report. A sensitivity analysis shall be included in the PEF report, to show the relevance of this limitation.

R_1 (input of scrap) shall be modelled with supplier-specific data. If no data is available, it shall be assumed to be primary production (R1 is set on zero – worst case scenario).

5.3 Data gaps

In case there is no specific or generic data available that is sufficiently representative of the given process in the product's life cycle, it should be filled with a data collection or a selection of available datasets that is a best available proxy (see also Section 5.6).

The selection of a best proxy from the list of available datasets (see Section 5.6). should be based on relevant expert judgement (such as sector experts) and shall be accompanied with an appropriate explanation respectively documentation.

All the proxies are specified in the respective Excel files - Life Cycle Inventory. For the processes in the table below, no appropriate proxies are available in the EF database and shall therefore not be included in any EF study that claims to be in compliance with this PEFCR:

Table 12: Data gaps with no suitable proxy in EF database

Data gap	***Unit***
Anticorroding Agent (unspecified)	kg
Deoiling agent	kg
Flocculating agent (unspecified)	kg
Oxidation inhibitor	kg

Data gap	*Unit*
Used oil	kg
Pickling solution (e.g. H_2SO_4, HCl)	kg
Absorbant for exhaust gas treatment	kg
Chlorine	kg
Fluxing salts	kg

To calculate the impact from these substances, the user should follow the guidance below:

- Check EF database for updates. If gap is closed, use data from EF database.
- If data gap is still there, and no data from the supplier of the substance is available, use data from life cycle databases e.g. ProBas, Gabi, Ecoinvent in accordance with DNM.

5.4 Data quality requirements

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:

$$DQR = \frac{\overline{Te_R} + \overline{G_R} + \overline{Ti_R} + \overline{P}}{4} \qquad \textit{[Equation B.1]}$$

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 sections provide tables with the criteria to be used for the semi-quantitative assessment of each criterion. 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 13.

> ***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 13. *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) TiR and P shall be evaluated at the level of the activity data (named TiR-AD, P-AD) and (ii) TeR, TiR and GR shall be evaluated at the level of the secondary dataset used (named TeR-SD, TiR-SD and GR-SD). As TiR is evaluated twice, the mathematical average of TiR-AD and TiR-SD represents the TiR 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 3).*

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

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.*

Table 13. How to assess the value of the DQR criteria for datasets with company specific information

Prescriptions of this table apply for:

- Aluminium and steel: rolling and finishing;
- Copper and lead: melting, casting, rolling and finishing.

	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 and externally verified*	*The data refers to -=< 2 years with respect to the EF report publication date*	*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 maximum 4 annual administration periods with respect to the EF report publication date*	*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 maximum 6 annual administration periods with respect to the EF report publication date*	*Not applicable*	*Not applicable*	*Not applicable*
4-5	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

5.5 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific (listed in Section 5.1) shall be evaluated using the Data Needs Matrix (see Table 13). The DNM shall be used by the PEFCR applicant to evaluate which data is needed and shall be used within the modelling of its PEF, 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:

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

Table 14. Data Needs Matrix (DNM)[14]

* Disaggregated datasets shall be used.

		Most relevant process	Other process
Situation 1: process run by the company applying the PEFCR	**Option 1**	Provide company-specific data (as requested in the PEFCR) 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 PEFCR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process <u>not</u> run by the company applying the PEFCR but with access to (company-)specific information	**Option 1**	Provide company-specific data (as requested in the PEFCR) 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 PEF 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 PEF compliant datasets (DQR ≤4.0). Use the default DQR values
Situation 3: process <u>not</u> run by the company applying the PEFCR and <u>without</u> 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 PEFCR, in aggregated form (DQR ≤4.0) Use the default DQR values

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

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

Situation 1/Option 1
For all processes run by the company and where the 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 PEFCR together with its default DQR values listed here.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR 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 PEFCR, but there is access to company-specific data, then there are two possible options:

- *The company applying the PEFCR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[15] (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 PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in Section 5.4.1.

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

Situation 2/Option 2

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

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

The applicant of the PEFCR shall make the DQR values of 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%[16] and the criteria P shall keep the original value.

In addition, new background datasets shall be used where the geographical coverage of the background dataset for most relevant process does not closely match the specific supply chain situation. For instance, when supply of metal is known to come from a specific region or country, yet the EF compliant dataset represents Rest of World.

For steel slab: A new ILCD compliant dataset shall be used when the geographic region, raw material mix and composition, energy carriers and specific valorisation of the by-products are not reflecting the background dataset. This is because the disaggregation of the electricity production alone is not the main contributor to the environmental profile of slab production via integrated route, and so further disaggregation is necessary. A new ILCD compliant slab production dataset can be obtained by use of company specific LCI data collection and modelling of all activity data and upstream processes as per Worldsteel LCI model as a proxy. This shall include all sub-processes of slab production including raw material upstreams, coke making, sintering, scrap, blast furnace, steelmaking, power plant and accounting for by-products. See: https://www.worldsteel.org/en/dam/jcr:6eefabf4-f562-4868-b919-f232280fd8b9/LCI%2520methodology%2520report_2017_vfinal.pdf

Situation 2/Option 3

For the non-most relevant processes, the applicant may use the corresponding secondary dataset listed in the PEFCR together with its DQR values.

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

Table 15. How to assess the value of the DQR criteria 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 countr-y/-ies the dataset is valid for.*

[16] 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.

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 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.*

5.5.3 Processes in situation 3

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

- *It is in the list of most relevant processes (Option 1)*
- *It is not in the list of most relevant processes (Option 2)*

<u>Situation 3/Option 1</u>

In this case, the applicant of the PEFCR shall make the DQR values of the dataset used 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.
Additionally, this PEFCR requires that $G_R \leq 2$ for this situation.

When assessing the DQR of background datasets (slab, Al ingot, Cu cathode….) in situation 3, the following criteria should be applied.

Table 16. How to assess the value of the DQR criteria when background 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*	*>90% of the origin of the metal supply corresponds to the geographical coverage of the dataset**

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*	*89-75% of the origin of the metal supply corresponds to the geographical coverage of the dataset**
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*	*74-50% of the origin of the metal supply corresponds to the geographical coverage of the dataset**
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*	*49-25% of the origin of the metal supply corresponds to the geographical coverage of the dataset**
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*	*>25% of the origin of the metal supply corresponds to the geographical coverage of the dataset or cannot be calculated **

* To assess Geographical representativeness (G_R), one shall look at the share of metal supply from each relevant region (% weight) as part of metal supply processed by the organization, check the deviation in comparison with the share of same region as covered by the data set and calculate weighted average deviation (%).

Situation 3/Option 2

For the non-most relevant processes, the applicant shall use the corresponding secondary dataset listed in the PEFCR together with its DQR values.
If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the original dataset.

5.6 Which datasets to use?

The secondary datasets to be used by the applicant are those listed in this PEFCR. Whenever a dataset needed to calculate the PEF-profile is not among those listed in this PEFCR, 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 Section 5.4 shall be used.

5.8 Allocation rules

The following Table 17 provides the allocation rules for co-products from processes under the scope of this PEFCR. It is based upon the paper Harmonization of LCA Methodologies for Metals [ICMM 2014].
In the exceptional cases where process scrap is leaving the system boundary, system expansion shall be used. In cases where waste for recovery leaves the boundary system, system expansion shall be used.
System expansion can only be applied, if alternative processes can be defined and where technologies are considered which deliver significant amounts of materials. If that is not possible, allocation needs to be applied.

Table 17. Allocation rules

Process	***Allocation rule***	***Modelling instructions***
Aluminium Production Processes		
Aluminium melting furnace	System expansion	Considering the metal aluminium fraction in dross (about 60%w) and salt slag (about 30%w) by converting it into aluminium ingot with a metal yield of 90% via recycling [Recycling of aluminium into aluminium ingot – from post-consumer; collection, transport, pre-treatment, remelting; production mix, at plant; aluminium waste, efficiency 90%; UUID: c4f3bfde-c15f-4f7f-8d35-bed6241704db] and assuming a substitution of primary aluminium [Aluminium ingot mix (high purity); primary production, aluminium casting; single route, at plant; 2.7 g/cm3, >99% Al (en);

		UUID: e3f12a3b-6cb9-49ab-b437-f6f7df83ec62]; Data node http://lcdn.thinkstep.com/Node
Steel Production Processes		
Steelmaking coke ovens	Partitioning based on energy relationship of inputs and outputs	Sub-division of process based on energy relationships of inputs and outputs according to Worldsteel 'Co-product methodology for the steel industry'. Approximate energy split 83% coke: 17% co-products (Coke oven gas, Benzene, Tar, Toluene, Xylene, Sulphuric acid, Ammonia)
Blast furnace hot metal (pig iron) production	1) Hot melt of pig iron and blast furnace-slag: Sub-division by physical partitioning 2) Blast furnace gas: system expansion	1) Sub-division of processes based on physical partitioning of inputs and outputs according to Worldsteel 'Co-product methodology for the steel industry'. Approximate energy split: 95% Hot metal: 5% blast furnace slag 2) System expansion by substituting natural gas mix [UUID 8ede8686-62d3-46d6-9ce6-59476542bdb0] Data node: http://lcdn.thinkstep.com/Node/
Basic oxygen steel production	1) Hot melt of pig iron and blast furnace-slag: Sub-division by physical partitioning 2) Blast furnace gas: system expansion	1) Sub-division of processes based on physical partitioning of inputs and outputs according to Worldsteel 'Co-product methodology for the steel industry'. Approximate energy split: 95% Hot metal: 5% blast furnace slag 2) System expansion by substituting natural gas mix [UUID 8ede8686-62d3-46d6-9ce6-59476542bdb0]. Data node: http://lcdn.thinkstep.com/Node/
Other secondary steelmaking and steel processing operations	1) Hot melt of steel and secondary steelmaking slag: Sub-division by physical partitioning 2) Mill scale: system expansion	1) Sub-division of processes based on physical partitioning of inputs and outputs according to Worldsteel 'Co-product methodology for the steel industry'. 2) System expansion by substituting Ferrite (iron ore); iron ore mining and processing; production mix, at plant; 5.00 g/cm3 [UUID 483f8675-daf6-

	3) Pickling liquor: system expansion	4105-b0f7-699c7deb2e84] Data node http://lcdn.thinkstep.com/Node/ 3) System expansion by substituting: • iron (III) chloride production technology mix production mix, at plant 100% active substance [UUID: caabff9b-4d10-417d-8c1a-59d38a06a14c]; Data node: http://ecoinvent.lca-data.com/ or • iron oxide production depending on end use Ferrite (iron ore); iron ore mining and processing; production mix, at plant; 5.00 g/cm3 [UUID: 483f8675-daf6-4105-b0f7-699c7deb2e84] Data node http://lcdn.thinkstep.com/Node/
Copper Production Processes		
Copper ore/concentrate production	Mass allocation	Shared burden according to the mass fraction of metal content Ore type (e.g. low grade, sulfidic, oxidic) Molybdenum concentrate Other metal concentrates
Copper smelting process	System expansion	Alternative production routes for sulphuric acid, lead tin alloy, steam and iron silicate: • Sulphuric acid = Sulphuric acid production technology mix, production mix, at plant, 100% active substance, UUID: eb6abe54-7e5d-4ee4-b3f1-08c1e220ef94 • Lead tin alloy = 70-30 Pb-Sn ratio of primary lead (production)/primary production, mining and processing production mix, at plant 11.3 g/cm^3 (UUID: 6edc85f3-d53b-4a2e-8e7b-7d834fce666a) and tin/sand extraction and processing, reduction production mix, at plant 118.71 g/mol (UUID: 59d6c0bf-add6-43fd-95f3-2134fac381fa) production

		• Steam = Steam dataset from natural gas, EU-28+3 Process steam from natural gas, UUID: 2e8bee44-f13b-4622-9af3-74954af8acea • Iron silicate = Gravel wet and dry quarry, drying production mix, at plant grain size 2/32, UUID: 9b32db32-4503-4238-9768-2d3c6b5bce0d
Copper refining process	Economic allocation	Allocation by market value for: • Copper cathode • Gold, Silver, Platinum, Palladium, Rhenium, Selenium, Tellurium based on their content in the anode slimes • Nickel sulphate The market value shall be based on average price for latest 10 years. The sources to be used to determine the reference price are: • London Metal Exchange (LME) listings: copper, • London Bullion Market Association listings: gold, silver, platinum, palladium • MetalBulletin.com/MetalPrices.com: tellurium, selenium, rhenium; • For nickel sulphate there are no market listings[17]. A common price cannot be determined therefore every organization shall take into account its own price and give evidence for the used price. Price is an effect of contractors' negotiation and it is based on the general formula: Price = market value of the valuable elements – contractors unit processing cost.
Copper sheet production	System expansion	Copper recovery in a smelter from: • Flue dust (filter dust) – cut-off applied • Dross (Copper scale) – cut-off applied

[17] According to the PEF guidelines the allocation factor shall be fixed in the PEFCR. However, in this exceptional case allocation factor could not be fixed. As this PEFCR is for an intermediate product no benchmark is available and comparability is less relevant.

Lead Production Processes		
Lead melting	Mass allocation	Mass of lead metal, i.e. considering the metal lead fraction (about 70%) in dross

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 & 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 can 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 PEF 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 PEF studies.*

<u>Set of minimal criteria to ensure contractual instruments from suppliers</u>:

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.*

<u>Modelling 'country-specific residual grid mix, consumption mix'</u>:

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 (<u>http://lcdn.thinkstep.com/Node/</u>). In case the necessary dataset is not available, an alternative dataset shall be chosen according to the procedure described in Section 5.8. 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:

For this PEFCR on metal sheet, it is critical to reflect properly the origins of the metal supply (i.e. slabs/ingot). The following Table 18 illustrates how such metal origin shall be considered for calculating the electricity mix in Situation 2/Option 2.

Table 18. Modelling of electricity for upstream processes – example for ingot/slab/cathodes

Process	Physical relationship	Modelling instructions
Ingot/Slabs/Cathodes from Region A	20%* by weight of the metal supply – Electricity mix A	The consolidated electricity mix shall consider same percentage as physical relationship (20%*) of Electricity mix A
Ingot/Slabs/Cathodes from Region B	30%* by weight of the metal supply – Electricity mix B	The consolidated electricity mix shall consider same percentage as physical relationship (30%*) of Electricity mix B
Ingot/Slabs/Cathodes from Region C	50%* by weight of the metal supply – Electricity mix C	The consolidated electricity mix shall consider same percentage as physical relationship (50%*) of Electricity mix C

* percentages are examples only

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, see Table 18 for illustration, *if a fraction of this total kWh consumed is coming from a specific supplier a supplier-specific electricity mix shall be used for this part. See below for on-site electricity use.*

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

a. *The production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site may be used.*
b. *The production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product specific information (measure, record, bill) may be used.*
c. *All the products produced in the specific plant are supplied with a public available PEF study. The company who wants to make the claim shall make all PEF studies available. The allocation rule applied shall be described in the PEF study, consistently applied in all PEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.*

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

- *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 PEF study.*
- *If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[18].*
- *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.*

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

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[19] 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 (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 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[20] 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

[19] 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.
[20] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2).

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.

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

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

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

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

1. *where the country of production is known, and the previous land use is known, the GHG emissions and removals arising from land use change shall be those resulting from the change in land use from the previous land use to the current land use in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*
2. *where the country of production is known, but the former land use is not known, the GHG emissions arising from land use change shall be the estimate of average emissions from the land use change for that crop in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*
3. *where neither the country of production nor the former land use is known, the GHG emissions arising from land use change shall be the weighted average of the average land use change emissions of that commodity in the countries in which it is grown.*

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

Soil carbon storage shall be modelled, calculated and reported as additional environmental information but it is not required in this PEFCR.

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

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

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

5.11 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 first part of this section covers the Circular Footprint Formula (CFF) and its parameters in general, whereas the rest of the section covers the aspects specifically for intermediate products, i.e. metal sheets.

For final products:

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

For construction products:

The Circular Footprint Formula is used to model the End-of-Life of products as well as the recycled content:

Production burdens	$(1-R_1)E_V + R_1 \times E_{recycled}$	**Cradle-to-gate**
Burdens and benefits related to secondary materials input	$-(1-A)R_1 \times \left(E_{recycled} - E_V \times \frac{Q_{Sin}}{Q_P}\right)$	**Additional information from the EoL stage**
Burdens and benefits related to secondary materials output	$(1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$	

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

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

With the following parameters:
***A:** allocation factor of burdens and credits between supplier and user of recycled materials.*

***B:** allocation factor of energy recovery processes: it applies both to burdens and credits. It shall be set to zero for all PEF 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.*
This PEFCR interprets 'material from a previous system' as 'scrap coming from another product system'.
Note: Scrap generated from within the production system under study shall not be considered in the R_1 calculation but shall be modelled according to the sections 7.18.7.2 and 7.18.7.4 of the PEFCR Guidance ver. 6.3 (May 2018). This PEFCR requires a modelling according to option 2 of the Guidance, i.e. scrap generated along the production chain are closed-loop recycled.
Any yield loss from melting secondary raw material inputs shall be already accounted for. If this information is not directly available, the choice of any proxy shall be clearly stated, explained and justified.

***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.*
This PEFCR interprets 'at the output of the recycling plant' as all the material losses in the collection, sorting and recycling (or reuse) processes up to the point of final substitution (e.g. the slab).

***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.*
Note: In this PEFCR $E_{recycled}$ may include melting depending on the point of substitution.

$E_{recyclingEoL}$ (E_{recEoL}): specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.
Note: In this PEFCR $E_{recyclingEoL}$ may include melting depending on the point of substitution.

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.

For intermediate products the formula shall be applied with the following factors as required in Section 7.18.12 of the PEFCR Guidance ver. 6.3 (May 2018):

- R_2, R_3, and E_d equal to 0

For metal sheet, the quality ratios are fixed to 1, e.g. $\frac{Q_{Sin}}{Q_p}$ & $\frac{Q_{Sout}}{Q_P}$ as reported in the Annex C – List of default values for A, R1, R2, R3 and Qs/Qp. The Excel file 'CFF_Default_Parameters_March2018.xlsx' is downloadable at:

- http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm
- the 2 following options for A factor
    - A = 1 (to be used as default in the PEF profile calculation)

$$= (1 - R_1)E_V + R_1 \times \ E_{recycled}$$

    - A=0.2 (as material-specific value to calculate the EF datasets of the Representative Products):

$$= \ (1 - R_1)E_V + R_1 \times \left(AE_{recycled} + (1 - A)E_V \times \frac{Q_{Sin}}{Q_p} \right)$$
$$= (1 - R_1)E_V + R_1 \times \left(0{,}2E_{recycled} + (0{,}8)E_V \times 1\right)$$

For calculating the mandatory additional technical information (the EoL stage of metal sheet), the formula shall also be applied with A=0.2, default R_2 values depending on the final product application (see Table 3 from Section 3.3 Functional unit) and $R_3 = 0$.
Hence, the results of the following equation related to the EoL stage shall be reported as a complementary information to the previous material-specific result:

$$\mathbf{(1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right) + (1-R_2) \times E_D}$$

$$= \mathbf{(0,8)R_2 \times \left(E_{recyclingEoL} - E_V^* \times 1\right) + (1-R_2) \times E_D}$$

Determination of E_v, $E_{recycled}$ and R_1,

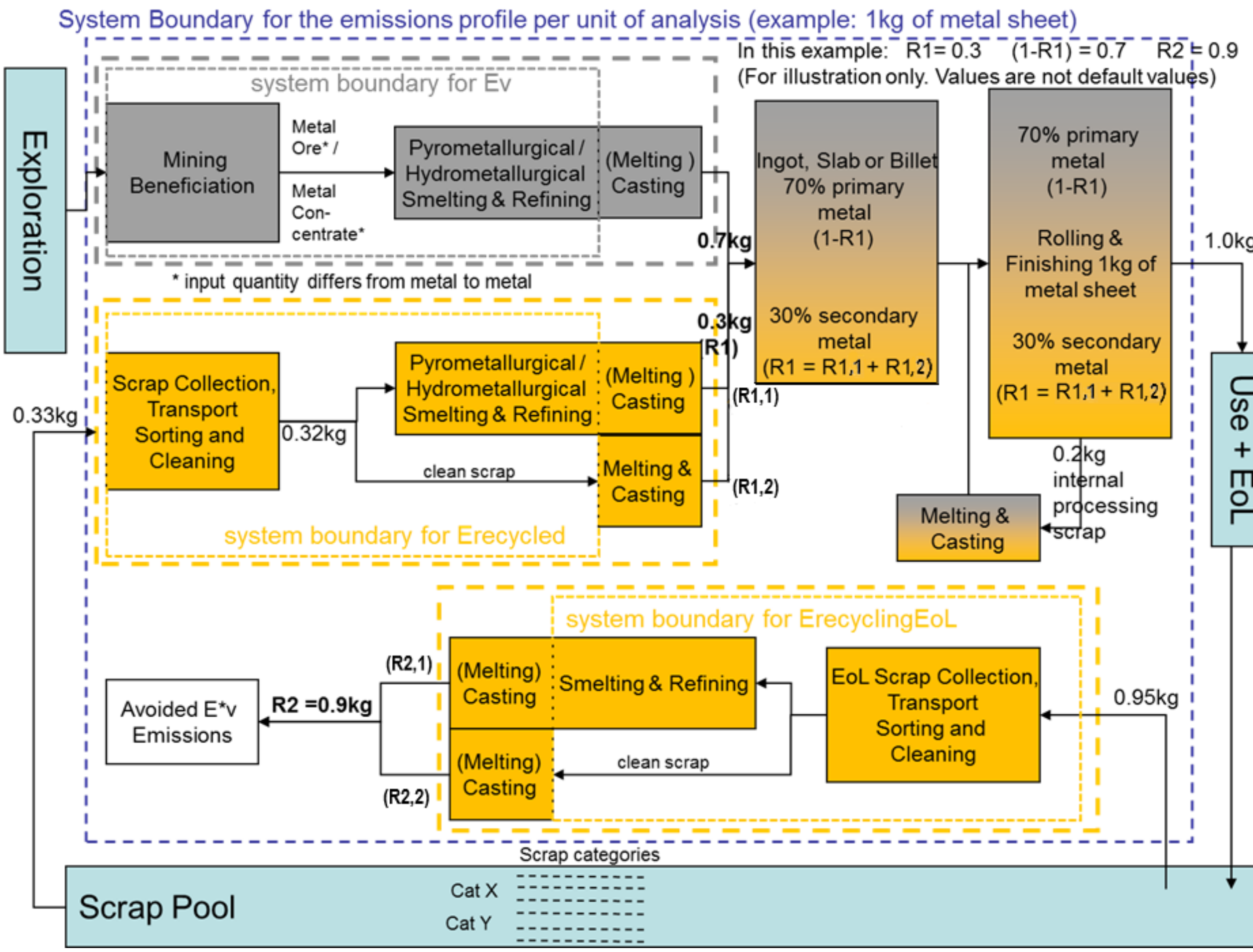
The requirements for R_1, i.e. supply chain specific or default figure, are defined in Table 30 of the PEFCR Guidance ver. 6.3 (May 2018). R_1 shall be calculated at the point of substitution.

The requirements regarding E_v and $E_{recycled}$, i.e. company-specific datasets or default secondary datasets, are defined in Table 35 of the PEFCR Guidance ver. 6.3 (May 2018). E_v and $E_{recycled}$ shall include all the relevant processes up to the point of substitution.

The following section provides guidance for the definition of the point of substitution.
As illustrated in the diagram below, the point of substitution can be defined as the point at which recycled material effectively substitutes primary material. In the case of metals, these recycling operations involve transforming metallic scrap (of varying composition) into metallic ingot, slab or billet of specified purity and composition with well-defined properties. These recycling operations can include smelting, refining, melting and alloying processes. For metal sheet, the point of substitution can be defined at different places of the production chain. For aluminium and steel sheet the point of substitution is at slab, which is the starting material for sheet production. The point of substitution for copper and lead sheet is after refining the metal (to copper cathode or lead ingot) and prior to melting and casting of a shape (slab). In the case of reuse of metallic sheet, the substitution can occur downstream of the slab level.

Figure 4. Illustration of the metal mass flow and system boundaries for the various terms used in the modular version of the integrated recycling equation for 1kg of metal sheet

Legend:
Grey: primary production profile, Yellow: secondary production



The CFF shall be applied at the point of substitution. The point of substitution is defined as follows for:

Aluminium

Point of substitution located at the slab (ingot) level.

- E_v: includes all the processes from bauxite mining up to slab casting (default datasets shall be used: UUID e3f12a3b-6cb9-49ab-b437-f6f7df83ec62 – Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al)
- $E_{recycled}$ includes the scrap preparation, sorting and melting & purification up to ingot casting (default datasets shall be used: UUID c4f3bfde-c15f-4f7f-8d35-bed6241704db – Recycling of aluminium into

aluminium ingot – from post-consumer collection, transport, pre-treatment, remelting production mix, at plant aluminium waste, efficiency 90%).

Copper

Before melting and casting of slab.

There are 2 recycling routes:

1) Secondary copper cathode $E_{rec\ 1}$: substituting primary copper cathode (E_v)

Default dataset shall be used: UUID 7169B9E0-13B2-4DD4-A126-B3983ED8B7A1 – Secondary Copper Cathode, copper scrap smelting and refining, single route, at plant.

2) Clean copper scrap $E_{rec\ 2}$: substituting primary copper cathode (E_v)

Default dataset shall be used: UUID 23a1a30f-e160-45bd-b586-ce56e46d4537 – Recycling of copper from clean scrap collection, transport, pre-treatment, production mix, at plant, copper waste, efficiency 90%.

Lead

Before melting and casting of slab.

There are 2 recycling routes:

1) Secondary lead ingot $E_{rec\ 1}$: substituting primary lead ingot (E_v)

Default dataset shall be used: UUID CEA35694-472D-400D-9667-D2025A700626 – Secondary lead secondary production, melting of lead scrap, single route, at plant,11.3 g/cm3.

2) Clean lead scrap $E_{rec\ 2}$: substituting primary lead ingot (E_v)

Default dataset shall be used: UUID 3309a9b5-760d-42a0-bf5c-6d946e11276a – Recycling of lead into lead scrap collection, transport, pre-treatment, production mix, at plant, lead waste, efficiency 89%.

Steel

Point of substitution located at slab level (melting, refining and casting).

E_v: includes all the processes from iron ore up to slab casting (default datasets shall be used: BF slab (theoretical 100% primary) UUID: f9f05832-5f4a-4dd1-809e-7c8bcff924b8, http://eplca.jrc.ec.europa.eu/EF-node/)

- $E_{recycled}$ includes the scrap preparation, sorting and melting & purification up to ingot casting (default datasets shall be used: UUID: 7bd54804-bcc4-4093-94e4-38e4facd4900 - Recycling of steel scrap into steel billet collection, transport, pre-treatment, remelting production mix, at plant steel waste, efficiency 95%).

Users of this PEFCR that are in 'Situation 1, Option 1' of the DNM for aluminium and steel slab production, lead ingot production shall develop company specific $E_{recycled}$ and E_V. All users of this PEFCR shall apply company specific R1.

Users of this PEFCR that are in 'Situation 1, Option 1' of the DNM for copper cathode production shall develop company specific $E_{recycled}$ and E_V. All users of this PEFCR shall apply company specific R1.

Also for the Situation 2 the user can adapt the default datasets with specific information on transport and electricity. Recycled content significantly influences the environmental profile of metal sheet, therefore where there is no company specific information the default application specific value shall be set to zero.

Table 19. Default parameters to apply the CFF formula for intermediate products (A=1)

	A	R1	Q_{sin}/Q_p	$E_{recycled}$	E_v
Aluminium slab	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Recycling of aluminium into aluminium ingot - from post-consumer	Aluminium ingot mix primary production
Copper: Clean copper scrap	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Recycling of copper from clean scrap collection, treatment, pre-treatment	Primary copper cathode
Copper: Secondary copper cathode	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Secondary copper cathode	Primary copper cathode
Lead ingot	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Secondary lead ingot	Primary lead ingot
Lead scrap	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Recycling of lead into lead scrap	Primary lead ingot
Steel slab	1	Company specific supply-chain For situation 2 and 3 default value is set at zero	1	Recycling of steel scrap into steel billet collection, transport, pre-treatment, remelting production mix, at plant steel waste, efficiency 95%	EU: 1 kg BF Slab (theoretical 100% primary)

Table 20. Default parameters to apply the CFF for the EoL of the intermediate product

This shall be reported as an additional information	**A**	**R2**	**Q_{sin}/Q_p**	**$E_{recyclingEoL}$**	**E^*_v**
Aluminium	0,2	0,9 (for appliance) 0,95 (for building)	1	Recycling of aluminium into aluminium ingot - from post-consumer	Aluminium ingot mix primary production
Copper	0,2	0,95	1	Recycling of copper from clean scrap	Primary copper cathode
Lead	0,2	0,95	1	Recycling of lead into lead scrap	Lead (primary)
Steel	0,2	0,9 (for appliance) 0,95 (for building)	1	Recycling of steel scrap into steel billet collection, transport, pre-treatment, remelting production mix, at plant steel waste, efficiency 95%	EU: 1 kg BF Slab (theoretical 100% primary)

6. Life cycle stages

6.1 Raw material acquisition and pre-processing

The life cycle stage 'Raw materials acquisition' includes the production of the metal as an input to the sheet production. This could be copper cathode, aluminium slab, steel slab, lead ingot.

For raw materials transport activities the primary data for transport should be collected on distance with different means of transport with train, road and ship (see respective Life Cycle Inventory Excel Files for each metal). If specific data is not available, default values from PEF Guidance (ver. 6.3), Section 7.14.2 From supplier to factory shall be used.

Table 21. Raw material acquisition and processing – Example: Copper

Process name*	***Unit of measurement (output)***	***Default***				***UUID***	***Default DQR***				***Most relevant process [Y/N]***
		R_1	***Amount per FU***	***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-18724142842f	2	1	3	1	Y
PRIMARY CATHODE	ton	0	Company specific	EU-28+EFTA Copper billet/slab (smelting and refining to produce primary copper cathode)	http://lcdn.thinkstep.com/Node/	664b08b1-9025-4d25-acab-eb138575848f	2	1	2	1	Y

Secondary Cathode	ton	1	Company specific	EU-28+EFTA Secondary Copper Cathode	http://lcdn.thinkstep.com/Node/	7169B9E0-13B2-4DD4-A126-B3983ED8B7A1	2	1	2	2	Y
Copper scrap	ton		Company specific	EU-28+EFTA Recycling of copper from clean scrap	http://lcdn.thinkstep.com/Node/	0e206ca6-5ee9-4e65-b8f4-fc70c923e7b5	2	2	2	2	N

** in CAPITAL LETTERS the name of those processes expected to be run by the company*

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

The modelling of transports to the production site shall be done using primary activity data: a data collection template is provided in the Excel Life Cycle Inventory files. The user shall check and adapt the utilisation factor according to the PEFCR Guidance Section 7.14.

Modelling the recycled content

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 specific at the point of substitution *and w*hen supply-chain specific information is not available, the default R1 value is equal to 0 (see Table 19). *Material-specific values based on supply market statistics are not accepted as a proxy. The applied R_1 values shall be subjected to PEF 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 a PEF profile is calculated and reported, this shall be stated as additional technical information of the PEF profile.*
- *Company-owned traceability systems can be applied as long as they cover the general guidelines outlined above.*

Primary data for transport should be collected for the core process (this means cathodes, scrap, slab, ingot as an input to the rolling/melting process). From supplier to factory this means the mode of transport, transport distance and the utilization ratio.
If no primary data for transport is available, the default transport modelling as described in PEFCR Guidance ver. 6.3 (May 2018) shall be used.

6.2 Manufacturing

Manufacturing of the metal sheet includes:

- for Al and steel: rolling and finishing
- for Cu and Pb: melting, casting, rolling and finishing

as described in Section 3.4 and Annex 5.
In addition, the data requirements for the manufacturing are described in Section 5.1. Please see also the respective Excel Life Cycle Inventory files.

6.3 Distribution stage

The transport of the metal sheet for the final product fabrication is outside of the scope of this PEFCR.

6.4 End-of-Life

As intermediate products, metal sheets will reach End-of-Life in a final product. However, to calculate the mandatory additional information on End-of-Life recycling refer to Section 7.3 of this PEFCR.

7. PEF results

7.1 Benchmark values

Intermediate products are excluded from the benchmarks results. Each representative product has its own environmental footprint at the intermediate level and cannot be compared to any of the other representative products at this level. Only when a function is well-defined, and the life cycle assessment is performed on the entire life cycle of this final function (including the use phase and the end of life stage), benchmarking could be considered.

7.2 PEF profile

The applicant shall calculate the PEF profile of its product in compliance with all requirements included in this PEFCR. The following information shall be included in the PEF 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.*

Together with the PEF report, the applicant shall develop an aggregated EF-compliant dataset of its product in scope. This dataset shall be made available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node). The disaggregated version may stay confidential.

7.3 Additional technical information

For intermediate products:

- *The recycled content (R_1) shall be reported.*
- *Results with application-specific A-values, if relevant.*

As intermediate products, metal sheets will reach End-of-Life in a final product. However, for the purpose of communicating adequately the mandatory additional environmental information about the end of life stage (including end of life recycling rate R_2), the Circular Footprint Formula shall be applied using A=0,2.
Specific attention should be paid to determine company-specific R2 correctly including material and product properties such as disassembling ability, recyclability, recoverability, reusability and resource efficiency in the implementation of the CFF.
It is indeed crucial to consider properly the recycling aspects over the full life cycle for metal containing products.
More detailed information about the application of the CFF can be found in Section 5.11 and Annex 5.

The following procedure shall be followed by the applicant to select the right R2 value:

- Company-specific values shall be used when available.
- If no company-specific values are available and the criteria for evaluation of recyclability are fulfilled (see below), application-specific R2 values shall be used as listed in the table 22.

Table 22. Default parameters to apply the CFF for the EoL of the intermediate product

This shall be reported as an additional information	**A**	**R2**	**Q_{sin}/Q_p**	**$E_{recyclingEoL}$**	**E^*_v**
Aluminium	0,2	0,9 (for appliance) 0,95 (for building)	1	Recycling of aluminium into aluminium ingot - from post-consumer	Aluminium ingot mix primary production
Copper	0,2	0,95	1	Recycling of copper from clean scrap	Primary copper cathode
Lead	0,2	0,95	1	Recycling of lead into lead scrap	Lead (primary)
Steel	0,2	0,9 (for appliance) 0,95 (for building)	1	Recycling of steel scrap into steel billet collection, transport, pre-treatment, remelting production mix, at plant steel waste, efficiency 95%	EU: 1 kg BF Slab (theoretical 100% primary)

Requirements for calculating the EoL for all the metals are included in Section 6.4 in the Life Cycle Inventory Files. The below table lists the required information giving example for lead.

Table 23. End of Life – Example: Lead

Name of the process	***Unit of measurem. (output)***	***Default amount per FU***	***Default dataset to be used***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant process [Y/N]***
						P	***Ti_R***	***G_R***	***Te_R***	
Primary material input	kg	Company specific	EU-28+EFTA Lead (primary)	http://lcdn.thinkstep.com/Node/	6edc85f3-d53b-4a2e-8e7b-7d834fce666a	2	1	2	1	N
Secondary material input, as recycled (R11) [Auxiliary flow]	kg	Company specific	EU-28+EFTA Recycling of lead into lead scrap	http://lcdn.thinkstep.com/Node/	3309a9b5-760d-42a0-bf5c-6d946e11276a	2	2	2	2	Y
Secondary material input, as recycled (R12) [Auxiliary flow]	kg	Company specific	EU-28+EFTA Secondary lead	http://lcdn.thinkstep.com/Node/	CEA35694-472D-400D-9667-D2025A700626	2	2	2	1	Y
Secondary material input, as virgin [Auxiliary flow]	kg	Company specific	EU-28+EFTA Lead (primary)	http://lcdn.thinkstep.com/Node/	6edc85f3-d53b-4a2e-8e7b-7d834fce666a	2	1	2	1	N
Material output to material recycling, burdens [Auxiliary flow]	kg	Company specific	EU-28+EFTA Recycling of lead into lead scrap	http://lcdn.thinkstep.com/Node/	3309a9b5-760d-42a0-bf5c-6d946e11276a	2	2	2	2	Y
Material output to energy	kg	Company specific	EU-28+EFTA Waste	http://lcdn.thinkstep.com/Node/	f7f901df-00b5-4b60-bf66-cf0336235dd0	2	1	1	2	Y

recovery, burdens [Auxiliary flow]			incineration of non-ferro metals, others							
Material output to disposal, burdens [Auxiliary flow]	kg	Company specific	EU-28+EFTA Landfill of inert (lead)	http://lcdn.thinkstep.com/Node/	7107e3f4-4ebd-4f8d-9e36-ec5d0df9cc3b	2	2	2	2	N
Material output to material recycling, credits [Auxiliary flow]	kg	Company specific	EU-28+EFTA Lead (primary)	http://lcdn.thinkstep.com/Node/	6edc85f3-d53b-4a2e-8e7b-7d834fce666a	2	1	2	1	N

7.4 Additional environmental information

Biodiversity

The relevance of biodiversity for the PEFCR is expressed by the indicators below.

Reporting of biodiversity impacts is relevant when determining an Environmental Footprint, including potential impacts arising from the metals sector and its supply chain on land-based, fresh- and marine-water ecosystems. However, it is not appropriate to consider *a priori* that impacts on biodiversity represent an environmental hotspot of a metal product system. An Environmental Footprint can, therefore, only indicate whether there is a significant risk that biodiversity impacts could result from the life cycle of the product concerned.

The PEF results for Climate Change; Acidification; Eutrophication – terrestrial; Eutrophication – aquatic (freshwater); Eutrophication – aquatic (marine); Water Scarcity; and Land Use collectively address potential impacts on biodiversity from material flows.[21]

However, biodiversity impacts are generally more relevant to specific locations (e.g., biodiversity hotspots and site-based practices) rather than products. It may in future be possible to indicate under Additional Environmental Information if a material risk of biodiversity impacts resulting from site-based practices is identified. 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).

Delayed emissions

Credits due to delayed emission shall not be considered. The models shall assume that manufacturing and end-of-life take place at the same time. Hence, any effects that would arise, if manufacturing and end-of-life are separated in time are neglected. This is considered as a conservative approach. Delayed emissions may be included as 'additional environmental information' according to the PEF Guide.

The TS however recommends not to include information on delayed emissions in the PEF.

8. Verification

The verification of an EF study/report carried out in compliance with this PEFCR shall be done according to all the general requirements included in Section 8 of the PEFCR Guidance ver. 6.3 (May 2018) and the requirements listed below.

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

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.

[21] Global Reporting Initiative (2007) Biodiversity a GRI Reporting Resource

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[22];*
- *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;*
- *the aggregated EF-compliant dataset of the product in scope (meaning, the EF study) is available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node).*
- *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 include 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.*
- the verifier shall check and validate the recycled content (R_1) and EoL recycling rate (R_2) values.

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 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 PEFCR Guidance ver. 6.3 (May 2018).

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

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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 PEF study

Each PEF study shall include this annex, completed with all the requested information[23].

ITEM	Included in the study (Y/N)	Section	Page
[This column shall list all the items that shall be included in PEF studies. One item per row shall be listed.]	*[The PEF study shall indicate if the item is included or not in the study.]*	*[The PEF study shall indicate in which section of the study the item is included.]*	*[The PEF study shall indicate in which page of the study the item is included.]*
Summary			
General information about the product			
General information about the company			
Diagram with system boundary and indication of the situation according to DNM			
List and description of processes included in the system boundaries			
List of co-products, by-products and waste			
List of activity data used			
List of secondary datasets used			
Data gaps			
Assumptions			
Scope of the study			

[23] This requirement does not apply to PEFCRs developed during the Environmental Footprint pilot phase (2013-2018).

ITEM	*Included in the study (Y/N)*	*Section*	*Page*
(Sub)Category to which the product belongs			
DQR calculation of each dataset used for the most relevant processes and, the new ones created.			
DQR (of each criteria) of the study			

ANNEX 3 – Critical review report of the PEFCR

Product Environmental Footprint Category Rules (PEFCR) for "Metal Sheets for various applications"

CRITICAL REVIEW REPORT

Review Panel

Name of the member	***Affiliation***	***Role***
Ugo Pretato	Studio Fieschi & soci Srl	Chair of the review panel
Karolien Peeters	VITO NV	Member of the review panel
Peter Saling	BASF SE	Member of the review panel

Review Scope

The task of the review panel was to assess the compliance of the PEFCR document against the following requirements:

- The PEFCR has been developed in accordance with the requirement provided in the PEFCR Guidance 6.3, and where appropriate in accordance with the requirements provided in the most recent approved version of the PEF Guide, and supports creation of credible and consistent PEF profiles,
- The functional unit, allocation and calculation rules are adequate for the product category under consideration,
- Company-specific and secondary datasets used to develop this PEFCR are relevant, representative, and reliable,
- The selected LCIA indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in the PEFCR Guidance and the most recent approved version of the PEF Guide,
- Both LCA-based data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product.
- The information provided in the supporting studies on copper and steel sheets have been considered to secure that this PEFCR is applicable for all metals covered by this PEFCR

Review Process

The review has been performed in two distinct rounds.

The first round was carried out in November and December 2016 on a previous version of the PEFCR document and against the requirements of the PEFCR guidance version 5.2. The panel made several comments, most of which were satisfactorily addressed by the Technical Secretariat in an updated PEFCR version.

The second round was performed between August and October 2018 on the final PEFCR version. This version applies the requirements of the PEFCR guidance version 6.3 and the results of the remodelling carried out on the representative products during 2017 and 2018. The panel made other comments which were promptly addressed by the Technical Secretariat in the Final PEFCR version.

The full list of the comments made in the two review rounds and the related responses and corrective actions from the Technical Secretariat are documented in the enclosed spreadsheet "PEFCR Metal Sheets_Review Panel_First and Second Round_Final".

Review Statement

We hereby confirm that, following the PEFCR examination, we have not established any relevant deviations by the above-referenced PEFCR document with respect to the requirements identified in the review scope.

We confirm we have been independent in our roles as reviewers, we have not been involved in the preparation of the PEFCR or related supporting studies and we have no conflicts of interest regarding this review.

The PEFCR validity is set until 31-12-2020.

We acknowledge the commitment undertaken by the Technical Secretariat in developing this PEFCR and the good and constructive collaboration with the TS members during the review.

Yours sincerely,

October 4th, 2018

Ugo Pretato	Karolien Peeters	Peter Saling

Excel file with detailed comments is available here:
https://ec.europa.eu/environment/eussd/smgp/documents/metalsheets_revreport.xlsx

ANNEX 4 – Scope and relevant standards

A) Sheet composition

This section focusses on what is in scope when considering the alloying-elements which can be added to give the required properties to the metal sheet.

While copper and lead sheets are composed almost exclusively from pure metal, aluminium and steel usually include alloying elements depending on the type of applications. Compositions of these alloys can vary significantly from one company to another. Hence, it is not possible to predefine these compositions. As a result, this PEFCR for metal sheets is valid within the alloy composition limits as indicated in the table below.

Table 24. Metal sheet compositions covered by this PEFCR

Metal type	Minimum	Description
Copper	Cu> 99%	Cu sheets are mostly produced from almost pure Cu.
Lead	Pb > 99%	Pb sheets are mostly produced from almost pure Pb.
Aluminium	Al > 97%*	Aluminium sheets are usually composed of alloys including several alloying elements. These alloying elements shall be considered in the PEF modelling.
Steel	Fe > 97%*	Steel sheets are usually composed of alloys including several alloying elements. These alloying elements shall be considered in the PEF modelling.

*if alloying elements exceeds 3% for steel or aluminium sheet, a sensitivity analysis shall be performed to secure that the conclusions established in this PEFCR are still valid for this alloy composition.

The following paragraphs describe the main alloys and compositions used for aluminium and steel.

<u>**Aluminium**</u>
By default, the aluminium LCI dataset used in the PEFCR is the following one: 'Aluminium ingot (magnesium main solute); primary production, aluminium casting and alloying; single route, at plant; 2.7 g/cm3 – UUID: f7b7e0ff-b423-4e9d-b921-10c81872eacb' which contains 1% of Mg.

The main alloys for Aluminium, from the perspective of the chosen application (buildings and appliances) are listed below:

Table 25. Main aluminium alloys used in the building and appliances sector

Main Alloys used

Sheet for building applications	3003, 3004, 5005, 5182 and 5754
Sheet for Appliances :	5005A & 5754

	Alloy	Mg	Mn	Fe	Si	Si+Fe	Cu	Zn	Cr	Other Elem	Total Other	Al
Building	**3003**	-	1.0-1.5	≤0.7	≤0.6	-	0.05-0.20	≤0.10	-	≤0.05	≤0.15	Rem.
Building	**3004**	0.8-1.3	1.0-1.5	≤0.7	≤0.30	-	≤0.25	≤0.25	-	≤0.05	≤0.15	Rem.
Building	**5005**	0.50-1.1	≤0.20	≤0.7	≤0.30	-	≤0.20	≤0.25	≤0.10	≤0.05	≤0.15	Rem.
Appliances	**5005A**	0.7-1.1	≤0.15	≤0.45	≤0.30	-	≤0.05	≤0.20	≤0.10	≤0.05	≤0.15	Rem.
Building	**5182**	4.0-5.0	0.20-0.50	≤0.35	≤0.20	-	≤0.15	≤0.25	≤0.10	≤0.05	≤0.15	Rem.
Building & Applinaces	**5754**	2.6-3.6	≤0.50	≤0.40	≤0.40	-	≤0.10	≤0.20	≤0.30	≤0.05	≤0.15	Rem.

The default dataset is an appropriate proxy for the alloys 5005 and 5005A. The other listed alloys shall use other proxies better reflecting their composition.

Steel

Generally, carbon steels have low alloying content (< 2%) as in combination with thermos-mechanical treatment a wide range of different mechanical properties can be created. Exceptions to this rule exist but involve relatively small volumes (e.g. stainless steel - a specific family with separate recycling collection). The table below shows examples for the chemical composition of alloys used in white good appliances.

Table 26. Example from deep drawing sheet quality (e.g. in white goods appliances)

Chemical composition

	C (%)	Mn (%)	P (%)	S (%)	Si (%)	Al (%)	C_{eq} (%)	Galvanisation
DD11 EN 10111	≤ 0.120	≤ 0.60	≤ 0.045	≤ 0.045	-	-	-	No
DD11 AM FCE	≤ 0.120	≤ 0.60	≤ 0.045	≤ **0.030**	-	≥ **0.010**	≤ **0.19**	No
DD11-CL1 AM FCE	**0.020 - 0.100**	**0.15 - 0.50**	≤ **0.030**	≤ **0.030**	≤ **0.03**	-	-	Class 1
DD12 EN 10111	≤ 0.100	≤ 0.45	≤ 0.035	≤ 0.035	-	-	-	No
DD12 AM FCE	**0.020** -0.100	≤ 0.45	≤ **0.030**	≤ **0.030**	≤ **0.03**	≥ **0.020**	≤ **0.18**	Class 1
DD13 EN 10111	≤ 0.080	≤ 0.40	≤ 0.030	≤ 0.030	-	-	-	No
DD13 AM FCE	≤ 0.080	≤ 0.40	≤ **0.025**	≤ **0.025**	≤ **0.03**	≥ **0.020**	≤ **0.15**	Class 1
DD14 EN 10111	≤ 0.080	≤ 0.35	≤ 0.025	≤ 0.025	-	-	-	No
DD14 AM FCE	≤ 0.080	≤ 0.35	≤ **0.020**	≤ 0.025	≤ **0.03**	≥ **0.020**	≤ **0.15**	Class 1
DD15 AM FCE	≤ 0.060	≤ 0.35	≤ 0.020	≤ 0.020	≤ 0.03	≥ 0.020	≤ 0.15	Class 1

Grades in italics: not included in the standard

Values in bold: tighter than the standard

Additionally, the table below lists the allowable content of each alloying element in carbon steels (steels for construction) according to EN 10346. The chemical composition of carbon steel (steels for construction) is defined by varying the ratio of these alloying elements, subject to the upper-limit specified below.

Table 27. Content of alloys according to EN 10346

Element	Chemical composition % by mass max.
C	0.20
Mn	1.70
P	0.10

S	0.045
Si	0.60
Fe	97.36

B) Relevant standards (application related)

A non-exhaustive list of relevant standards for the metals and their applications is shown below.

Product standards – Aluminium

Table 28. Examples of products standards for aluminium

Standard reference	Title	Area
EN 1090-1:2009	Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components	Building
EN 12258-1:2012	Aluminium and aluminium alloys - Terms and definitions - Part 1: General terms	alloys
EN 12258-2:2004	Aluminium and aluminium alloys - Terms and definitions - Part 2: Chemical analysis	alloys
EN 13859-1:2010	Flexible sheets for waterproofing - Definitions and characteristics of underlays - Part 1: Underlays for discontinuous roofing	Building
EN 13859-2:2010	Flexible sheets for waterproofing - Definitions and characteristics of underlays - Part 2: Underlays for walls	Building
EN 1396:2007	Aluminium and aluminium alloys - Coil coated sheet and strip for general applications - Specifications	Coil coated sheet
EN 14509:2006	Self-supporting double skin metal faced insulating panels - Factory made products - Specifications	Building
EN 14782:2006	Self-supporting metal sheet for roofing, external cladding and internal lining - Product specification and requirements	Building
EN 14783:2006	Fully supported metal sheet and strip for roofing, external cladding and internal lining - Product specification and requirements	Building
EN507 : 1999	Roofing products of metal sheet – Specification for fully supported roofing product of aluminium sheet	Building
EN508-22008	Roofing products from metal sheet – specification for self-supporting products of steel, aluminium or stainless steel sheet – Part 2 : Aluminium	Building
EN 573-1:2004	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 1: Numerical designation system	Generic
EN 573-2:1994	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 2: Chemical symbol based designation system	Generic
EN 573-3:2013	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 3: Chemical composition and form of products	Generic
EN 573-5:2007	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 5: Codification of standardized wrought products	Generic

Product standards – Copper

Table 29. Examples of product standards for copper

Standard reference	Title	Area
EN 1172:2012-02	Copper and copper alloys - Sheet and strip for building purpose	Building
EN ISO 6507-1:2005	Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1:2005)	
EN ISO 6507-2:2005	Metallic materials - Vickers hardness test - Part 2: Verification and calibration of testing machines (ISO 6507-2:2005)	
EN ISO 6892-1:2009	Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2009)	
EN 504:1999	Roofing products from metal sheet - Specification for fully supported roofing products from copper sheet	
EN 506:2008	Roofing products of metal sheet - Specification for self-supporting products of copper or zinc sheet	
EN 1172:2011	Copper and copper alloys - Sheet and strip for building purposes	
EN 1462:2004	Brackets for eaves gutters - Requirements and testing	
EN 1652:1997	Copper and copper alloys - Plate, sheet, strip and circles for general purposes	
EN 14783:2013	Fully supported metal sheet and strip for roofing, external cladding and internal lining - Product specification and requirements	
ISO 1811-2:1988-10	Copper and copper alloys; selection and preparation of samples for chemical analysis; part 2: sampling of wrought products and castings	
EN 1976:2012	Copper and copper alloys - Cast unwrought copper products	
DIN 17933-16:1997-07	, Copper and copper alloys - Determination of residual stresses in the Border area of slit strip	
DIN 1402-1:1998-01	Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests	
ISO 4739:1985-05	Wrought copper and copper alloy products; Selection and preparation of specimens and test pieces for mechanical testing	

Product standards – Lead

For lead sheet used in roofing application, the standard BS EN 12588 2007-01-31/EN 12588:2006 applies.

Product standards – Steel

A non-exhaustive list of standards applicable for steel is provided below.

Table 30. Examples of products and standards for steel (Hot rolled products)

Standard reference	Title	Area
EN 10025/5 (2004)	Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance;	Hot rolled steel
EN 10083-2 (2006)	Steels for quenching and tempering - Part 2: Technical delivery conditions for non alloy steels;	
EN 10132-4 (2000)	Cold-rolled narrow steel strip for heat-treatment - Technical delivery conditions - Part 4: Spring steels and other applications;	
EN 10149/2 (95)	Hot rolled flat products made of high yield strength steels for cold forming - Part 2: Technical delivery conditions for thermomechanically rolled steels;	
EN 10083-3 (2006)	Steels for quenching and tempering - Part 3: Technical delivery conditions for alloy steels	
ASTM A 568	Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for	
EN 10111 (2008)	Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions	
EN 10084 (2008)	Case hardening steels - Technical delivery conditions	
EN 10130 (after CR)	Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions	
EN 10120 (2008)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels	
EN 10025/2 (2004)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels	
EN 10111 (2008)	Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions	
API 5L (2007)	Specification for Line Pipe	
EN 10028-2 (2009)	Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties	
EN 10028-3 (2009)	Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized	
EN 10028-5 (2009)	Flat products made of steels for pressure purposes - Part 5: Weldable fine grain steels, thermomechanically rolled	
EN 10207 (2005)	Steels for simple pressure vessels - Technical delivery requirements for plates, strips and bars	
EN 10111	Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions	
EN 10025 (90)	Hot rolled products of structural steels - Part 1: General technical delivery conditions	
EN 10025/2 (2004)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels	

Table 31. Examples of products and standards for steel (Cold rolled, metallic/organic coated products)

Standard reference	Title	Area
EN 10268 (2006)	Cold rolled steel flat products with high yield strength for cold forming - Technical delivery conditions	Cold rolled steel
EN 10130 (2006)	Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions	
ASTM A 568	Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for	
ASTM A109	Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled	
EN 10268 (2006)	Cold rolled steel flat products with high yield strength for cold forming - Technical delivery conditions;	Metallic coated steel
EN 10152 (2009)	Electrolytically zinc coated cold rolled steel flat products for cold forming - Technical delivery conditions	
EN 10346 (2009)	Continuously hot-dip coated steel flat products - Technical delivery conditions	
NFA 36-345	Iron and steel. Aluminium coated sheet. Cut lengths and coils	
SEW 022 (2010)	Continuously hot-dip coated steel flat products - Zinc-magnesium coatings - Technical delivery conditions	
EN 10169 (2010)	Continuously organic coated (coil coated) steel flat products - Technical delivery conditions	Organic coated steel

Table 32. Examples of products and standards for steel (Enamelling, electrical applications)

Standard reference	Title	Area
EN 10209 (96)	Cold rolled low carbon steel flat products for vitreous enamelling - Technical delivery conditions	Steel for enamelling
EN 10265 (95)	Magnetic materials - Specification for steel sheet and strip with specified mechanical properties and magnetic permeability	Steels for electrical applications
EN 10303 (2006)	Industrial automation systems and integration - Product data representation and exchange - Part 112: Integrated application resource: Modelling commands for the exchange of procedurally represented 2D CAD models	
EN 10106 (2007)	Cold rolled non-oriented electrical steel sheet and strip delivered in the fully processed state	
EN 10107 (2005)	Grain-oriented electrical steel sheet and strip delivered in the fully processed state	
EN 10265 (95)	Magnetic materials - Specification for steel sheet and strip with specified mechanical properties and magnetic permeability	
EN 10341 (2006)	Cold rolled electrical non-alloy and alloy steel sheet and strip delivered in the semi-processed state	

ANNEX 5 – Description of the various life cycle stages, processes and parameters related to the PEFCR on metal sheets

1. System boundaries – life-cycle stages and processes

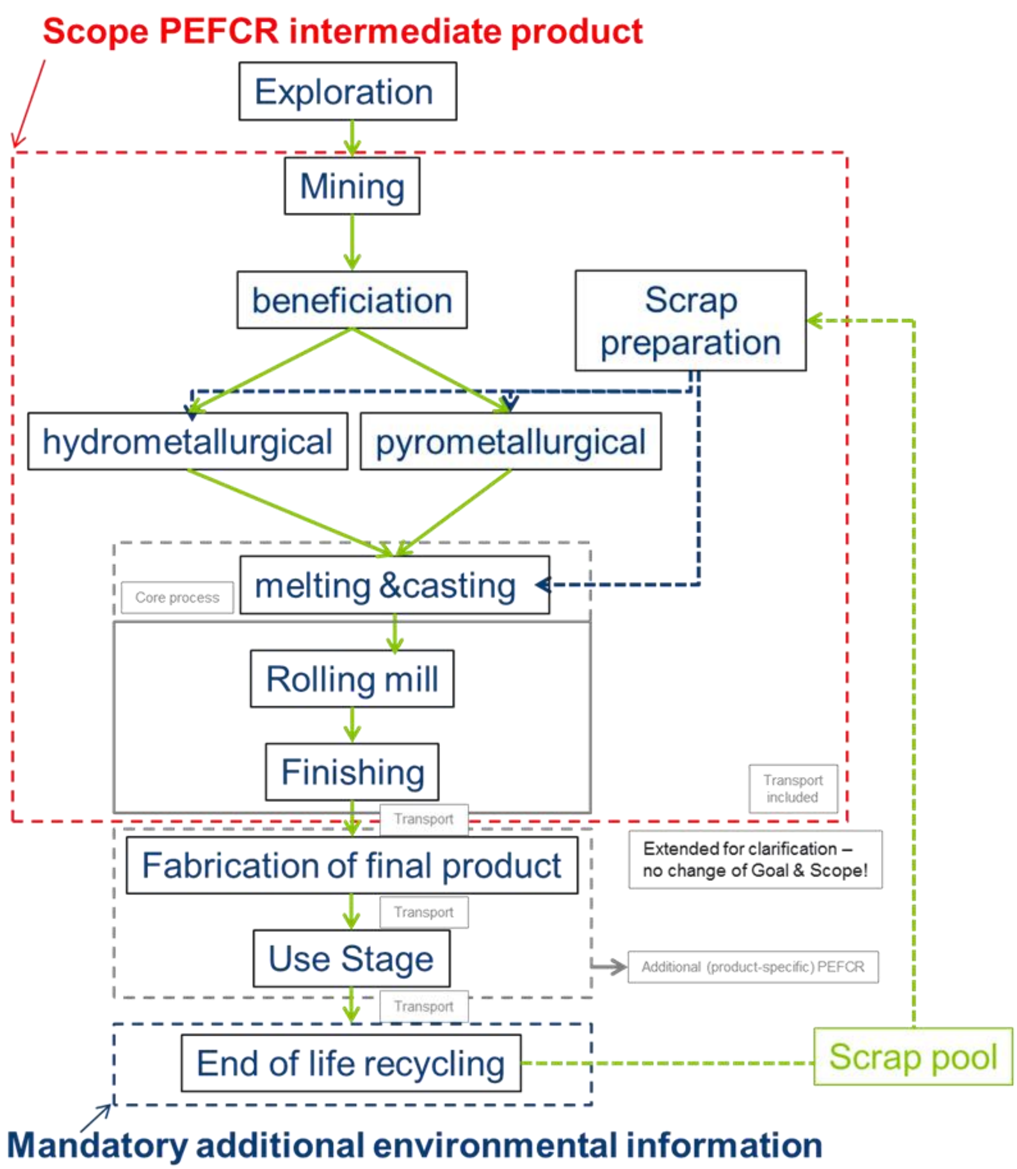

Figure 5. Product flow sheet and system boundaries

The Production stage (red dotted area) and EoL stage (blue dotted as a mandatory additional environmental information) are included in the PEFCR for metal sheets. The use stage (fabrication of final product, use stage and demolition incl. transport processes) is not considered in this PEFCR and shall be covered by a specific PEFCR for the metal sheet application, due to the fact that metal sheets are intermediate products and can be used for the manufacture of end-use products for various applications. Exploration and identification of reserves of natural resources have been excluded from the Screening Study used to develop this PEFCR. The impact of the use stage of a metal sheet is unknown and excluded from this PEFCR. Specifications for use by Original Equipment Manufacturers (OEM), architects and other designers of the final applications can vary according to the type of application (and also within each specific application). Therefore, it would be necessary to define the exact conditions of downstream applications, when evaluating the use-stage of the sheets.

Figure 5 describes the generic metal sheet production route. This generic flow-diagram includes a metal supply based on primary production, on recycling or on a mix of both sourcing. Primary production requires exploration, mining, beneficiation, hydro- or pyrometallurgical processing followed by melting and/or casting, rolling and finishing. Secondary production requires collection of waste and recycling.

The metal sheet collected at end-of-life enters the scrap pool. The scrap pool will comprise metallic scrap generated from many life cycles of the same metal. The end-of-life scrap (post-consumer scrap) is then recycled into secondary metal. This metal can subsequently be used in to manufacture products (for use in the same application that generated the scrap, or for use in new applications). The scrap pool comprises not only post-consumer scrap from various product life cycles but also process scrap generated during the fabrication stage. Similarly, the scrap pool is used as a secondary raw material source by various product life cycles of the same metal.

Depending on the metal sheet and the composition of the metal scrap (i.e. secondary raw material), recycling may follow the different routes represented by the blue dotted line in Figure 5. Recycling of secondary raw material can be a stand-alone production process or can be performed in conjunction with the primary production process, covering additional upstream operations such as scrap collection and sorting. The red-dotted line encompasses the scope of the PEFCR. The rolling mill and finishing step can be regarded as the core process (foreground system) to manufacture a metal sheet from virgin and / or secondary raw material. In specific cases, e.g. continuous strip casting process, this core process may also include melting and/or casting.

For the core process (rolling and finishing which includes in some cases melting and casting before the rolling process) primary data shall be collected.

- **Production stage**

The production stage can include some or all of the following steps:

1. Raw material extraction, beneficiation and metallurgical treatment and primary material preparation (smelting and refining) including alloying. Casting of slab/ingot/billet/cathode (starting material for sheet production). This includes transportation.
2. Secondary raw material (i.e. scrap) preparation and recycling, metal melting/remelting including alloying. Casting of slab/ingot/billet/cathode (starting material for sheet production). This includes transportation. Transportation of the slab/billet/ingot/cathode to the sheet production site.

Transport shall be considered. In some cases the ingot will be produced at the same site as that conducts sheet production, and in some cases this will be a fully automated process (e.g. lead sheet production).

3. Manufacturing, the transformation of ingots/slab/billet/cathode into the finished intermediate sheet, including rolling and finishing processes. The life cycle model should loop back the Manufacturing scrap into the input side of the core process, including processes of treatment if necessary. This internal scrap loop shall not be considered in the evaluation of R1.

Provision of all materials, products and energy, as well as waste processing up to the end-of waste state or disposal of final residues during the production stage are included in the system boundaries.

- **End-of-Life stage**

Metal sheets are intermediate products and can be used for the manufacture of end-use products for various applications. The end-of-life stage of a metal sheet is determined from the conditions of the application and becomes a ‘module’ to be used when developing PEFCRs for products further down that supply chain. This is equally applicable if the intermediate product can be used in different supply chains (e.g. metal sheets). Therefore, the end-of-life stage is considered as a mandatory additional environmental information that shall provide the environmental footprint for the EoL stage of the intermediate product based on a realistic and justified scenario.

Examples of end-of-life processes that shall, if applicable, be included are:

- The production of the secondary raw material, i.e. metal scrap, which usually includes
  - Collection and transport of end-of-life products and packages;
  - Dismantling of components; Shredding and sorting;
- The conversion of metal scrap into a recycled metal ingot, i.e. slab/billet/ingot/cathode. This usually includes melting/remelting, refining and casting and if needed metallurgical treatment.

This stage also includes transportation operations and provision of all materials, products and related energy and water use.

2. The scrap pool concept and the typical mass flow of a metal sheet

Reflecting adequately the recycling situation of metal sheet is crucial to assess its PEF profile. Indeed, when a metal product reaches the end of its life, it is sometimes reused but in most cases it is recycled. Hence, most metal products at end-of-life are collected for recycling. For example, currently more than 95% of the metal products used in buildings are collected and recycled.

- **Scrap pool concept**

Before being recycled at end of life, metal products are often pre-processed into sorted metal scrap. This scrap metal enters the 'scrap pool'-a concept for the metallic scrap that is available for recycling into secondary metal (as defined in the terms and glossary). Depending on the origin of the scrap, operations such as shredding, sorting and cleaning may be required before recycling can be conducted. (scrap preparation) These processes generate scrap which satisfies specific composition criteria which are typically classified in various scrap categories or codes[24]. Hence, the scrap pool can be composed of various categories of scrap. For the sake of simplicity Figure 6 depicts the scrap preparation operations taking place downstream of the scrap pool. However, this is just an illustrative example and not indicative of all practices.

In addition to end of life scrap (post-consumer scrap), several production routes of metals products can generate production scrap (also referred to as process scrap). For example, fabricating a metal casing for a PC from a metal sheet generates some scrap from cutting and machining operations. This fabrication scrap is considered as process scrap and will be recycled for producing new metal sheet or other metal products. Both process scrap and post-consumer scrap are considered as secondary raw material sources for producing metal sheets.

The quality of the scrap type can affect the values of R_1 and $E_{recycled}$. For example, recycling of lower grade scrap may have a lower recycling yield, and require additional recycling processes that the recycling of higher grade scrap. Similarly, lower quality scrap may require smelting and refining stages to produce a high quality ingot, whereas higher quality scrap may only require refining. This means that in the case of lower grade recycling there may be some material losses along the recycling chain. The result of this is that the recycling of low grade scrap may in some cases result in lower primary metals savings. It is therefore important that the types of scrap used at production stage and generated at end of life are properly considered as this will affect respectively R_1 and $E_{recycled}$ for the production stage and R_2 and $E_{recyclingEoL}$ for the end of life stage.

It should also be noted that the quality factor of the recycled metal ingot should not be directly correlated to or derived from the grade of the scrap category or code from which the recycled metal originates. In most cases, recycling is undertaken to ensure that the recycled metal has the same physical and chemical properties to that of the primary metal.

The point of substitution should correspond to the point at which the quality of the substitution can be measured. This point can be measured at the end of the process, not at the beginning. Therefore, it is important that the footprint of the processes is taken into account up to the point of measurement. Hence, $E_{recycled}$ and E_v shall include all emissions up to this point of the process.

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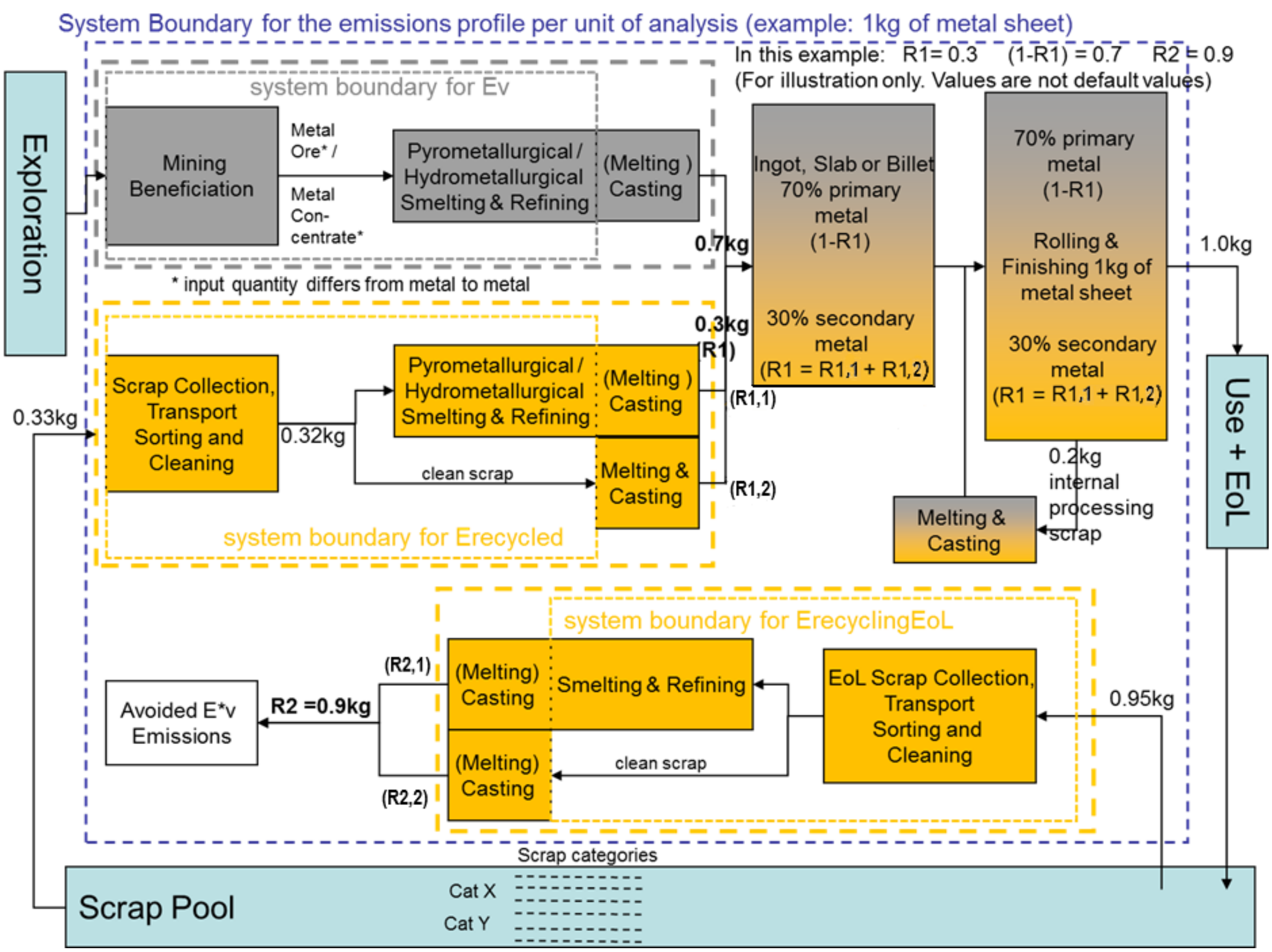
[24] Scrap Specifications Circular 2015 - Guidelines for Nonferrous Scrap, Ferrous Scrap, Glass Cullet, Paper Stock, Plastic Scrap, Electronics Scrap, Tire Scrap; EFFECTIVE 15 Jan 2015, ISRI, http://www.isri.org/

- **Defining the metal mass flow**

In order to provide clarity on what is included or excluded from the terms described in CFF, Figure 6 provides an example of metal flows and helps define R_1 and R_2 and clarify the connection with the scrap pool. For the purposes of illustration, the unit of analysis is 1kg, which can be taken to be fulfilling the functional unit of 1m² of metal sheet. The diagram provides a generic and conceptual overview for all metals, describing all possible levels of processing applicable to metal scrap. In general, metal scrap does not require all levels of processing as illustrated in the diagram. In practice melting & casting of clean scrap, secondary metal and primary metals, which are assigned to different system boundaries can take place simultaneously, in the same technological unit.

Figure 6. Illustration of the metal mass flow and system boundaries for the various terms used in the modular version of the integrated recycling equation for 1kg of metal sheet

Legend:
Grey: primary production profile, Yellow: secondary production



The system boundaries for $E_{recycled}$ and $E_{recyclingEoL}$ may vary according to the metal and the recycling processes used. The system boundary for $E_{recycled}$ is defined by the point of substitution after melting and casting of the slab (for steel and aluminium) and after refining of the cathode /ingot for copper and lead.

The numbers presented, are purely theoretical and not to be used as default values. In the example presented, 0,33 kg of scrap is taken from the scrap pool, as secondary raw material sourcing. This scrap is then processed and cast into a shape suitable for further processing i.e. slab, ingot or billet or into a cathode in case of electrolytic refining. At this point the metal comprises 30% recycled metal and 70% primary metal. On further processing into a sheet, the metal may generate process scrap (e.g. 0,2 kg of scrap /kg of final sheet) that is returned to the melting and casting process. This process scrap does not contribute to R_1 because it is circulating within the product system boundary and the scrap does not come from outside the system. This diagram can be considered as a simplification of reality and in some cases, metal scrap may not require the same level of processing as illustrated in the diagram.

In addition, some metal losses, e.g. 1-2%, may occur at the rolling process and the associated remelting of process scrap. Hence, the metal flow at the material acquisition level may be slightly higher than the metal in the unit of analysis, i.e. the metal sheet.
After use (end of life), metal sheet is collected and directed to recycling. After shredding and sorting, a quantity of 0,95 kg of metal scrap is provided to the scrap pool from which 0,9 kg of recycled metal is produced.

Figure 6 also illustrates the inclusion of potential yield losses when processing scrap, which can be assumed to go to disposal.

3. Guidance for calculating $E_{recycled}$ and $E_{recyclingEoL}$

The environmental burdens of the recycling processes shall consider all recycling operations up to the point of substitution. The point of substitution can be defined as the point at which recycled material effectively substitutes primary material. In the case of metals, these recycling operations involve transforming metallic scrap (of varying composition) into metallic ingot, slab or billet of specified purity and composition with well-defined properties. These recycling operations can include smelting, refining, melting and alloying processes. For metal sheet, the point of substitution can be defined at different places of the production chain. For aluminium and steel sheet the point of substitution is at slab or billet, which is usually the starting material for sheet production. The point of substitution for copper and lead sheet is after refining the metal (to copper cathode or lead ingot) and prior to melting and casting of a shape (slab/billet). In the case of reuse of metallic sheet, the substitution can occur downstream of the slab/billet level.
In the PEF communication, the point(s) of substitution shall be explicitly defined and justified. $E_{recycled}$ and $E_{recyclingEoL}$ shall then consider accordingly all the burdens of the recycling processes up to their respective point of substitution. In addition, the reference flow used in $E_{recycled}$ and $E_{recyclingEoL}$ shall be the recycled material which is effectively produced at the point of substitution, i.e. considering all the losses taking place in the upstream recycling processes.

4. Guidance for calculating R_1 and R_2

The recycled content (R_1) or the end of recycling rate (R_2) shall be defined at their respective point of substitution which has been defined.

The recycled content in the metal sheet, i.e. R_1, represents the fraction of metal manufactured from secondary metal at the point of substitution. R_1 shall be calculated according to ISO14021 and shall exclude any process scrap produced upstream (i.e. any scrap generated at the sheet production step). Process scrap generated at sheet production step level shall be clearly excluded from R_1 calculation. The LCA modelling shall take into account such internal scrap flow in an adequate manner.

For R_1, preference shall be given to specific values provided by the metal sheet manufacturer. When no specific values are available, semi-specific values (i.e. specific to a product type) shall be preferred to a generic value. In all cases, the determination of the R_1 value shall be justified and documented.

In Figure 6, R_1 is 30% (i.e. 0,3 kg of a 1 kg of total metal comes from recycled metal).

Similarly, the end of life recycling rate, i.e. R_2, shall be calculated at the point of substitution.

For R_2, preference shall be given to specific values provided by the metal sheet manufacturer. Specific values shall be assessed at the point of substitution. This specific value shall be based on a realistic and justified end of life scenario using current end of life recycling practices. When no specific values are available, semi-specific value, i.e. specific to a product type, shall be preferred to a generic value. In all cases, the determination of R_2 shall be justified and documented.

In Figure 6, R_2 is 90% (i.e. at the point of substitution 0,9 kg total metal weight of 1 kg comes from recycled material.

5. Guidance for calculating E^*_V

Similarly, E^*_V shall consider all the environmental burdens of primary metal production up to the defined points of substitution. The choice of the LCI datasets representing E^*_V shall be justified and documented.

6. Guidance for calculating Q_{Sin}/Q_P and Q_{Sout}/Q_P

The quality ratio Q_{Sin}/Q_P (or Q_{Sout}/Q_P) aims at considering the loss of inherent properties of the recycled material compared to primary material. This ratio shall be assessed at the point of substitution. The default value used in PEF studies shall be one for metal sheets as stated in the PEFCR Guidance ver. 6.3 in its Annex C – List of default values for A, R1, R2, R3 and Qs/Qp.
The Excel file 'CFF_Default_Parameters_March2018.xlsx' is downloadable at:
http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm .

Primary and secondary materials are selected in order to make the correct composition up to the point of substitution. The composition is a prerequisite to achieve the desired quality. The metallurgical processes after the point of substitution determine all the important characteristics of the intermediate sheet.[25] Hence, the metal industry recommends using a quality ratio of '1' as default value which is representative for most recycling cases.

In specific cases, e.g. when end of life treatment does not follow the optimal recycling route, the quality factor may be affected and a value of less than one may be used. This may happen when some inherent properties of the metal are irreversibly affected by an inadequate end of life treatment and therefore cannot be fully restored through the recycling process. In such a case the yield of the recycling process will reflect the loss of properties due to the increase in rework.

For some highly alloyed metal products (e.g. some aluminium cast products may contain higher percentages of other metals such as silicon) the recycling process may require addition or mixing of pure primary metal or specific refining process in order to produce the required alloy specification of the product.

This PEFCR covers only pure metals (i.e. lead and copper, typically >99%) or low alloyed metal sheet (i.e. aluminium and steel) as defined in the Section 3.3. The production of metals that require any significant mixing or addition of primary material process during recycling is not considered a significant issue for metal sheets and therefore not covered by this PEFCR.

In those specific cases, ISO14044 recommends using the most relevant physical or mechanical property to assess the loss of quality between recycled material and primary material. If not possible, the economic value may be used as a proxy. In any case, the calculation of the quality ratio shall be always justified and explained.

ANNEX 6 – Excel file 'Metal Sheets PEFCR – Life Cycle Inventory'

Excel files presenting Life Cycle Inventory for all the metal sheets under this PEFCR (aluminium, copper, lead and steel) is available at: https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm#final

[25] The inherent properties of metals are usually fully restored through recycling, i.e. typically through melting, refining and solidification. Metals remain metals, even after having passed through many recycling loops, because metallic bonds are restored upon solidification. Recycled metals and alloys from metal sheet then keep the same properties as the original metal sheet. Hence, in most cases, the quality is fully maintained through recycling and the quality ratio stays equal to '1' at the point of substitution, e.g. an ingot, slab or billet made from recycled metal has the same properties as an ingot made from primary metal.