PRODUCT CATEGORY RULES (PCR)

PUBLICATION DATE 2026-03-09

TECHNICAL CERAMIC GRAINS AND POWDERS (NON-CONSTRUCTION)

PRODUCT CATEGORY CLASSIFICATION: UN CPC 37960,37291

PCR 2026:02

VERSION 1.0.0

VALID UNTIL 2030-03-09

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1 INTRODUCTION

This document constitutes Product Category Rules (PCR) developed in the framework of the International EPD System: a programme for Environmental Product Declarations (EPD)[1] according to ISO 14025:2006, ISO 14040:2006, ISO 14044:2006, and product-specific standards, such as EN 15804 and ISO 21930 for construction products.[2] EPDs are voluntary documents for a company or an industry association to present transparent, consistent, and verifiable information about the environmental performance of their products (goods or services).

The General Programme Instructions (GPI), publicly available on www.environdec.com, includes the rules for the overall administration and operation of the programme and the basic rules for developing EPDs registered in the programme. A PCR complements the GPI and the normative standards by providing specific rules, and guidelines for developing an EPD for one or more specific product categories (see Figure 1), thereby enabling the generation of consistent EPDs within a product category. A PCR should not repeat the rules and guidelines of the GPI, but include additions, specifications and deviations to the rules set in the GPI. As such, a PCR shall be used together with the GPI.

This PCR is a main PCR that may be complemented with one or several complementary PCR (c-PCR). If there is an applicable and valid c-PCR, it shall be used in case it has been valid for at least 90 days when the EPD is verified[3]. If it has been valid for less than 90 days, it is optional to use the c-PCR. The valid c-PCRs can be found on www.environdec.com.

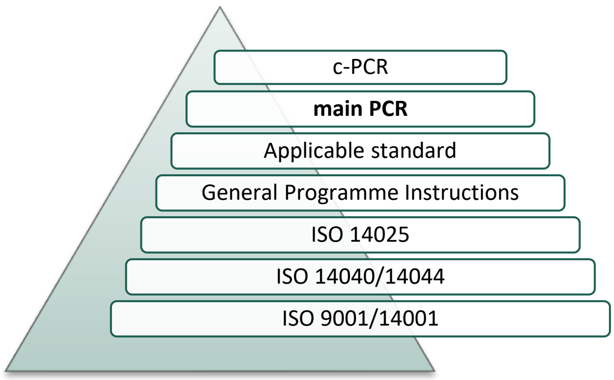

Figure 1 This PCR in relation to the hierarchy of standards and other documents.

The present PCR uses the following terminology:

- The term “shall” is used to indicate what is obligatory, i.e., a requirement.
- The term “should” is used to indicate a recommendation. Any deviation from a recommendation shall be justified in the EPD development process.
- The terms “may” or “can” are used to indicate an option that is permissible.

For definitions of other terms used in the document, see the GPI and normative standards.

Any references to this PCR shall include the PCR registration number, name, and version number.

The programme operator maintains the copyright of the PCR to ensure that it is possible to publish, update, and make it available to all organisations to develop and register EPDs. Stakeholders participating in PCR development should be acknowledged in the final document and on the website.

[1] Termed type III environmental declarations in ISO 14025.

[2] When standards are referred to in this document, the version listed in Section 8 is intended unless otherwise stated.

[3] This does not apply when the EPD is re-verified during its validity, unless the validity period is extended.

2 GENERAL INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Name:	Technical Ceramic Grains and Powders
Registration number and version:	PCR 2026:02, version 1.0.0
Programme:	EPD INTERNATIONAL EPD SYSTEM
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: support@environdec.com
PCR Moderator:	Simeng Wang, Compagnie de Saint-Gobain S.A Saint-Gobain, (Simeng.Wang@saint-gobain.com)
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Publication date:	2026-03-09 See Section 9 for a version history of the PCR.
Valid until:	2030-03-09 The validity may change. See www.environdec.com for the latest version of the PCR and the latest information on its validity and transition periods between versions.
Development and updates:	The PCR has been developed following ISO 14027, including public consultation and review. The rules for the development and updating processes are described in Section 9 of the GPI. The PCR is valid for a pre-determined time period to ensure that it is updated at regular intervals. When the PCR is about to expire, the PCR Moderator shall initiate a discussion with the Secretariat on if and how to proceed with updating the PCR and renewing its validity. A PCR may be updated before it expires, based on changes in normative standards or provided significant and well-justified proposals for changes or amendments are presented.

	When there has been an update of the PCR, the new version should be used to develop EPDs. For small updates (change of third-digit version number), the previous version is normally immediately removed from the PCR library on www.environdec.com and there is no transition period. For medium updates (change of second-digit version number), the previous version of the PCR is valid in parallel during a transition period of at least 90 days, but not exceeding its previously set validity period. For large updates (change of first-digit version number), the previous version is valid in parallel during a transition period of at least 180 days, but not exceeding its previously set validity period. Stakeholder feedback on PCRs is very much encouraged. Any comments on this PCR may be sent directly to the PCR Moderator and/or the Secretariat during its development or during its period of validity.
Standards and documents conformance:	General Programme Instructions of the International EPD System, version 5.0.1, based on ISO 14025 and ISO 14040/14044.[4]
PCR language(s):	At the time of publication, this PCR was available in English. If the PCR is available in several languages, these are available on www.environdec.com. In case of translated versions, the English version takes precedence in case of any discrepancies.

2.2 SCOPE OF PCR

2.2.1 PRODUCT CATEGORY DEFINITION AND DESCRIPTION

This document provides Product Category Rules (PCR) for the assessment of the environmental performance of technical ceramic grains and powders and the declaration of this performance by an EPD. The product category corresponds to the following UN CPCs:

- Subclass 37960 Other non-metallic mineral products n.e.c Artificial corundum
- Subclass 37291 Ceramic wares for laboratory, chemical or other technical uses; ceramic troughs, tubs and similar receptacles of a kind used in agriculture; ceramic pots, jars and similar articles of a kind used for the conveyance or packing of goods

Technical ceramic particulates are engineered for specialized applications that demand advanced material properties, distinct from conventional ceramics parts such as bricks or roofing tiles used in the construction sector. When used directly or as a raw material for technical ceramics, these particulates exhibit exceptional intrinsic performance characteristics, including high hardness, resistance to corrosion resistance, thermal stability, and unique electrical properties. Their typical applications include for example:

- Abrasive materials used e.g. in surface treatment processes (e.g., shot blasting)
- Polishing slurries e.g. for wafer production
- Raw materials for electronic components e.g. for conductive ceramics
- Raw materials for anti-wear coatings
- Raw materials for industrial consumables
- Raw materials for technical ceramics
- Raw materials for refractories

Technical ceramic particulates are e.g. made from synthetic materials, such as aluminium oxides (alumina) and zirconium oxides (zirconia) and silicon carbide (SiC), along with other materials incorporated into mixtures for manufacturing technical ceramic components. These may include:

- Alumina-based particulates: derived from aluminium oxide, including alumina-zirconia and alumina-zirconia-silica composites.

[4] Some rules influencing EPD development are independent of the GPI version referred to in the PCR. For example, the latest rules on EPD verification procedures in the GPI shall be followed within 90 days of its publication. See Section 5.1 in the GPI for a description of the four categories of rules and when they shall be followed.

- Zirconia-based particulates: comprising pure zirconium oxide or zirconium oxide doped with elements like calcium, magnesium, or rare earth elements.

Both alumina- and zirconia-based particulates may contain trace elements originating from natural ore or chemical processing, which can influence their colour and performance attributes.

The International EPD System uses the UN CPC system for classification for PCRs. As this PCR covers a product category where the final sector of use is the defining factor, it can be difficult to classify it according to the UN CPC system. While the listed UN CPC codes above are included in the PCR, certain products within its scope may extend beyond these subclasses. Such products can still be covered by this PCR if they meet the product description criteria.

2.2.2 GEOGRAPHICAL SCOPE

This PCR may be used globally.

2.2.3 EPD VALIDITY

An EPD becomes valid as of its version date (see Section 8.4.5 of the GPI). When an EPD is originally published, the validity period is normally five years starting from the version date or until the EPD has been de-registered from the International EPD System. Shorter validity periods are also accepted, for example if decided by the EPD owner.

For rules on when an EPD shall be updated and re-verified during its validity, see Section 6.8.1 of the GPI. For validity periods in case of updates of EPDs, see Section 6.8 of the GPI.

The version date and the period of validity shall be stated in the EPD.

Publication of a new version of the PCR or the GPI does not affect the validity of already published EPDs.

3 REVIEW AND BACKGROUND INFORMATION

This PCR was developed in accordance with the PCR development process described in the GPI of the International EPD System, including open consultation and review.

3.1 OPEN CONSULTATION

3.1.1 VERSION 1.0.0

Version 1.0.0 of this PCR was available for open consultation from 2025-07-17 until 2025-09-12, during which any stakeholder was able to provide comments by contacting the PCR Moderator and/or the Secretariat.

Stakeholders were invited via e-mail or other means to take part in the open consultation and were encouraged to forward the invitation to other relevant stakeholders. The following stakeholders provided comments during the open consultation and agreed to be listed as contributors in the PCR and on www.environdec.com:

- Silicon Carbide Manufacturers Association (SiCMa)

3.2 PCR REVIEW

3.2.1 VERSION 1.0.0

PCR review panel:	The Technical Committee of the International EPD System. A full list of members is available on www.environdec.com. The review panel may be contacted via support@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR Committee, and if there were conflicts of interest they were excused from the review.
Chair of the PCR review:	Hudai Kara
Review dates:	2025-11-03 until 2026-01-19

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this PCR, existing PCRs and other internationally standardised methods that could potentially act as PCRs were considered to avoid unnecessary overlaps in scope and to ensure harmonisation with established methods of relevance for the product category. The existence of such documents was checked among the following EPD programmes and international standardisation bodies:

- International EPD System. www.environdec.com.
- GlobalEPD. www.aenor.com.
- EPD Norway. www.epd-norge.no.
- PEP Ecopassport. www.pep-ecopassport.org.
- Keiti Environmental. www.keiti.re.kr.
- JEMAI EcoLeaf. www.ecoleaf-jemai.jp.
- UL Solutions. www.ul.com.
- ASTM International EPD. www.astm.org.
- NSF International National Centre for Sustainability Standards. www.nsf.org/nsf-standards.
- SM Transparency Catalog™. transparencycatalog.com.

- ICC Evaluation Service. icc-es.org.
- DAPcons®. www.dapcons.com
- SCS Global Services. fr.scsglobalservices.com.
- Smart EPD. smartepd.com.
- IBU. ibu-epd.com.
- EPD Italy. www.epditaly.it.

Table 1 lists the identified PCRs and other standardised methods.

Table 1. Existing PCRs and other internationally standardised methods that were considered to avoid overlap in scope and to ensure harmonisation with established methods.

Name of PCR/standard, incl. registration number	Programme/standardisation body	Version number/date of publication	Scope
Abrasives (c-PCR to PCR 2019:14)	International EPD® System	PCR 2019:14-c-PCR-030 (VERSION: 2024-06-20)	Sub-class 37910 Millstones, grindstones, grinding wheels and the like, without frameworks, for working stones, and parts thereof, of natural stone, of agglomerated natural or artificial abrasives, or of ceramics; natural or artificial abrasive powder or grain, on a base of textile, paper or other material, and Sub-class 35333 Polishes and creams, for footwear, furniture, floors, coachwork, glass or metal.
PCR 2021:03 Basic chemicals	International EPD® System	PCR 2021:03, Version 1.1.1	Group: 341 - Basic organic chemicals ○ Class 3411 - Hydrocarbons and their halogenated, sulphonated, nitrated or nitrosated derivatives ○ Class 3412 - Industrial monocarboxylic fatty acids; acid oils from refining ○ Class 3413 - Alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives, industrial fatty alcohols ○ Class 3414 - Carboxylic acids and their anhydrides, halides, peroxides and peroxyacids and their halogenated, sulphonated, nitrated or nitrosated derivatives, except salicylic acid and its salts and esters and their salts ○ Class 3415 - Amine-function compounds; oxygen-function amino-compounds, except lysine and its esters and salts thereof and glutamic acid and its salts; ureines and their derivatives and salts thereof; carboxyimide-function compounds and imine-compounds; nitrile-function compounds; diazo-, azo- or azoxy-compounds; organic derivatives of hydrazine or of hydroxylamine; compounds with other nitrogen function ○ Class 3416 - Organo-sulphur compounds and other organo-inorganic compounds; heterocyclic compounds n.e.c.; nucleic acids and their salts ○ Class 3417 - Ethers, alcohol peroxides, ether peroxides, epoxides, acetals and hemiacetals, and their halogenated, sulphonated, nitrated or nitrosated derivatives; aldehyde-function compounds; ketone-function compounds and

			quinone-function compounds; enzymes; prepared enzymes n.e.c.; organic compounds n.e.c. o Class 3418 - Phosphoric esters and their salts or esters of other inorganic acids (excluding esters of hydrogen halides) and their salts; and their halogenated, sulphonated, nitrated or nitrosated derivatives Group: 342 - Basic inorganic chemicals o Class 3421 - Hydrogen, nitrogen, oxygen, carbon dioxide and rare gases; inorganic oxygen compounds of nonmetals n.e.c. o Class 3422 - Zinc oxide; zinc peroxide; chromium oxides and hydroxides; manganese oxides; iron oxides and hydroxides; earth colours; cobalt oxides and hydroxides; titanium oxides; lead oxides; red lead and orange lead; inorganic bases n.e.c.; metal oxides, hydroxides and peroxides n.e.c., except of mercury o Class 3423 - Chemical elements n.e.c.; inorganic acids; inorganic oxygen compounds of boron, silicon and carbon; halogen or sulphur compounds of non-metals; sodium hydroxide; hydroxide and peroxide of magnesium; oxides, hydroxides and peroxides of strontium or barium; aluminium hydroxide; hydrozine and hydroxylamine and their inorganic salts o Class 3424 - Phosphates of triammonium; salts and peroxysalts of inorganic acids and metals n.e.c. o Class 3425 - Salts of oxometallic or peroxometallic acids; colloidal precious metals and compounds thereof; inorganic and organic compounds of mercury; other inorganic chemicals n.e.c.; compressed air; amalgams o Class 3426 - Isotopes n.e.c. and compounds thereof (including heavy water) o Class 3427 - Cyanides, cyanide oxides and complex cyanides; fulminates, cyanates and thiocyanates; silicates; borates; perborates o Class 3428 - Hydrogen peroxide; phosphides; carbides; hydrides, nitrides, azides, silicides and borides o Class 3429 - Compounds of rare earth metals, of yttrium or of scandium Group: 343 - Tanning or dyeing extracts; tannins and their derivatives; colouring matter n.e.c. o Class 3431 - Synthetic organic colouring matter and preparations based thereon; synthetic organic products of a kind used as fluorescent brightening agents or as luminophores; colour lakes and preparations based thereon o Class 3432 - Tanning extracts of vegetable origin; tannins and their salts, ethers, esters and other derivatives; colouring matter of vegetable or animal origin, except animal black; preparations based on colouring matter of vegetable or animal origin o Class 3433 - Synthetic organic tanning substances; inorganic tanning substances;

			tanning preparations; enzymatic preparations for pre-tanning ○ Class 3434 - Colouring matter n.e.c.; inorganic products of a kind used as luminophores Group: 345 - Miscellaneous basic chemical products (except Class 3451 Wood charcoal) ○ Class 3452 - Sulphur, except sublimed sulphur, precipitated sulphur and colloidal sulphur ○ Class 3453 - Roasted iron pyrites ○ Class 3454 - Oils and other products of the distillation of high temperature coal tar, and similar products; pitch and pitch coke, obtained from mineral tars ○ Class 3455 - Animal or vegetable fats and oils and their fractions, chemically modified, except those hydrogenated, inter-esterified, re-esterified or elaidinized; inedible mixtures or preparations of animal or vegetable fats or oils ○ Class 3456 - Synthetic or reconstructed precious or semiprecious stones, unworked Class 3457 – Glycerol

3.4 REASONING FOR DEVELOPMENT OF PCR

This PCR was developed to enable publication of EPDs for the product category defined in Section 2.2.1 based on ISO 14025 and ISO 14040/14044. The PCR enables different practitioners to generate consistent results when assessing the environmental impact of products of the same product category, and thereby it supports comparability of products within a product category.

Many technical ceramic grains and powders are produced in multi-product plants that encounter similar LCA challenges such as unbalanced closed-loop recycling and complex material flows. This PCR aims to clarify allocation rules and address unbalanced closed-loop recycling, secondary materials content and recycled content calculations to ensure transparency and consistency in LCAs.

3.5 UNDERLYING STUDIES USED FOR PCR DEVELOPMENT

The methodological choices made during the development of this PCR (declared/functional unit, system boundary, allocation methods, impact categories, data quality rules, etc.) were primarily based on the following underlying studies:

- Alumina Zirconia
  - EPD-IES-0007334:002 (S-P-07334) AZ25 (2022). Available at https://www.environdec.com/library/epd7334
  - EPD-IES-0009990:002 (S-P-09990) AZ40 (2023). Available at https://www.environdec.com/library/epd9990
  - EPD-IES-0002696:002 (S-P-02696) AZ25L (2024). Available at https://www.environdec.com/library/epd2696
- Monocrystalline alumina
  - EPD-IES-0011990:001 (S-P-11990) Monocrystalline alumina MA88 (2023). Available at: https://www.environdec.com/library/epd11990
- Seeded gel
  - EPD-IES-0016114:001 HTB ® Ceramic Abrasive Grain (2024). Available at: https://www.environdec.com/library/epd16114
  - EPD-IES-0016113:001 EPD of Multiple Products, Based on Average Results of the Product Group: Cerpass XTL® (SG), Hipal I, HTB II (2024). Available at: https://www.environdec.com/library/epd16113
- Zirconia doped with Calcium oxide and Yttrium oxide:
  - EPD-IES-0018638:004 YCZ3/ CYZ/CSZY Refractory Zirconia Grain (2025). Available at https://www.environdec.com/library/epd18638
  - Zirconia (fused, chemical) – not publicly available

- Imerys Life Cycle Assessment studies (not publicly available), according to the ISO 14040, 14044 methodologies, in industrial sites located in EU and Brazil. The studies were conducted between 2022 and 2024 on the following product families:
  - Brown Fused Alumina
  - White Fused Alumina
  - Alumina Zirconia
  - Silicon Carbide
  - Stabilised Zirconia

4 LCA METHOD

This section provides rules for the LCA method used to develop an EPD for the product category as defined in Section 2.2.1. The basic rules of the LCA method are set in Annex A of the GPI, and this section only includes additions, specifications and deviations to the rules set in the GPI. Guidance and examples of applying the LCA method are also available on www.environdec.com/methodology.

4.1 MODELLING APPROACH

See Section A.1 of the GPI.

4.2 DECLARED/FUNCTIONAL UNIT

If the function of the product in the use stage is known and can be clearly defined, a functional unit shall be used. Depending on the intended application, a functional unit shall be the amount of technical ceramic material required to perform a specified function under defined conditions.

Functional units should be strictly limited, clearly justified, and supported by mandatory performance definitions to preserve comparability.

If the function of the product in the use stage is unknown, if the product can be used for several diverging functions, or if the function cannot be clearly defined, a declared unit shall be used instead of a functional unit. All relevant functional aspects shall, however, be considered when comparing EPDs based on this PCR. A declared unit may, for example, be suitable for intermediate products which can be further processed, or combined with other products, into different end products.

The declared unit shall be defined as 1 kg unit of technical ceramic material, and its packaging (the weight of the packaging is not included in this 1 kg). The reference flow corresponds to the declared unit and shall be defined at the point where the product arrives at the customer gate, i.e., any losses occurring before then shall be accounted for.

4.2.1 REFERENCE SERVICE LIFE (RSL)

No reference service life (RSL) is defined for the EPDs based on this PCR.

4.2.2 PRODUCT LIFESPAN

No product lifespan is defined for the EPDs based on this PCR.

4.2.3 TECHNICAL SPECIFICATION

To ensure comparability of the LCA results, especially considering that the choice of a declared unit may reduce comparability between EPDs, the following specific product information shall be declared in the EPD:

- Chemical composition/purity
- Specific gravity (g/cm^3)
- Surface treatment: yes/no
- % organic binder
- For powders specifically: Particle Size Distribution (PSD) and/or grit size

Additional technical specification may be given such as crystal size and loose packed density (g/cm^3).

See Section 6.4.4.

4.3 SYSTEM BOUNDARY

Since technical ceramic grains and powders are used across a wide range of sectors and applications, both as intermediate products and as finished goods, their specific uses and end-of-life scenarios are not fully known and therefore cannot be precisely defined.

That is why this PCR allows three scopes of the LCA reported in the EPD:

- "Cradle to gate", covering the upstream and core stages.
- "Cradle to gate with options and module D", covering the upstream, core, part of the downstream stages (only the product end-of-life) module D
- "Cradle to grave", covering all stages from upstream to downstream and module D of Section 4.3.1, in accordance with GPI Section A.3.

By default, the applicable scope shall be cradle-to-gate. The other scopes shall only be permitted under the following conditions:

- Cradle-to-gate with options and module D shall only be permitted where downstream declarations are justified and based on documented scenarios.
  - The transportation, integration, and use stages shall be excluded under this approach, as the broad scope of this PCR (technical ceramic grains and powders intended for any application) does not allow the definition of consistent and representative use-phase scenarios. Defining the integration and use stages would require detailed information on the function of the finished product and specific parameters to ensure comparability between products. Finished technical ceramic products may be used in a wide variety of applications (e.g., automotive, aerospace, construction, electronics). The environmental impacts associated with integration and use phases shall therefore be assessed and allocated by the manufacturers of the finished products, using the intermediate LCA/EPD results as upstream data. For this reason, the "cradle-to-gate with options and module D" scope is provided.
- Cradle-to-grave shall only be permitted where the product is a finished good with a clearly defined function and where representative use and EoL scenarios are documented.
  - Where multiple use scenarios exist for a given technical ceramic grains or powders product, the most representative use scenario (i.e., the most relevant in terms of market share or proportion of use) shall be selected, together with the corresponding most representative EoL scenario.

The EPD shall clearly state in the cover page which one of the scopes has been selected.
Where use and end-of-life stages are included, the EPD shall present the corresponding scenarios to ensure transparency and enable comparability within the relevant application.

4.3.1 LIFE-CYCLE STAGES AND INFORMATION MODULES

Because of different data quality rules and the presentation of results, the product life cycle shall be divided into the following life-cycle stages:

- Upstream (from cradle-to-gate)
- Core (from gate-to-gate)
- Downstream (from gate-to-grave).

In addition, consequences of recovered material/energy beyond the product cycle shall be reported in module D.

In the EPD, the environmental performance of each of the life-cycle stages and module D shall be reported separately, and in aggregated form for the life-cycle stages (modules upstream-downstream or upstream-core for cradle-to-gate system boundary).

Section A.3.1 of the GPI outlines rules for how to assign generation of electricity and production of fuels, steam and other energy carriers used, and losses arising, in each information module.

Sections 4.3.1.1-4.3.1.3 further describe the processes to include or exclude for each life-cycle stage.

4.3.1.1 Upstream stage

- Extraction and manufacturing of raw materials
- Processing of secondary raw materials after they have reached end-of-waste status shall be taken into account (e.g., crushing of alumina scrap). Where the point of end-of-waste status is uncertain, a conservative approach shall be adopted by including all recycling processes carried out following the initial generation of the secondary raw material.
- Manufacturing of the product's distribution packaging
- Extraction and manufacturing of auxiliary materials. Common materials examples (non-exhaustive) are shown below:
  - Graphite electrodes used in fusion process
  - Process gas (e.g., nitrogen, argon, oxygen)

  - Materials for emissions treatment (e.g., ammonia)
  - Water treatment materials (e.g., magnesium chloride)
  - Production mould (e.g., plywood, silica sand)
  - Chemical treatment materials
- Generation of electricity and production of fuels, steam and other energy carriers used in upstream processes

4.3.1.2 Processes not listed here may also be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section 4.5. Core stage

- Transport of raw materials and auxiliary materials from their manufacturing site to our facility
- Transport of delivery packaging materials from their manufacturing site to our facility
- Product manufacturing includes (but is not limited to) mixing, fusion, sintering, calcination, milling, sieving, chemical processing, and any processes related to closed-loop material reuse. All such processes must be accounted for, regardless of whether they are performed in-house or by third parties, and whether they take place on-site or at external facilities.
  - Due to the high-temperature processes involved in ceramic production, significant direct emissions may result from the transformation of raw materials, and these emissions shall be fully accounted for. Common sources include CO_2 emissions from the use of coke or graphite electrodes during fusion, and NO_x emissions from nitric acid used in calcination or as a process consumable.
- Additional pre-processing steps applied to input flows shall also be included (e.g., crushing of some raw materials)
- End-of-life treatment of manufacturing waste and wastewater, even if carried out by third parties, including transportation when relevant.
- Generation of electricity and production of fuels, steam and other energy carriers used in core processes

Processes not listed here may also be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section 4.5.

4.3.1.3 Downstream stage

- Transport of product to manufacturers or users
- Storage of product (e.g., warehouse and retail operations)
- Integration processes of the technical ceramics into their functional roles such as sintering, grinding, bonding, adhesion, surface treatments, etc., including energy, resource and auxiliary material consumption, waste generation and emissions
- Product use, e.g. use of electricity or water, use activities causing direct emissions, maintenance activities,
- End-of-life treatment of the used product and its packaging, including transportation
- Generation of electricity and production of fuels, steam and other energy carriers used in downstream processes

Processes not listed here may also be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section 4.5.

4.3.1.4 Excluded processes

See Section A.3.1.1 of the GPI.

4.3.1.5 Infrastructure and capital goods

See Section A.3.1.2 of the GPI.

4.3.2 OTHER BOUNDARY SETTING RULES

See Section A.3.2 of the GPI for rules on setting boundaries to nature as well as geographical and temporal boundaries. See Section A.4 of the GPI and Section 4.6 for rules on setting boundaries to other product systems.

4.4 PROCESS FLOW DIAGRAM

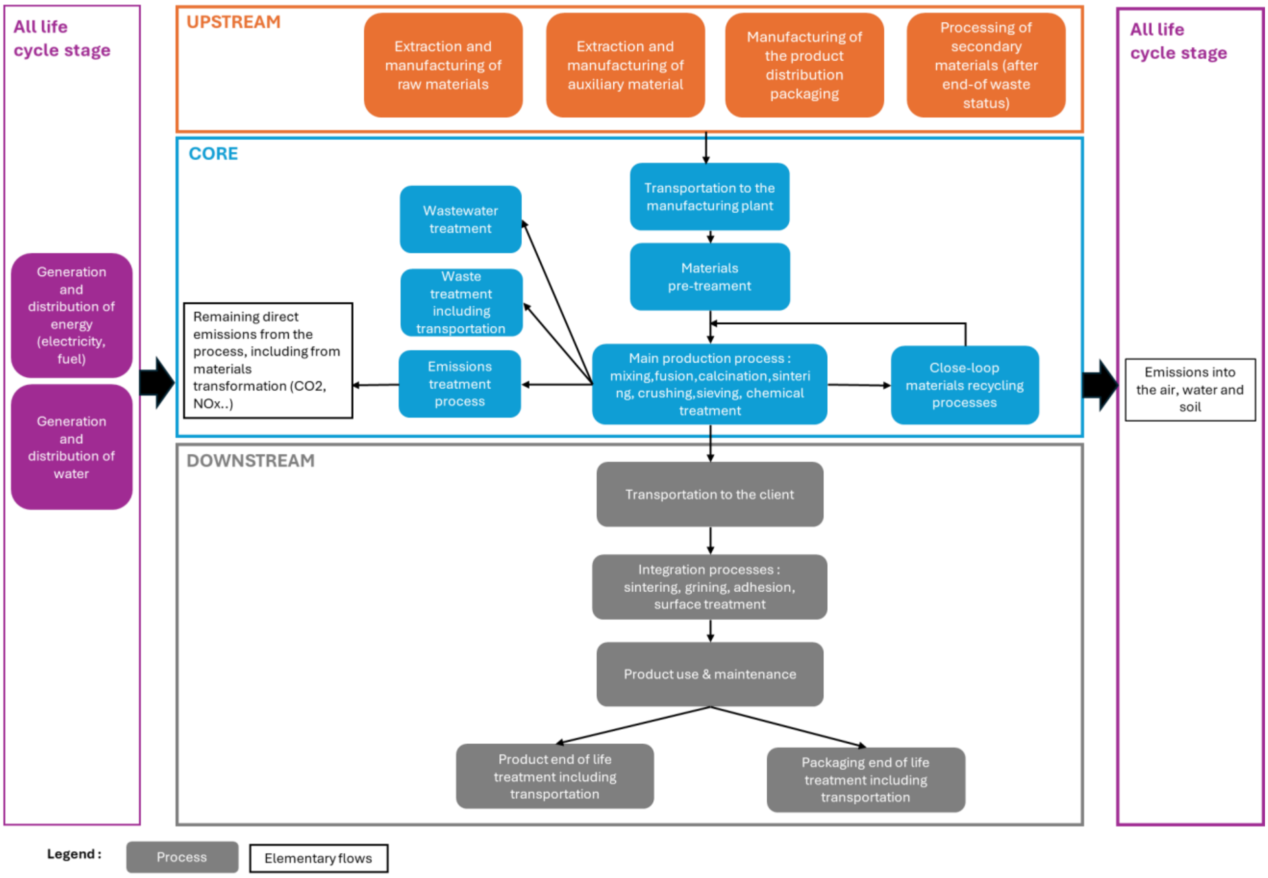

Figure 2. Process flow diagram illustrating the processes that shall be included in the product system, divided into the life-cycle stages. The illustration of processes to include may not be exhaustive.

4.5 CUT-OFF RULES

See Section A.3.3 of the GPI.

4.6 ALLOCATION RULES

See Section A.4 of the GPI.

4.6.1 ALLOCATION OF CO-PRODUCTS

See Section A.4.1 of the GPI.

Further guidance along with the GPI:

- The economic allocation criteria shall be based on the ratio of economic value of the co-products. The economic value should be per unit (usually unit of mass). This ratio should be calculated by placing the highest value in the numerator and the lowest value in the denominator. Economic allocation shall be applied if this ratio is greater than five (>5).
- If there are more than two co-products, the economic value ratio shall be calculated based on the ratio between the highest-valued and the lowest-valued co-product, regardless of whether that includes the studied product. This approach aims to ensure consistency in the allocation followed regardless of which product becomes the studied product.

- The economic allocation factors shall be based on revenue. Revenue shall be calculated using representative values and the net-saleable production. When calculating revenue for each individual co-product, it is crucial to ensure production data completeness through a mass balance check that accounts for all co-products.
- Some guidelines for determining a representative value:
  - Market prices shall be used when available. If market prices are not available, other financial metrics (e.g., costs) may be used as long as they are justified and transparently communicated.
  - When market prices fluctuate, consider using an average market price calculated over several years to obtain a more stable and representative value.
  - If the LCA is assessing a product group with multiple market prices, a weighted average based on the respective volumes associated with each price can be used as a representative value.
  - For allocation at intermediate stages, the market price of the end-product may be used as a representative value.
  - Additionally, only one type of representative value (e.g., market price or production costs) shall be chosen and applied consistently per allocation. If different types of values are used, this must be justified in the LCA and clearly declared in the EPDs.
- Allocation procedures shall be uniformly applied to similar inputs and outputs of the product under study. For example, if allocation is made to co-products leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system.
- In all cases, the sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation.
- Pre-consumer material (as defined in ISO 14021) is conservatively assumed to be a valuable flow and is therefore assigned an environmental burden, in accordance with the co-product allocation rules of the system that generated it.

An example illustrating the economic allocation can be found in Annex A – Economical allocation example.

Case of low economic value and conservative assumption
In co-product allocation, conservative assumptions may be made when the effort of allocation is disproportionate to any improvement in accuracy. Flows leaving the studied product system with a very low revenue (for instance <1%) can be assumed to have no economic value and thereby allocated no environmental burden which is often the case for dust, sludge and fines co-product.
Similarly, for co-product and pre-consumer flows entering the product system, if the economic value is low (less than 1%) and the quantity used in the material recipe is small (less than 5%), these inputs can also be considered to have no economic value and thus may be excluded from environmental burden allocation. This typically applies to known low-value materials such as dust, sludge, and fines.

In multi-product plants, conservative assumptions must be carefully evaluated at the plant level, with consistent allocation practices applied across all product systems. For example, if a low-value co-product from one system (e.g., Product A) serves as a significant input for another (e.g., Product B), it may be more appropriate to assign an environmental burden to that flow rather than treating it as waste. This approach helps avoid underestimating the environmental impact of Product B. The rationale for such choices must be clearly documented in the LCA and consistency shall be ensured: if a co-product exits the system boundary of Product A without an environmental burden, it should not re-enter the system boundary of Product B carrying one.

The zero-burden approach shall only be applied when supporting mass balance and revenue documentation are provided.
Inconsistent modelling approaches shall be avoided (e.g., allocating burdens in one system while assuming zero-burden inputs for the same flow in another), particularly when products are produced and used internally or within affiliated business units of the same corporate group. For co-products used by external stakeholders, the company shall provide relevant information to those stakeholders.

Documentation and reporting requirement:
All assumptions for allocation should be clearly stated in the LCA report and the EPD, including:
- The selected allocation method (e.g., mass-based or economic allocation), along with a clear justification for its choice.
- The allocation factors applied (e.g., 98% for Product A and 2% for its co-products).
- The source of economic values and the reference year used for each co-product (e.g., market price based on a three-year average from 2022 to 2025).
- Special attention must be given to input flows that come from another product system within the same facility. The allocation approach for these flows must be clearly described and justified, including whether they carry an associated environmental burden.

- If the zero-burden approach is applied to a co-product—either as an input or output—this shall be clearly stated as a key assumption in the EPD.

4.6.2 ALLOCATION OF WASTE

See Section A.4.2 of the GPI.

Additionally, recycled materials from a scrapyard where the origin is unknown (e.g., data/statistics are missing for the specific scrapyard or the country of its location), shall be assumed to be waste and allocated accordingly, unless default data provided on www.environdec.com/methodology says otherwise. For consistency, scrap sent to a scrapyard shall be assumed to be waste and allocated accordingly, unless default data provided on www.environdec.com/methodology says otherwise.

4.7 DATA AND DATA QUALITY RULES

See Section A.5 of the GPI.

See Section 4.8 for further rules related to data and data quality per life-cycle stage and module D.

4.7.1 DATA CATEGORIES

See Section A.5.1 of the GPI.

4.7.2 DATA QUALITY REQUIREMENTS FOR PRIMARY DATA

See Section A.5.2 of the GPI.

Additionally, the reference year of the primary data shall not be more than five years old and shall be representative for the validity period of the EPD (if not, the EPD shall be updated, see Section 2.2.4). The reference year, which does not need to be a calendar year, is the latest year in which the data provider confirmed the data to be representative/valid, i.e., the end year for the most recently set validity period.[5] This means that primary LCI data can have been collected more than five years ago, but the representativeness/validity shall have been reassessed and confirmed by the data provider (the manufacturer/service provider) within the past five years.[6] In such reassessments, it may be that data is confirmed to be conservative compared to fully representative data, for example because it is known that the manufacturing process has improved (e.g., less material losses or lower energy use) but collected data from the past five years is missing. In such cases, the reference year can still be updated, and the data can still qualify as primary data. If this is done, it shall be described and justified in the LCA report.

4.7.3 DATA QUALITY REQUIREMENTS FOR REPRESENTATIVE SECONDARY DATA

See Section A.5.3 of the GPI.

4.7.4 DATA QUALITY ASSESSMENT AND DECLARATION

See Section A.5.4 of the GPI.

4.7.5 EXAMPLES OF DATABASES FOR SECONDARY DATA

No specific requirement for databases for secondary data.

[5] This definition of “reference year” is a specification and merge of the definitions in EN 15804, EN 15941, ISO 21930 and in the ILCD format.

[6] This reassessment can, for example, be done based on collected metadata, such as information on the type of machinery being used in a manufacturing process. So it can be that some data (LCI and/or meta data) have been collected within five years, while some data are older than five years but has been confirmed to still be representative based on the more recently collected data. An example: the amount of electricity a machinery use and the emissions generated was measured seven years ago, but within the past five years the producer has confirmed the same machine is still in use and has provided updated data on the type of electricity used to run the machine.

4.8 OTHER LCA RULES

See Section A.6 of the GPI.

For specific LCA rules per life-cycle stage, see Section 4.9.

4.8.1 MASS BALANCE

See Section A.6.1 of the GPI.

4.8.2 ELECTRICITY MODELLING

See Section A.6.2 of the GPI.

The following requirement for contractual instruments in the GPI may not be possible to comply with in all markets for contractual instruments: “the contractual instrument shall … be valid for at least the upcoming six months from the publication of the EPD.” Therefore, it is replaced with the following: “is produced as close as possible to the period to which the contractual instrument is applied and comprises a corresponding timespan.”

4.8.3 BIOGAS MODELLING

See Section A.6.3 of the GPI.

4.9 SPECIFIC RULES PER LIFE-CYCLE STAGE AND MODULE D

See Section A.7 of the GPI.

4.9.1 UPSTREAM AND CORE STAGE

See Section A.7.1 of the GPI.

Ceramic production typically takes place in multi-product, multi-process plants characterized by complex material flows and extensive internal recycling. The growing use of secondary materials further adds to this complexity. However, current standards do not adequately address these intricate material flow scenarios, leading to potential inconsistencies in flow status classification—and, consequently, in accounting methods—depending on the individual LCA practitioner's interpretation.

In addition to the GPI guidance, this chapter explains how to account for material flows in upstream and core steps, with a focus on closed-loop recycled materials. The first step is to clearly identify and classify all relevant flows within the product system. Once the flows are properly categorized, specific allocation and calculation rules are applied according to their classification.

Step 1: Identification and classification of all material flows

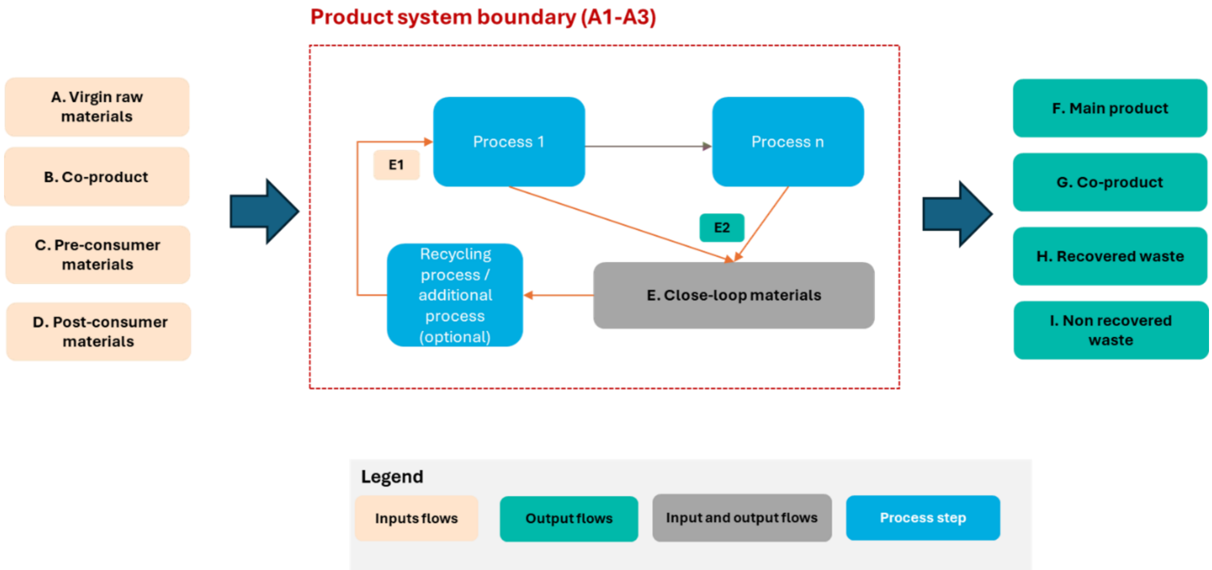

Figure 3 Material flows diagram

All material flows entering and leaving the product system can be classified into distinct categories, as illustrated in the schema above.

- All inputs flows (A, B, C and D) are coming from outside the product system boundaries, but they can be generated within the same plant, except for the post-consumer materials (D).
- All outputs flows (F, G, H,I) are leaving the product system but they can be used in another product system within the same production facilities.
  - The recovered waste output flow is a pre-consumer waste input flows for another product system.
- Close-loop materials (E) are materials that are produced and recycled in the same process
  - For example, alumina grains manufactured via electro-fusion and then crushing will produce many production residues such as dust, scraps, etc. Those materials are usually recycled in the electro-fusion process of the same grains.

The first step aims to accurately classify the different flows with the following points of attention:

- To classify output flows as co-products or recovered waste when they are used in another product system within the same plant, it must be clearly demonstrated that the material is effectively utilized. If this cannot be verified, or in cases of uncertainty, a conservative approach shall be applied by classifying the material as waste. In such cases, all associated environmental impacts shall be attributed to the main product and any co-products. For example, materials stored for potential future use without documented evidence of recycling shall be considered waste. Effective use can be demonstrated through documented production volumes and evidence of consumption within another product system. One such form of evidence may include a product recipe or formulation record.
- The same material can be recycled in the same production flow and used in another production (the flow is partly categorized as E and partly as G or H). For example, part of the off-size grains can be recycled in the same production and the rest is used as co-product or pre-consumer material in another product production.
- Identifying the E category can be challenging due to the complexity of the production steps. As a general rule, products that share production processes, including the production and recycling of materials, are considered to belong to the same production flow. This means that these products may share all or some production processes. The term 'share' implies that they are produced together. The notion of same production flow shall not be defined by marketing and sales product line standards.
  - For example, alumina grains share the same fusion step, no matter the final grit size. During the fusion step and the crushing step, many internal materials are produced and usually recycled in the fusion step. Therefore, all alumina grains are produced in the same

production flow as they are produced together, and their close-loop materials are recycled in a shared step within the same production processes.

- However, if product A and product B have close chemistry and are both fused in the same furnace but in different batches then they are produced separately. In this case, they are not considered from the same production flow. Therefore, materials from product B used in product A should be categorized as G or H.

- When the status of an input flow is unknown, the conservative approach that such material is a co-product should be prioritized.
- In case the production flow yielding the material is uncertain or difficult to ascertain, conservative assumptions must be made. This can be done by either considering the material as 100% close-loop materials, or by prorating it based on the total production volume. The choice has to be justified and clearly documented in the LCA and EPDs.
  - For example, dust materials are often generated and recycled within the same production plant. However, tracking dust flows at the product level is typically challenging. Therefore, when dealing with dust inputs, it can be difficult to determine if the material originates from the same production flow or from other products within the plant. As a result, a conservative assumption could involve treating it as close-loop materials (E) from the same production flow or prorating based on product volume (e.g., if the product accounts for 25% of total production, then 25% of the total dust input is assumed to come from the same production flow, while the remainder comes from other products).

Step 2: Allocation and accounting method

The accounting approach varies based on the classification of each flow. Three main cases can be distinguished

- Allocation of waste. Refer to Section 4.6.2 for waste allocation rules.
- Allocation of co-product. Refer to Section 4.6.1 for co-product allocation rules.

Close loop materials accounting. Refer to Section Error! Reference source not found. **for close-loop materials accounting.**

Type of flow	Allocation waste	Allocation of co-product	Close-loop materials
Input	**D**	**B, C**	**E1**
Output	**I**	**G, H**	**E2**

Table 2 Allocation and accounting method by flow category

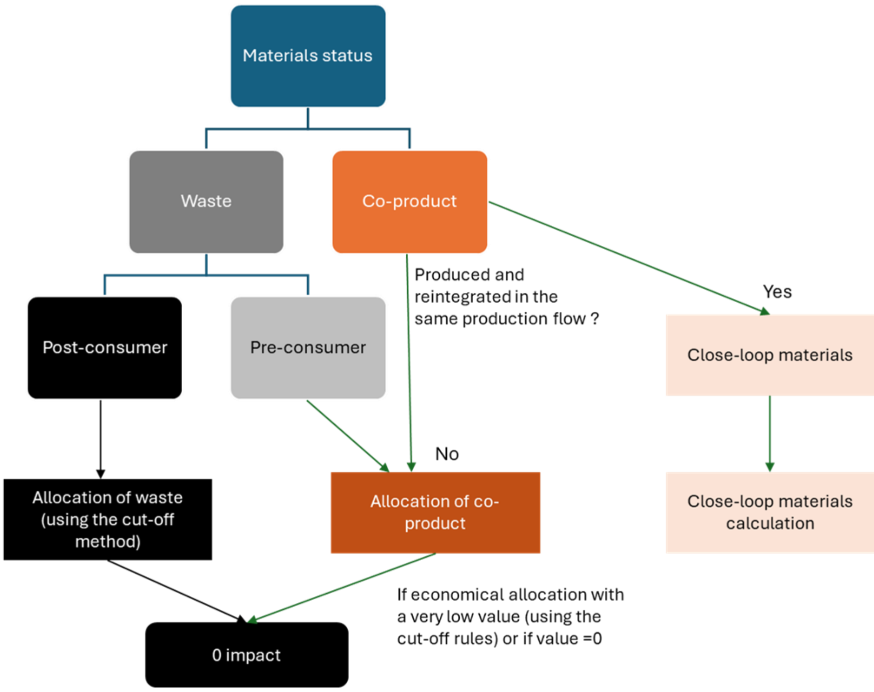

Figure 4. Allocation decision tree for input flows

Some additional guidance regarding co-product input calculation:

- In case of recursion between two distinct products (e.g., product A consumes product B's co-product as input and product B consumes product A's co-product as input), assumptions can be made to calculate the impact of the co-product. For example, one approach could involve considering the production of one of the products without the use of the other co-products by considering all the co-products as virgin raw materials. Any other methodology should be justified in the LCA and mentioned in the EPDs.

4.9.2 CLOSE-LOOP MATERIAL IN CORE STAGE

See Section 4.9.1 of the PCR for the definition of close-loop materials as well as guidance to identify them.

One challenge with closed-loop materials accounting is that its input and output flows are not always balanced. While the manufacturing goal is to minimize the close-loop materials output and reintegrate as much as possible into the process, practical constraints—such as product-specific limitations, product changes or operational disruptions—can prevent full reintegration. Therefore, the unbalanced close-loop flows are often observed when the data is based on actual annual production data rather than predefined theoretical recipes. Moreover, collecting data over multiple years is often either not feasible or not meaningful, as variations in product formulations and process conditions can occur year to year, limiting comparability.

This chapter explains how to account for imbalances in closed-loop materials in the LCA.

Scenario	Description	Accounting method
Scenario 1: **D = Close-loop input (E1) – Close-loop output (E2) > 0**	More closed-loop material is consumed than generated. This difference (D) is referred to as *surplus close-loop input.* This situation may occur, for example, when products are heavily downgraded in one year and only recycled in a subsequent year.	- **A burden shall be applied to D**. This burden shall correspond to the production of the raw materials mix (excluding close-loop materials) normalized to 100%. Alternative burden calculation may only be applied where technically justified and clearly documented in both the LCA report and the EPD. - The burden is applied based on the assumption that, in the absence of the surplus closed-loop input, the product system would have to rely on virgin material inputs.
Scenario 2: **D = Close-loop input (E1) – Close-loop output (E2) <0**	More closed-loop material is generated than recycled. This absolute difference (D) is referred to as *surplus closed-loop output*. This situation may occur, for example, from changes in production orders—such as increased demand for a specific grain size. These changes can affect production yields and lead to the generation of surplus closed-loop output which is typically stored by the manufacturing site for future use.	- Surplus closed-loop output shall be considered waste, based on the assumption that the quantity of material that can be physically reintegrated into the same system is limited by the input requirements. Such surplus is treated as an occasional loss. - However, misclassifications may occur. In some cases, surplus closed-loop output is not reused within the same product system but is instead used in a different product system. In such instances, it should be reclassified as a co-product (G) or recovered waste (H), depending on the context and use.

Table 3 Overview of unbalanced closed-loop scenarios and applicable accounting approaches. (E1 and E2 flow are defined in Section 4.9.1 of the PCR)

Some further guidance:

- It's crucial to ensure that the difference calculation (D) is performed on comparable input and output of close-loop materials. For example, some close-loop materials need to be crushed before being re-integrated in the process, the input is made of crushed close-loop materials whereas the actual output is made of close-loop materials before crushing. Therefore, E1 and E2 must be made comparable by either multiplying the output by the crushing yield to determine the quantity of crushed internal materials obtained from the output, or by dividing the input by the yield to calculate the output needed to produce the crushed close-loop materials.
- If the closed-loop output flow (E2) requires additional processing or transportation before being reintegrated into the system, the environmental burdens of these steps shall be accounted for within the product life cycle, regardless of the difference D calculation. This additional impact shall be accounted for the close-loop input flow (E1) quantities.

However, we recognize that in more complex situations—such as when traceability of closed-loop materials is limited—applying this method can be challenging. In such cases, the LCA practitioner must ensure the following:

- All inputs and outputs are thoroughly documented and factored into the calculation, ensuring consistency between plant-level consumptions and product-level consumptions, and accounting for stock fluctuations.
- Mass balance verification, at least checking that producing 1 kg of product requires more than 1 kg of external (non-closed-loop) materials
- A net positive closed-loop material flow at the plant-level, meaning production of closed-loop materials exceeds consumption. If not, a burden shall be applied to the products as described in the methodology above (case where D>0).
- The method used to account for the close-loop materials shall be well documented and justified in the LCA report and the EPD.

Examples illustrating the principles described in this section can be found in Annex B – Close-loop materials.

4.9.3 DOWNSTREAM STAGE

This PCR does not provide any additions to the rules and guidance in the GPI on the modelling of the downstream stage.

4.9.4 CONSEQUENCES FOR RECOVERED MATERIAL/ENERGY BEYOND THE PRODUCT LIFE CYCLE (MODULE D)

Where module D is declared, all assumptions, scenarios, and calculation parameters shall be transparently documented in the LCA and the EPD, with particular emphasis on the avoided impact hypothesis.
Recycling and recovery shall only be accounted where a technically feasible route exists within the declared geography. Where uncertainty exists regarding the end-of-life route or substitution, conservative assumptions shall be applied.
By default, avoided impacts shall be calculated using the declared product's raw material mix (excluding close-loop materials), normalised to 100%. Alternative substitution assumptions may only be applied where technically justified and clearly documented in both the LCA report and the EPD.

4.10 ENVIRONMENTAL PERFORMANCE INDICATORS

See Section A.8 of the GPI.

4.11 SPECIFIC RULES PER EPD TYPE

4.11.1 MULTIPLE PRODUCTS FROM THE SAME COMPANY

See Section A.9.1 of the GPI.

4.11.2 SECTOR EPD

See Section A.9.2 of the GPI.

4.11.3 EPD OWNED BY A TRADER

See Section A.9.3 of the GPI.

4.11.4 EPD OF PRODUCT NOT YET ON THE MARKET

See Section A.9.4 of the GPI.

4.11.5 EPD OF PRODUCT RECENTLY ON THE MARKET

See Section A.9.5 of the GPI.

5 CONTENT OF LCA REPORT

Data for verification shall be presented in the form of an LCA report – a systematic and comprehensive summary of the project documentation that supports the verification of an EPD. The LCA report is not part of the public communication.

See Section 8.3.1 of the GPI for rules on the content of the LCA report.

Note that there may be rules on the content of the LCA report elsewhere in the GPI or in this PCR.

6 CONTENT AND FORMAT OF EPD

See Section 7 of the GPI.

6.1 EPD LANGUAGES

See Section 7.1 of the GPI.

6.2 UNITS AND QUANTITIES

See Section 7.2 of the GPI.

6.3 USE OF IMAGES IN EPD

See Section 7.3 of the GPI.

6.4 SECTIONS OF THE EPD

See Section 7.4 of the GPI.

6.4.1 COVER PAGE

See Section 7.4.1 of the GPI.

6.4.2 GENERAL INFORMATION

See Section 7.4.2 of the GPI.

6.4.3 INFORMATION ABOUT EPD OWNER

See Section 7.4.3 of the GPI.

6.4.4 PRODUCT INFORMATION

See Section 7.4.4 of the GPI.

6.4.5 CONTENT DECLARATION

See Section 7.4.5 of the GPI.

6.4.5.1 Recycled content calculation

When a product is made entirely or partially from recycled materials, the origin of these materials (pre-consumer or post-consumer) should be specified in the EPD as part of the content declaration. To avoid any misunderstanding about which material may be considered as "recycled material", the guidance given in ISO 14021 shall be considered. In brief, the standard states that:

- Only pre-consumer and post-consumer material shall be considered in the accounting of the recycled materials,
- and materials coming from scrap reusage (such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) shall not be considered as pre-consumer materials and therefore excluded from the recycled content

This chapter aims to clarify the application of ISO 14021 regarding recycled content calculation, particularly in cases involving closed-loop material flows—referred to as "scrap reuse" in the standard—which are open to interpretation. Indeed, ISO 14021 states that close-loop materials should be excluded from recycled content. However, this can be interpreted in different ways such as either that close-loop materials should be excluded from the calculation entirely, or that it should not influence the recycled content result. This distinction becomes especially important when the closed-loop materials is unbalanced.

To harmonize our approach, we propose the following guiding principles derived from the different close-loop materials scenarios:

Scenario	Description	Guiding principles
Scenario 1: Close-loop materials Input ≈ Close-loop materials Output	The materials turn in loop and is neutral in the balance of input and output flows.	- Close-loop materials should not affect the recycled content calculation. - Product can reach 100% recycled content if all other inputs are secondary materials.
Scenario 2: Close-loop materials Input < Close-loop materials Output	More materials are produced than the amount re-integrated in the system. The difference between close-loop materials output and input is called surplus close-loop output.	- Surplus close-loop output should not affect the recycled content calculation. - Product can reach 100% recycled content if all other inputs are secondary materials.
Scenario 3: Close-loop materials Input > Close-loop materials Output	More materials are used as input than the amount produced. The difference between close-loop materials input and output is called surplus close-loop input.	- Surplus close-loop input is not considered secondary material. - This surplus should not contribute and increase the recycled content of the product.

Table 4 Guiding principles for recycled content calculation regarding close-loop materials

In accordance with ISO 14021 and the guiding principles outlined above, recycled content—if calculated and reported in the EPD—shall be determined using the formula provided below. The terms used in the formula are illustrated in Figure 5 Material Flow for Recycled Content calculation and more information on unbalanced close-loop flow can be found in Section **Error! Reference source not found.**.

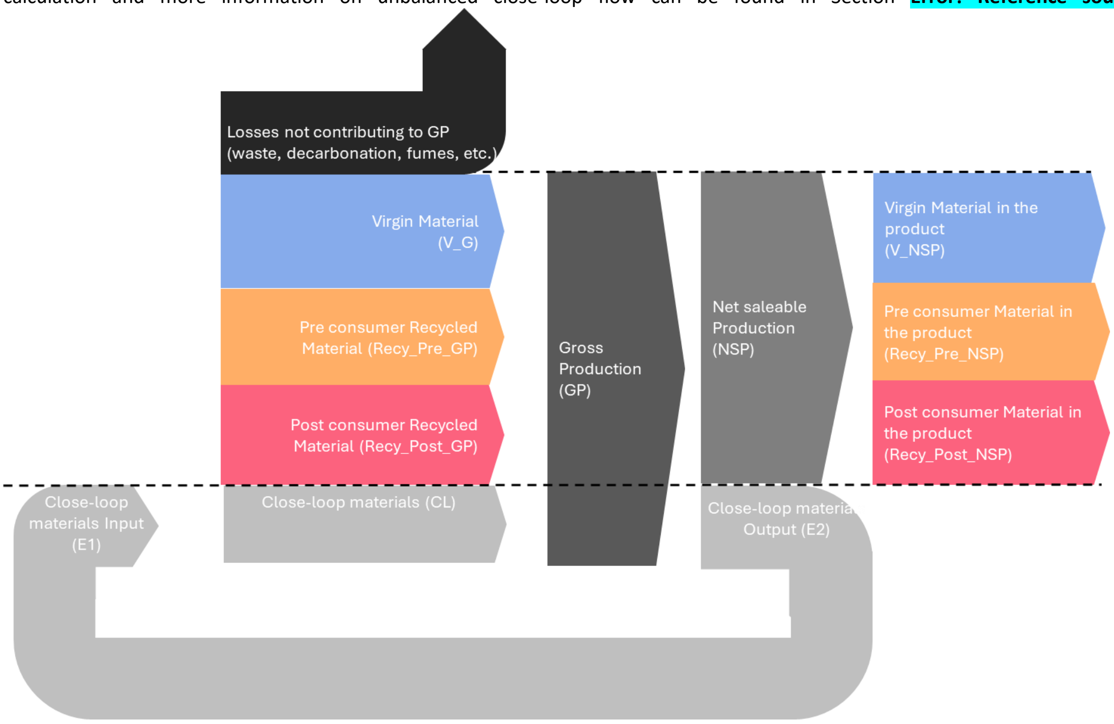

Figure 5 Material Flow for Recycled Content calculation

$$Recycled\ content = \frac{\text{Mass secondary materials in Net saleable production}}{\text{Mass of Net saleable production}} = \frac{\text{Recy\_Pre\_NSP+Recy\_Post\_NSP}}{\text{NSP}}$$

$$=> Recycled\ content = \frac{\text{Mass secondary materials in the Gross Production}}{\text{Mass of Gross Production}} = \frac{\text{Recy\_Pre\_GP+Recy\_Post\_GP}}{\text{GP} - CL}$$

$$=> \boldsymbol{Recycled\ content} = \frac{\textbf{Recy\_Pre\_GP+Recy\_Post\_GP}}{\textbf{GP} - \textbf{Min}(\textbf{E1},\textbf{E2})}$$

Where:

- Min (E1,E2) = minimum between E1 and E2 flows.

Min(E1,E2) correspond to the quantity of balanced close-loop in the product system. When the close-loop is balanced E1 is equal to E2. Refer to Annex C – Recycled content or the detailed derivation of the recycled content calculation.

Some further guidance regarding the calculation:

- Net saleable production is the reference basis for calculating recycled content under the ISO 14021 standard. However, this requires accurate data on the quantities of pre-consumer, post-consumer, and closed-loop materials contained in the net saleable output—data that is often challenging to obtain directly from manufacturing sites, especially when chemical transformations occur. In such cases, determining these quantities typically involves multiple intermediate calculation steps, including conversions from gross production data. Therefore, we also propose an alternative calculation method based directly on gross production as it is more practical and widely applicable in practice.
- E1 and E2 correspond to close-loop materials flows as defined in Section 4.8.4.
- Pre- and post-consumer materials inputs should only include those that are physically present in the product. For instance, if a chemical transformation leads to the release of a portion of these materials into the air, the recycled content must be adjusted to reflect only the quantity of pre- or post-consumer material retained in the product. In complex cases, this may require separating recycled content flows based on chemical composition.
- When certain losses (e.g., off-size grains, dust from crushing) have the same chemical composition as the gross or net saleable production, the recycled content can be calculated based on the total of the gross (or net) production plus the associated waste. This simplifies the calculation process by eliminating an intermediate step to exclude pre- and post-consumer material quantities contained in the waste, as their proportions are assumed to mirror those in the product—thus not affecting the percentage-based recycled content calculation. However, if the declaration is made in absolute terms (e.g., mass or volume rather than percentage), these quantities must be explicitly excluded.
- If there is uncertainty about whether a material input should classified as pre-consumer material or co-product, one should make the conservative assumption that such material is a co-product. This approach is particularly important for materials that are recycled between different product system but within the same plant
- If the recycled content of a raw material/co-product input is unknown, a conservative assumption of 0% recycled content shall be made.
- When EPDs are based on data from multiple plants (e.g. an EPD of a single product produced in several plants, or an EPD of the weighted average), the recycled content must accurately reflect the physical realities and should not rely on any form of allocation. For example, while data is often weighted and averaged based on the production volume of each plant, this approach does not reliably represent the physical flows of recycled materials.
- The LCA report must provide thorough documentation of the recycled content calculation. In the EPD, qualitative information regarding the accounting treatment of close-loop recycling and complex physical flows shall be described.

Examples of recycled content calculation can be found in Annex C – Recycled content.

6.4.6 LCA INFORMATION

See Section 7.4.6 of the GPI.

6.4.7 ENVIRONMENTAL PERFORMANCE

See Section 7.4.7 of the GPI.

The EPD shall declare the environmental performance indicators listed or referred to in Section 4.10, per declared or functional unit, per life-cycle stage and module D.

6.4.8 ADDITIONAL ENVIRONMENTAL INFORMATION

See Section 7.4.8 of the GPI.

6.4.9 ADDITIONAL SOCIAL AND ECONOMIC INFORMATION

See Section 7.4.9 of the GPI.

6.4.10 INFORMATION RELATED TO SECTOR EPDS

See Section 7.4.10 of the GPI.

6.4.11 VERSION HISTORY

See Section 7.4.11 of the GPI.

6.4.12 ABBREVIATIONS

See Section 7.4.12 of the GPI.

6.4.13 REFERENCES

See Section 7.4.13 of the GPI.

7 LIST OF ABBREVIATIONS

CPC	Central product classification
EPD	Environmental product declaration
GPI	General Programme Instructions
ISO	International Organization for Standardization
LCA	Life cycle assessment
PCR	Product category rules
RSL	Reference service life
UN	United Nations

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9 VERSION HISTORY OF PCR

VERSION 1.0.0, 2026-03-09

Original version of the PCR.

ANNEX A – ECONOMICAL ALLOCATION EXAMPLE

Please find below an example illustrating multiple co-products allocation calculation as described in Section 4.6.1.
In this example, the co-products A,B,C are produced in a joint production process.

Step 1: Definition of the main product and calculation of the allocation criteria
The allocation criteria (P_r) is defined as: $P_r = P_{max}/P_{min}$
Where:

- P_r represents the ratio of price per unit (usually mass)
- P_{max} represents the highest price between the products considered
- P_{min} represents the lowest price between the products considered
-

	Product A	Product B	Product C	Total
Price (€/kg)	10	1	2	/

Table 5. Economic allocation criteria calculation

The allocation criteria is more than 5 (P_r = 10/1 >10), therefore economical allocation shall be applied to product A,B and C.

Step 2: Calculation of the revenue and the economical allocation factor
The revenue (R) is defined as: R = P * O
Where:

- R represents the total income generated from selling the product or co-product
- P represents the price per unit of the product or co-product
- O represents the netsaleable production of product or co-product

It is crucial to use the representative mass balance when determining revenue for each individual co-product.

The economical allocation factors (Xi) should be calculated as: $X_i = \frac{R_i}{\sum_{i=1}^{n} R_i} * 100$
Where:

- X_i represents the economical allocation factor for product *i*
- R_i represents the revenue of product *i*
- $\sum_{i=1}^{n} R_i$ represents the sum of the revenues of all the products and co-products generated by the unit process

For each flow, the allocation of the impact should be as: $F_i = X_i * F_x$

Where:

- F_x represents the total impact of flow *F* (e.g total impact of raw material, electricity..etc)
- F_i represents the impact of flow *F* allocated to product *i*
- X_i represents the allocation factor of product *i*

The co-products A, B, C are produced in a joint production process. To produce 230kg of total production, raw material 1 is used as input and its total climate change impact is 10kgCO2eq.

	Product A	Product B	Product C	Total
Price (€/kg)	10	1	2	/
Production (kg)	10	20	10	40
Revenue (€)	100 (10*10)	20 (1*20)	20 (2*10)	140 (100+20+20)
Economical allocation factors (%) - X_i	71,4% (100/140)*100	14,3% (20/140) * 100	14,3% (20/140) * 100	100,0% (71,4+14,3+14,3)
Total climate change impact for raw material 1 allocated to each product (kgCO2eq.) – F_i	7,14 (10*0,71)	1,43 (10*0,14)	1,43 (10*0,14)	10 (7,14+1,43+14,3)

Interpretation	71,4% of the impact of raw material 1 will be allocated to 10kg of product A.	14,3% of the impact of raw material 1 will be allocated to 20kg of product B.	14,3% of the impact of raw material 1 will be allocated to 10kg of product C.	/
Impact of raw material 1 allocated to each product (kgCO2/ kg product $_i$)	0,714 (7,14/10)	0,072 (1,43/20)	0,143 (1,43/10)	

Table 6 Economical allocation calculation

ANNEX B – CLOSE-LOOP MATERIALS

Below a few examples illustrating the principled described in Section **Error! Reference source not found.**.

B.1 EXAMPLE 1 - BASIC CASE

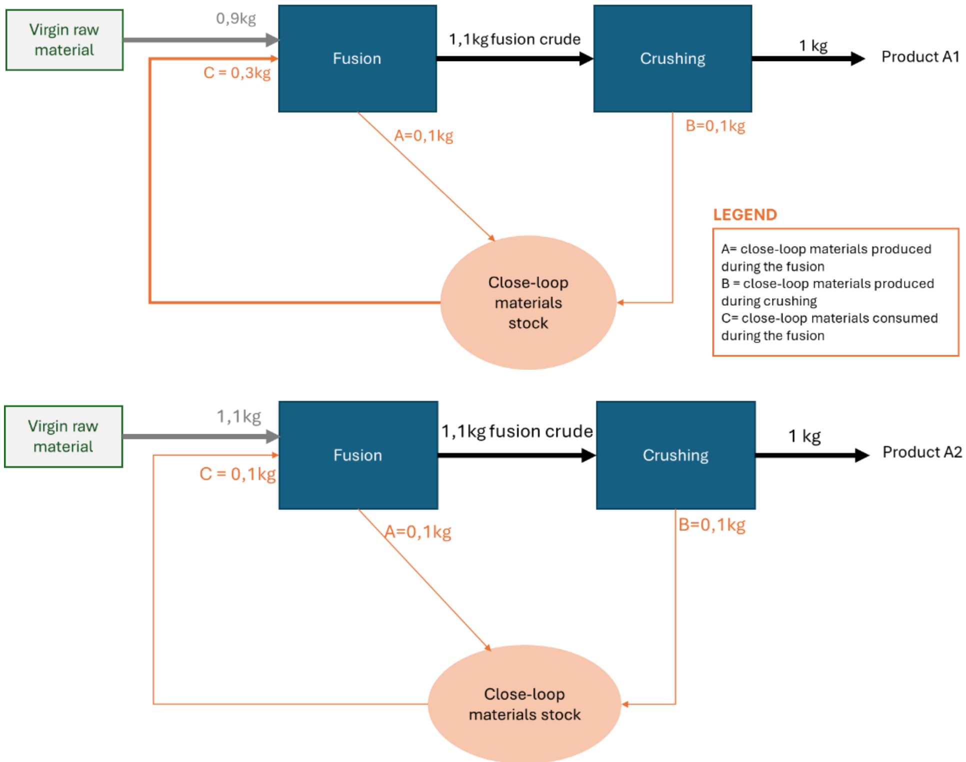

Figure 6 Close-loop recycling scenario. Top figure: balanced close-loop. Bottom figure: unbalanced close-loop (output > input)

As the materials from fusion and crushing are both recycled in the same fusion process, they are considered to belong to the same production flows. Therefore, the flows A and B are classified as E2 and the flow C is classified as E1.

Step 1: Calculation of D

	Product A1	Product A2
E1	C = 0,3	C = 0,1
E2	A+B = 0,2	A+B = 0,2
Difference (D)	D= A+B-C = -0,1 <0	D = A+B-C=0,1>0

Table 7. Calculation of difference D

Step 2: Calculation of the impact

		Product A1		Product A2	
	EF (kgCO2eq./kg)	**Quantity (kg)**	**CF total (kgCO2eq.)**	**Quantity (kg)**	**CF total (kgCO2eq.)**
Inputs					
Virgin raw materials	2	0,9	1,8	1,1	2,2
Close-loop materials	0	0,3	0	0,1	0
Outputs					
Close-loop materials		0,2		0,2	0
Difference D	*2*	*0,1*	*0,2*	*-0,1*	*0*
Product		1	**2**	1	**2,2**

Table 8. Calculation of the impact for products A1 and A2 (EF = emission factors; CF = Carbon Footprint)

For product A1, there is more consumption than production of close-loop materials. Therefore, the difference D was accounted as virgin raw materials (+0,2 kgCO2eq./kg product A1).

For product A2, there is more production than consumption of close-loop materials. However, no credits were attributed to the surplus close-loop output.

In the case of an additional recycling step, such as crushing, accounting for the impact associated with the crushing of the input close-loop materials separately from the difference calculation (D) is essential. For example, if there was an extra crushing step with 1 kgCO2eq. per kg of close-loop materials crushed, this impact would need to be included. Consequently, 0,3 kgCO2eq would be added to product A1 and 0,1 kgCO2eq. to product A2.

B.2 EXAMPLE 2 - A MORE COMPLEX PRODUCTION FLOWS

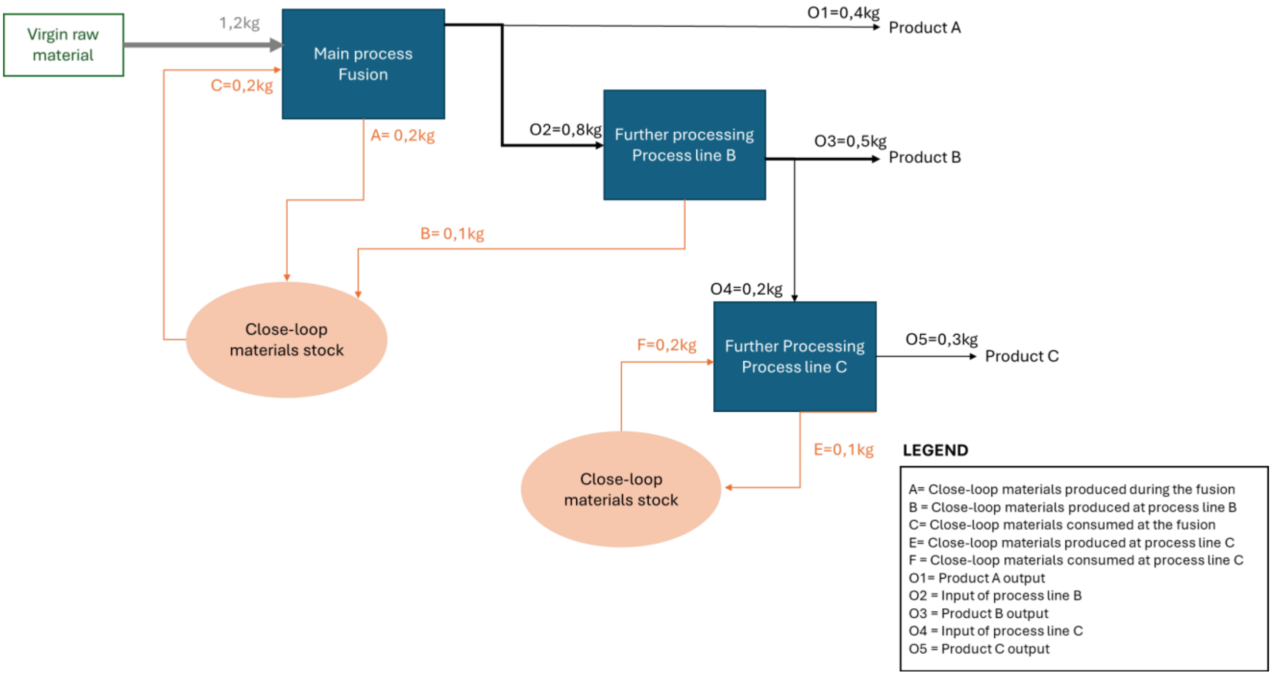

Figure 7. Flow-chart of a more complex production process

Step 1: Identification of close-loop flows (E1 and E2)
There are two distinct close-loop recycling system. The first group consist of materials from both the fusion process and the process line B. These materials are recycled within the fusion process and belong to the same production flows.
The second grouping is specific to process line C with materials produced and recycled within the same process C only.
Step 2: Calculation of D

	Product A & B	Product C
E1	C = 0,2	F = 0,2
E2	A+B = 0,3	E = 0,1
Difference (D)	D= C-A+B = -0,1 <0	D = F-E = 0,1>0

Table 9 Calculation of D for product A,B and C

Step 3: Calculation of the impact

		Product A		**Product B**		**Product C**	
	EF (kgCO2eq./kg)	**Recipe**	**Total (kgCO2eq)**	**Recipe**	**Total (kgCO2eq)**	**Recipe**	**Total (kgCO2eq)**
Inputs (kg)		**1,4**		**0,8**		**0,4**	
Virgin raw materials	2,0	1,2	2,4				
Close-loop materials 1		0,2					
Close-loop materials 2						0,2	
Product A	2,0	0,0		0,8	1,6		
Product B	2,3					0,2	0,5
Outputs (kg)		**0,2**		**0,1**		**0,1**	
Close-loop materials 1		0,2		0,1			
Close-loop materials 2						0,1	
Difference (D) 1		0,0		-0,1	0,0		
Difference (D) 2	2,3					0,1	0,2
Product A		1,2	2,4				
Product B		0,0		0,7	1,6		
Product C		0,0				0,3	0,7
Total							
Total product A		**1,0**	**2,0**				
Total product B		1,0		1,0	**2,3**		
Total product C		1,0				1,0	**2,3**

Table 10. Calculation of the impact for product A and B and C (EF = emission factors; CF = Carbon Footprint)

A mass allocation was considered for the fusion and the process line B co-production. Therefore, the recipe of product A is equivalent to that of the fusion process with all the product outputs (O1+O2) considered as product A. Same reasoning is applied for product B's recipe, which is equivalent to that of the process line B with all the product outputs (O3+O4) considered as product B.

For product A and B, there is more production than consumption of close-loop materials. Therefore, neither additional burden nor credit were accounted.

For product C, there is more consumption than production of process C close-loop materials. Therefore, the difference D was accounted for as virgin product B (+0,2 kgCO2eq./kg product C).

B.3 EXAMPLE 3 - MIX OF CLOSE-LOOP MATERIALS AND CO-PRODUCTS

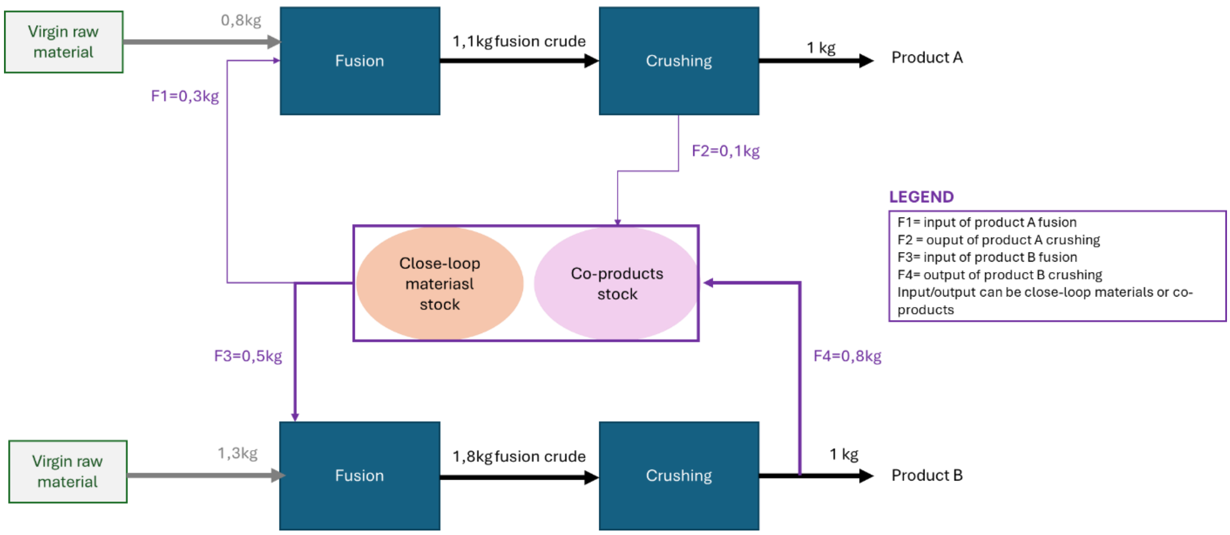

Figure 8. Example 3 flow-chart before classification of the flows

Product A and B are produced separately but within the same manufacturing site. They both:

- have close-loop recycled materials (product B produces close-loop materials at the crushing steps that are recycled in product B fusion step)
- share materials between them (materials from product B are used for the production of product A and vice versa)

Therefore, in this example, **the different material flows are not easily distinguishable within the plant.**

Step 1: Classification of flows
In this case, product A and B are not considered in the same production flow but their material flows get mixed and are not well traceable or discernable. Therefore, assumptions need to be made in order for one to distinguish the closed-loop flows of each product from the co-product flows shared between them. The following assumptions were made:

- To determine the closed-loop recycling (E1 and E2) of each product **the minimum amount is considered, which constitutes the limiting factor between the total input and output of close-loop materials.**
- For product A, as the production of materials is lower than its consumption, the balanced closed-loop quantities of product A is limited by its output of materials.
- For product B, it is the opposite, therefore, the inputs of materials are considered as the quantity of closed-loop materials for product B. Therefore, additional materials produced by product B are considered as its co-products. To avoid recursive recipe calculation and to be able to calculate the co-product allocation, we assume that product B does not consume any product A materials.

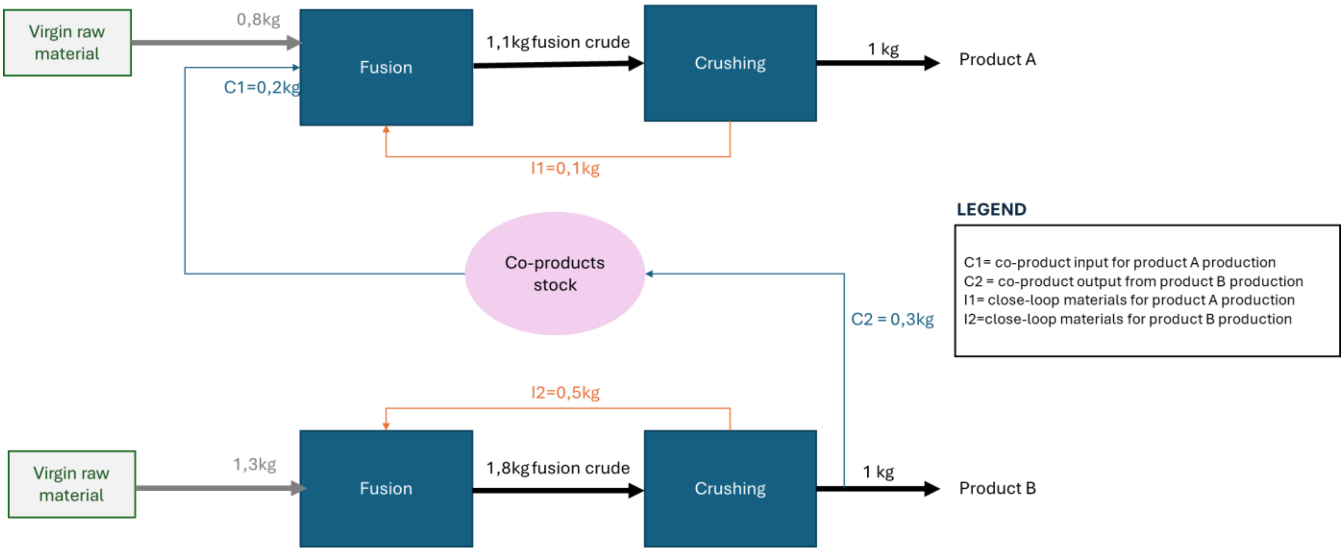

Figure 9 Example 3 flow-chart after classification of the flows

Step 2: Calculation of the impact

Mass allocation scenario		Product B		Product A	
	EF (kgCO2eq./kg)	Quantity (kg)	Total (kgCO2eq.)	Quantity (kg)	Total (kgCO2eq.)
Inputs (kg)		**1,8**		**1,1**	
Virgin raw materials	2	1,3	2,6	0,8	1,6
Co-product B	2	0	0	0,2	0,4
Close-loop materials	0	0,5	0	0,1	0
Outputs (kg)		**1,8**		**1,1**	
Product		1	2	1	1
Co-product		0,3	0,6	0	0
Close-loop materials		0,5	0	0,1	0
Difference (D)		0	0	0	0
Product		1	**2**	1	**2**
Co-product		1	**2**		

Table 11. Calculation of the impact for product A and B with a mass allocation for co-product B (EF = emission factors; CF = Carbon Footprint)

Economical allocation scenario		Product B		Product A	
	EF (kgCO2eq./kg)	Quantity (kg)	Total (kgCO2eq.)	Quantity (kg)	Total (kgCO2eq.)
Inputs (kg)		**1,8**		**1,1**	
Virgin raw materials	2	1,3	2,6	0,8	1,6
Co-product B (low value)	0	0	0	0,2	0
Close-loop materials	0	0,5	0	0,1	0
Outputs (kg)		**1,8**		**1,1**	
Product		1	2,6	1	1
Co-product		0,3	0	0	0
Close-loop materials		0,5	0	0,1	0
Difference (D)		0	0	0	0
Product		1	**2,6**	1	**1,6**
Co-product		1	**0**		

Table 12. Calculation of the impact for product A and B with an economical allocation for co-product B. Co-product B has a low value compared to product B. (EF = emission factors; CF = Carbon Footprint)

For product B, a balanced closed-loop recycling was assumed. Therefore, the close-loop materials have no additional burden. For the co-product allocation, depending on the type of allocation chosen, the impact of the co-product varies between 0 to 2kgCO2eq./kg and the impact of product B varies between 2 and 2,6kgCO2eq./kg.

For product A, a balanced closed-loop recycling was also assumed. Therefore, the close-loop materials have no additional burden. The impact of product A also depends on the allocation choice for product B's co-product (between 1,6 to 2kgCO2eq./kg product A).

ANNEX C – RECYCLED CONTENT

Below some examples to illustrate the notion described in Section 6.4.5.1

C.1 RECYCLED CONTENT FORMULA DETAILS

This section outlines the various scenarios for recycled content calculation that lead to the final formula presented Section 6.4.5.1. All formulas below are derived in accordance with the guiding principles described in the previously referenced section.

Scenario 1: Close-loop materials Input = Close-loop materials Output

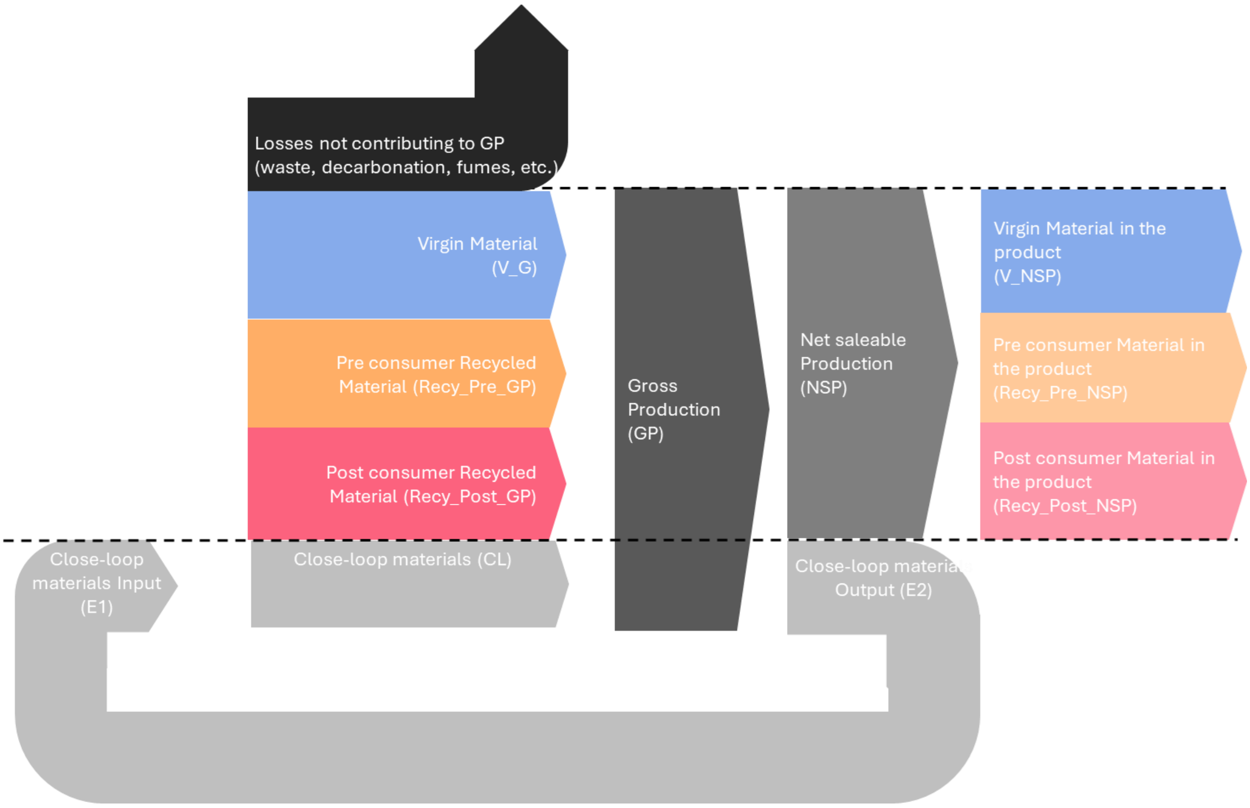

Figure 10 Material flow in a balanced close-loop scenario

The close loop is balanced with E1 = E2 = CL.

$$Recycled\ content = \frac{Recy\_Pre\_NSP + Rec\_Post\_NSP}{V\_NSP + Recy\_Pre\_NSP + Recy\_Post\_NSP} = \frac{Recy\_Pre\_NSP + Recy\_Post\_NSP}{NSP}$$

⇨ $$Recycled\ content = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - E1} = \frac{Recy\_Pre + Recy\_Post}{GP - E2} = \frac{Recy\_Pre + Recy\_Post}{GP - CL}$$

Scenario 2: Close-loop materials Input < Close-loop materials Output

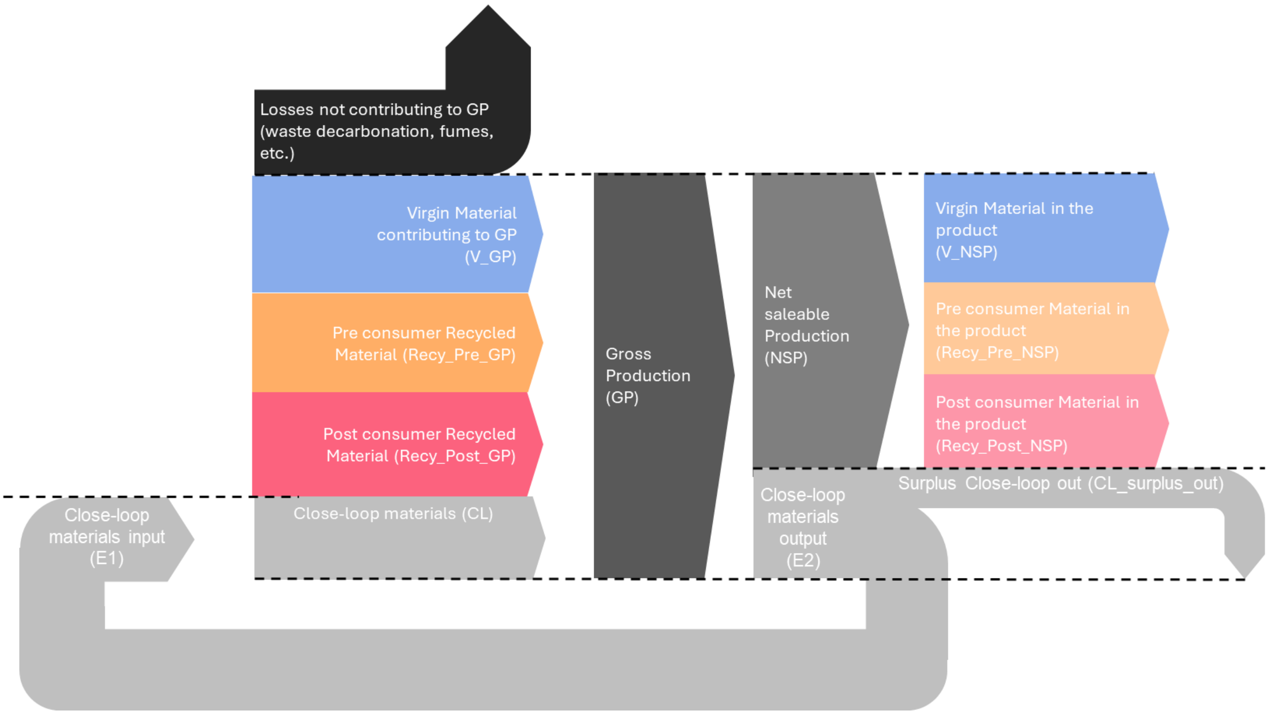

Figure 11 Material flow in an unbalanced close-loop scenario (output > input)

The close-loop is unbalanced with E2 > E1 = CL.

Closed-loop surplus output is assumed to have the same composition as the gross and net saleable production.

$$Recycled\ content = \frac{Recy\_Pre\_NSP + Recy\_Post\_NSP}{V\_NSP + Recy\_Pre\_NSP + Recy\_Post\_NSP} = \frac{Recy\_Pre\_NSP + Recy\_Post\_NSP}{NSP}$$

⇨ $$Recycled\ content = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - E1} = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - CL}$$

Scenario 3: Close-loop materials Input > Close-loop materials Output

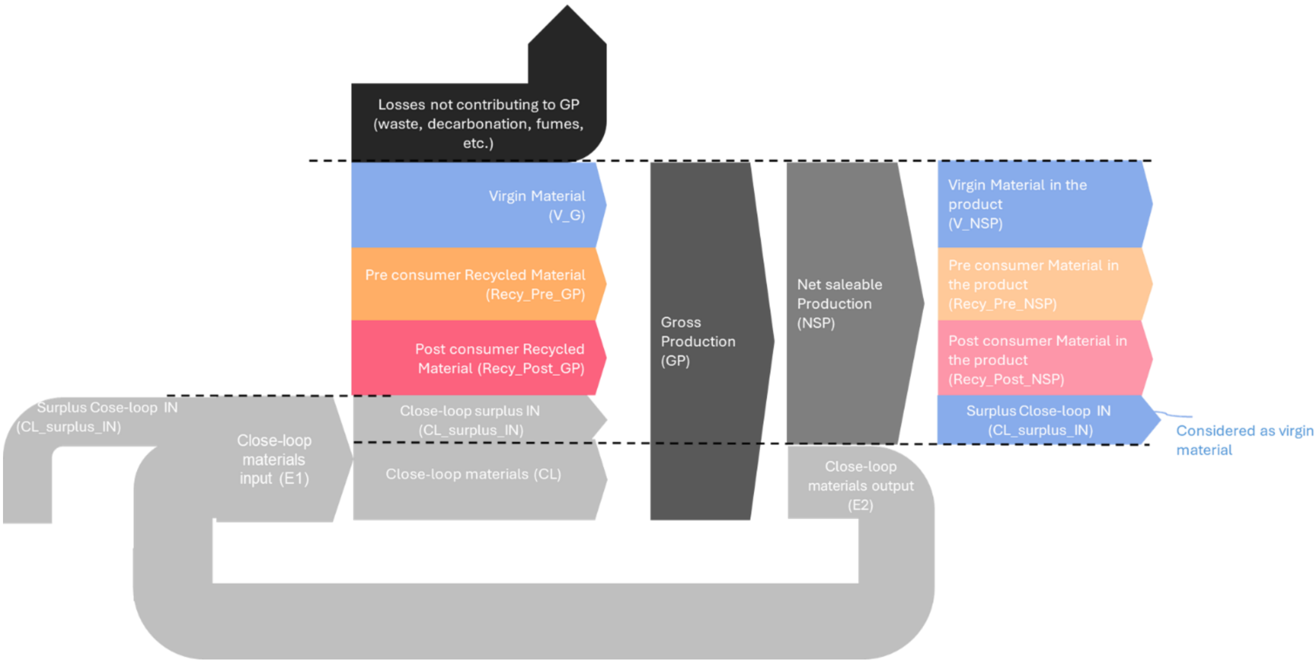

Figure 12 Material flow in an unbalanced scenario (input > output)

The close-loop is unbalanced with E1 > E2 = CL.

Closed-loop surplus input is considered as virgin material.

$$Recycled\ content = \frac{Recy\_Pre\_NSP + Recy\_Post\_NSP}{V_{NSP} + Recy\_Pre\_NSP + Recy\_Post\_NSP + CL\_surplus\_IN} = \frac{Recy\_Pre\_NSP + Recy\_Post\_NSP}{NSP + CL\_surplus\_IN}$$

$$\Rightarrow\ Recycled\ content = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - E2} = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - CL}$$

Therefore, the final formula is:

$$\boldsymbol{Recycled\ content = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - CL} = \frac{Recy\_Pre\_GP + Recy\_Post\_GP}{GP - Min(E1, E2)}}$$

CL represents the balanced closed-loop quantity within the system and is therefore equivalent to the minimum quantity between close loop input (E1) and output flows (E2).

C.2 EXAMPLE 1 - A SIMPLE CASE

Close-loop materials scenario		Balanced close-loop	More output than input	More input than output
Inputs	Unit	1,44	1,44	1,44
Virgin raw materials	kg	1,24	1,24	1,14
Post-consumer materials	kg	0,10	0,10	0,10
Close-loop materials (E1)	kg	0,10	0,10	0,20
Outputs		1,44	1,44	1,44
Product	kg	1,10	1,10	1,10
Close-loop materials (E2)	kg	0,10	0,20	0,10
Waste	kg	0,24	0,14	0,24

Table 13. Recycled content – example 1 mass balance details

In all three scenarios, min(E1, E2) is equal to 0,10 kg. It is assumed that the waste shares the same chemical composition as the final product. As a result, the waste and its associated input materials are not excluded from the calculation. Removing them would introduce an additional step without affecting the relative outcome, as their composition is proportionally identical to that of the product.

Therefore,the recycled content is the same for all the cases $R = \frac{0{,}10}{1{,}44-0{,}10} * 100 = 7{,}5\%$.

C.3 EXEMPLE 2 - DIRECT CO_2 EMISSIONS FROM CALCIUM CARBONATE

	% calcium oxide	Total consumption (kg)	Direct CO2 emissions (kg)	Materials contained in the Product (kg)
Inputs		1,30	0,09	**1,21**
Virgin raw materials	100%	1,00	0,00	**1,00**
pre-consumer (calcium carbonate)	44%	0,20	0,09	**0,11**
Close-loop materials (E1)		0,10		**0,10**
Outputs		1,30	0,09	**1,21**
Product	100%	1,00	0,00	**1,00**
CO2 emissions	0%	0,09	0,09	**0,00**
Close-loop materials (E2)		0,21		**0,21**

Table 14. Recycled content – example 2 mass balance details

In the example above, pre-consumer calcium carbonate material is used in the input. Due to a chemical transformation, part of the calcium carbonate will be emitted as CO_2 and the rest will go into the main product. Therefore, the process will yield two products: the main product, and CO_2 gas.

The first step is to calculate the quantity of pre-consumer calcium carbonate that physically goes into the final product. This calculation has been done based on stoichiometric balance. Therefore, there are 0.2 * 0.56 = 0.11 kg of pre-consumer calcium carbonate materials that will go into the final product, and 0.2 * 0.44 = 0.09 kg of the materials that will evaporate as CO_2 gas.

Calcium carbonate				
CaCO3 -> CaO + CO2				
	mol	molecular mass (g/mol)	Weight	
Calcium carbonate	1	100	1	
CO2	1	44	**0,44**	kgCO2/ kg calcium carbonate
CaO	1	56,0774	**0,56**	kg CaO / kg calcium carbonate

Table 15. Stoichiometric calculation for calcium carbonate decomposition

The recycled content of the products is calculated using the gross production as described below:

	Product
Pre or post consumer materials (kg)	0,11
Min (E1,E2)	E1 = 0,10 E2 = 0,21 Min (E1,E2) = 0,10

Gross production (kg)	1,00 + 0,21 = 1,21
Recycled content (%)	$\frac{0{,}11}{1{,}21 - 0{,}10} * 100 = 10{,}1\%$

Table 16. Recycled content calculation details for example 2

C.4 EXAMPLE 3 - SILICA FUMES CO-PRODUCT

	% silica	Total consumption (kg)	Part that goes in Silica fumes co-product (kg)	**Part that goes in the main product (kg)**
Inputs		1,44	0,34	**1,10**
Zircon sand	25%	1,10	0,28	**0,83**
Post-consumer	60%	0,10	0,06	**0,04**
Close-loop materials (E1)	0%	0,24		**0,24**
Outputs		1,44	0,34	**1,10**
Product	0%	1,00	0	**1,00**
Silica fumes co-product	100%	0,34	0,34	**0,00**
Close-loop materials (E2)	0%	0,10		**0,10**

Table 17 Recycled content – example 3 mass balance details

In the example above, post-consumer materials containing silica are used in the input. The silica portion of these materials will become silica fumes. The first step is to calculate the quantity of post-consumer materials that physically goes into the final product. This calculation was done based on the materials' chemistry (percentage of silica in the materials). Therefore, one can consider that 60% of the silica would go into the silica fumes (0.1 * 0.6 = 0.06 kg), while the rest would go into the final product

The recycled content of the products is calculated as below:

	Silica fumes co-product	Main product
Pre or post consumer materials (kg)	0,06	0,04
Min (E1,E2)	E1 = 0 E2 = 0 Min (E1,E2) = 0	E1 = 0,24 E2 = 0,10 Min (E1,E2) = 0,10
Type of total production	Net saleable production	Gross production
Total production (kg)	0,34	1,00 + 0,10 = 1,10
Recycled content (kg)	$\frac{0{,}06}{0{,}34 - 0} * 100 = 17{,}9\%$	$\frac{0{,}04}{1{,}10 - 0{,}10} * 100 = 4{,}6\%$

Table 18. Recycled content calculation details for example 3

NAME OF PRODUCT CATEGORY

PRODUCT CATEGORY CLASSIFICATION: UN CPC 37960,37291