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Draft *Indian Standard*

GREENHOUSE GASES — CARBON FOOTPRINT OF PRODUCTS — REQUIREMENTS AND GUIDELINES FOR QUANTIFICATION

भारतीय मानक मसौदा

ग्रीनहाउस गैसें — उत्पादों के कार्बन फुटप्रिंट — परिमाणन के लिए आवश्यकताएं एवं दिशा-निर्देश

ICS 13.020.40

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FOREWORD

(Formal clause shall be added later)

Climate change arising from anthropogenic activity has been identified as one of the greatest challenges facing the world and will continue to affect business and citizens over future decades.

Climate change has implications for both human and natural systems and could lead to significant impacts on resource availability, economic activity and human wellbeing. In response, international, regional, national and local initiatives are being developed and implemented by public and private sectors to mitigate greenhouse gas (GHG) concentrations in the Earth's atmosphere as well as to facilitate adaptation to climate change.

GHG initiatives on mitigation rely on the quantification, monitoring, reporting and verification of GHG emissions and/or removals.

The IS/ISO 14060 family along with this standard provides clarity and consistency for quantifying, monitoring, reporting and validating or verifying GHG emissions and removals to support sustainable development through a low-carbon economy. It also benefits organizations, project proponents and stakeholders worldwide by providing clarity and consistency on quantifying, monitoring, reporting, and validating or verifying GHG emissions and removals. Specifically, the use of the IS/ISO 14060 family and this standard:

— enhances the environmental integrity of GHG quantification;

— enhances the credibility, consistency, and transparency of GHG quantification, monitoring, reporting, validation and verification;

— facilitates the development and implementation of GHG management strategies and plans;

— facilitates the development and implementation of mitigation actions through emission reductions or removal enhancements;

— facilitates the ability to track performance and progress in the reduction of GHG emissions and/or increase in GHG removals.

Applications of the IS/ISO 14060 family and this standard include:

— corporate decisions, such as identifying GHG emission reduction opportunities and increasing profitability by reducing energy consumption;

— carbon risk management, such as the identification and management of risks and opportunities;

— voluntary initiatives, such as participation in voluntary GHG registries or sustainability reporting initiatives;

— GHG markets, such as the buying and selling of GHG allowances or credits;

— regulatory/government GHG programmes, such as credit for early action, agreements or national and local reporting initiatives.

IS/ISO 14064-1 details principles and requirements for designing, developing, managing and reporting organization-level GHG inventories. It includes requirements for determining GHG emission and removal boundaries, quantifying an organization's GHG emissions and removals, and identifying specific company actions or activities aimed at improving GHG management. It also includes requirements and guidance on inventory quality management, reporting, internal auditing and the organization's responsibilities in verification activities.

IS/ISO 14064-2 details principles and requirements for determining baselines and for the monitoring, quantifying and reporting of project emissions. It focuses on GHG projects or project-based activities specifically designed to reduce GHG emissions and/or enhance GHG removals. It provides the basis for GHG projects to be validated and verified.

IS/ISO 14064-3 details requirements for verifying GHG statements related to GHG inventories, GHG projects, and carbon footprints of products. It describes the process for validation or verification, including validation or verification planning, assessment procedures, and the evaluation of organizational, project and product GHG statements.

IS/ISO 14065 defines requirements for bodies that validate and verify GHG statements. Its requirements cover impartiality, competence, communication, validation and verification processes, appeals, complaints, and the management system of validation and verification bodies. It can be used as a basis for accreditation and other forms of recognition in relation to the impartiality, competence, and consistency of validation and verification bodies.

IS/ISO 14066 specifies competence requirements for validation teams and verification teams. It includes principles and specifies competence requirements based on the tasks that validation teams or verification teams must be able to perform.

This document defines the principles, requirements and guidelines for the quantification of the carbon footprint of products. The aim of this document is to quantify GHG emissions associated with the life cycle stages of a product, beginning with resource extraction and raw material sourcing and extending through the production, use and end-of-life stages of the product.

GHGs can be emitted and removed throughout the life cycle of a product which includes acquisition of raw material, design, production, transportation/delivery, use and the end-of-life treatment. Quantification of the carbon footprint of a product (CFP) will assist in the understanding and action to increase GHG removals and reduce GHG emissions throughout the life cycle of a product. This document details principles, requirements and guidelines for the quantification of CFPs, i.e. goods and services, based on GHG emissions and removals over their life cycle. Requirements and guidelines for the quantification of a partial CFP are also provided. Communication related to the CFP or the partial CFP is covered in IS/ISO 14026.

This document is based on principles, requirements and guidelines identified in existing International Standards on life cycle assessment (LCA), IS/ISO 14040 and IS/ISO 14044, and aims to set specific requirements for the quantification of a CFP and a partial CFP.

Limitations of CFPs based on this document are described in Annex A.

Departure from ISO 14067: 2018 is listed below:

1. Definition of double-counting of GHG emissions and removals is provided is added at sub-clause 3.1.1.12 and an additional text related to the limitations of CFP due to double counting is added in Annex A.

2. In clause 4 Applications, a disclaimer is added regarding the misuse/ non-intended use of the standard.

3. Text under sub-clause 5.5 has been modified in order to ensure the use of natural sciences for CFP study to reduce the uncertainties.

4. Text under sub-clause 6.4.9.1 has been modified so that when it comes to application of specific requirements given at sub-clause 6.4.9.1 and subsequent sub-clauses of 6.4.9, the scenario at national situations conflicting with these requirements do not arise.

5. Text under sub-clause 6.4.9.5 has been modified in view of the emissions due to LUC varies with country’s circumstances (Natural, environmental, financial, technical capacity, agro-climatic condition & management and conventional/ traditional practices.) In case there are national approaches available, they always take precedence of the remaining methods either IPCC or other international methods.

Draft Indian Standard

Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

1 SCOPE

This document specifies principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product (CFP), in a manner consistent with International Standards on life cycle assessment (LCA) (IS/ISO 14040 and IS/ISO 14044).

Requirements and guidelines for the quantification of a partial CFP are also specified.

This document is applicable to CFP studies, the results of which provide the basis for different applications.

This document addresses only a single impact category: climate change. Carbon offsetting and communication of CFP or partial CFP information are outside the scope of this document.

This document does not assess any social or economic aspects or impacts, or any other environmental aspects and related impacts potentially arising from the life cycle of a product.

2 REFERENCES

The Standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS/ISO 14044: 2006	*Environmental management — Life cycle assessment — Requirements and guidelines*

NOTE — for reference to publications other than Indian Standards, see Bibliography.

ISO/TS 14027:2017, *Environmental labels and declarations — Development of product category rules*

ISO/TS 14071, *Environmental management — Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006*

3 TERMS, DEFINITIONS AND ABBREVIATED TERMS

3.1 Terms and definitions

3.1.1 *Quantification of the carbon footprint of a product*

3.1.1.1 *Carbon footprint of a product CFP* — sum of GHG emissions and GHG removals in a product system, expressed as CO2 equivalents and based on a life cycle assessment using the single impact category of climate change.

Note 1: A CFP can be disaggregated into a set of figures identifying specific GHG emissions and removals. A CFP can also be disaggregated into the stages of the life cycle.

Note 2: The results of the quantification of the CFP are documented in the CFP study report expressed in mass of CO2e per functional unit.

3.1.1.2 *Partial carbon footprint of a product partial CFP* — sum of GHG emissions and GHG removals of one or more selected process(es) in a product system, expressed as CO2 equivalents and based on the selected stages or processes within the life cycle.

Note 1: A partial CFP is based on or compiled from data related to (a) specific process(es) or footprint information modules, which is (are) part of a product system and can form the basis for quantification of a CFP. More detailed information on information modules is given in IS/ISO 14025:2006, 5.4.

Note 2: “Footprint information modules” is defined in ISO 14026:2017, 3.1.4.

Note 3: The results of the quantification of the partial CFP are documented in the CFP study report expressed in mass of CO2e per declared unit.

3.1.1.3 *Carbon footprint of a product systematic approach CFP systematic approach* — set of procedures to facilitate the quantification of the CFP for two or more products of the same organization.

3.1.1.4 *Carbon footprint of a product study CFP study* — all activities that are necessary to quantify and report a CFP or a partial CFP.

3.1.1.5 *Carbon footprint of a product study report CFP study report* **—** report that documents the CFP study, presents the CFP or partial CFP, and shows the decisions taken within the study.

Note: The CFP study report demonstrates that the provisions of this document are met.

3.1.1.6 *Quantification of the carbon footprint of a product quantification of the CFP* **—** activities that result in the determination of a CFP or a partial CFP.

Note: Quantification of the CFP or the partial CFP is part of the CFP study.

3.1.1.7 *Carbon offsetting* **—** mechanism for compensating for all or a part of the CFP or the partial CFP through the prevention of the release of, reduction in, or removal of an amount of GHG emissions in a process outside the product system under study.

EXAMPLE: Investment outside the relevant product system, e.g. in renewable energy technologies, energy efficiency measures, afforestation/reforestation.

Note 1: Carbon offsetting is not allowed in the *quantification of a CFP* or a partial CFP, and communication of carbon offsetting is outside of the scope of this document.

Note 2: Footprint communication and relevant claims regarding carbon offsetting and carbon neutrality are covered in ISO 14026 and IS 16555.

Note 3: Adapted from the definition of "offsetting" in ISO 16555:2017, 3.1.12.

3.1.1.8 *Product category* **—** group of products that can fulfil equivalent functions.

3.1.1.9 *Product category rules PCR* **—** set of specific rules, requirements and guidelines for developing Type III environmental declarations and footprint communications for one or more product categories.

Note 1: PCR include quantification rules conforming to IS/ISO 14044.

Note 2: ISO/TS 14027 describes the development of PCR applicable to this document.

Note 3: "Footprint communication" is defined in ISO 14026:2017, 3.1.1.

3.1.1.10 *Carbon footprint of a product – product category rules CFP–PCR* **—** set of specific rules, requirements and guidelines for CFP or partial CFP quantification and communication for one or more product categories.

Note 1: CFP–PCR include quantification rules conforming to IS/ISO 14044.

Note 2: ISO/TS 14027 describes the development of *PCR* applicable to this document.

3.1.1.11 *Carbon footprint of a product performance tracking CFP performance tracking* **—** comparing the CFP or the partial CFP of one specific product of the same organization over time.

Note 1: It includes calculating the change to the CFP for one specific product, or between superseding products with the same functional unit or declared unit over time.

3.1.1.12 *Double-counting of GHG emissions and removals* **—** When two or more companies hold interests in the same joint operation and use different consolidation approaches (e.g., Company A follows the equity share approach while Company B uses the financial control approach), emissions from that joint operation could be double counted.

NOTE:

1. Reference taken from "The Greenhouse Gas Protocol, A corporate accounting and reporting standard, Revised Edition 2008"

2. Concern is often expressed that accounting for indirect emissions will lead to double counting when two different companies include the same emissions in their respective inventories. Whether or not double counting occurs depends on how consistently companies with shared ownership or trading program administrators choose the same approach (equity or control) to set the organizational boundaries. Whether or not double counting matters, depends on how the reported information is used.

3.1.2 *Greenhouse gases*

3.1.2.1 *Greenhouse gas GHG* **—** gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds.

Note 1: *For a list of GHGs, see the latest IPCC Assessment Report [16].*

Note 2: *Water vapour and ozone, which are anthropogenic as well as natural GHGs, are not included in the CFP and partial CFP.*

Note 3: *The focus of this document is limited to long-lived GHGs and it therefore excludes climate effects due to changes in surface reflectivity (albedo) and short-lived radiative forcing agents (e.g. black carbon and aerosols).*

3.1.2.2 *Carbon dioxide equivalent CO2 equivalent CO2e* **—** unit for comparing the radiative forcing of a GHG to that of carbon dioxide.

Note 1: *Mass of a GHG is converted into CO2 equivalents by multiplying the mass of the GHG by the corresponding GWP or GTP of that gas.*

Note 2: In the case of GTP, CO2 equivalent is the unit for comparing the change in global mean surface temperature caused by a GHG to the temperature change caused by CO2.

3.1.2.3 *Global temperature change potential GTP* **—** index measuring the change in global mean surface temperature at a chosen point in time in response to a GHG emission pulse, relative to the change in temperature attributed to carbon dioxide (CO2).

Note 1: "Index" as used this document is a "characterization factor" as defined in IS/ISO 14040:2006, 3.37.

Note 2: The GTP is based on temperature change for a selected year.

Note 3: Derived from the Working Group 1 IPCC Fifth Assessment Report (AR5), Climate Change 2013: The Physical Science Basis.

3.1.2.4 *Global warming potential GWP* **—** index, based on radiative properties of GHGs, measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO2).

Note 1: "Index" as used in this document is a "characterization factor" as defined in IS/ISO 14040:2006, 3.37.

Note 2: *A "pulse emission" is an emission at one point in time.*

3.1.2.5 *Greenhouse gas emission GHG emission* **—** release of a GHG into the atmosphere.

3.1.2.6 *Greenhouse gas removal GHG removal* **—** withdrawal of a GHG from the atmosphere.

3.1.2.7 *Greenhouse gas emission factor GHG emission factor* **—** coefficient relating activity data with the GHG emission.

3.1.3 *Products, product systems and processes*

3.1.3.1 *Product* **—** goods or service

Note 1: The product can be categorized as follows:

— service (e.g. transport, implementation of events);

— software (e.g. computer program);

— hardware (e.g. engine mechanical part);

— processed material (e.g. lubricant, ore, fuel);

— unprocessed material (e.g. agricultural product).

Note 2: Services have tangible and intangible elements. Provision of a service can involve, for example, the following:

— an activity performed on a customer-supplied tangible product (e.g. automobile to be repaired);

— an activity performed on a customer-supplied intangible product (e.g. the income statement needed to prepare a tax return);

— the delivery of an intangible product (e.g. the delivery of information in the context of knowledge transmission);

— the creation of ambience for the customer (e.g. in hotels and restaurants).

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

Note 1: "Product flow" is defined in IS/ISO 14040:2006, 3.27.

3.1.3.3 *Co-product* **—** any of two or more products coming from the same unit process or product system.

3.1.3.4 *System boundary* **—** boundary based on a set of criteria representing which unit processes are a part of the system under study.

3.1.3.5 *Process* **—** set of interrelated or interacting activities that transforms inputs into outputs.

3.1.3.6 *Unit process* **—** smallest element considered in the life cycle inventory analysis for which input and output data are quantified.

3.1.3.7 *Functional unit* **—** quantified performance of a product system for use as a reference unit.

Note 1: As the CFP treats information on a product basis, an additional calculation based on a declared unit can be presented.

3.1.3.8 *Declared unit* **—** quantity of a product for use as a reference unit in the quantification of a partial CFP.

EXAMPLE: Mass (1 kg of primary steel), volume (1 m3 of crude oil).

3.1.3.9 *Reference flow* **—** measure of the inputs to or outputs from processes in a given product system required to fulfil the function expressed by the functional unit.

Note 1: For an example of applying the concept of a reference flow, see the example in 6.3.3.

Note 2: In the case of a partial CFP, the reference flow refers to the declared unit.

3.1.3.10 *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

Note 1: "Environment" is defined in IS/ISO 14001:2015, 3.2.1.

3.1.3.11 *Service life* **—** period of time during which a product in use meets or exceeds the performance requirements.

3.1.4 *Life cycle assessment*

3.1.4.1 *Cut-off criteria* **—** specification of the amount of material or energy flow or the level of significance of GHG emissions associated with unit processes or the product system to be excluded from a CFP study.

Note 1: "Energy flow" is defined in IS/ISO 14040:2006, 3.13.

3.1.4.2 *Life cycle* **—** consecutive and interlinked stages related to a product, from raw material acquisition or generation from natural resources to end-of-life treatment.

Note 1: "Raw material" is defined in IS/ISO 14040:2006, 3.15.

Note 2: Stages of a life cycle related to a product include raw material acquisition, production, distribution, use and end-of-life treatment.

3.1.4.3 *Life cycle assessment LCA* **—** compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Note 1: "Environmental impact" is defined in IS/ISO 14001:2015, 3.2.4.

3.1.4.4 *Life cycle inventory analysis LCI* **—** phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle.

3.1.4.5 *Life cycle impact assessment LCIA* **—** phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product.

3.1.4.6 *Life cycle interpretation* **—** phase of life cycle assessment in which the findings of either the life cycle inventory analysis or the life cycle impact assessment, or both, are evaluated in relation to the defined goal and scope in order to reach conclusions and recommendations.

3.1.4.7 *Sensitivity analysis* **—** systematic procedures for estimating the effects of the choices made regarding methods and data on the outcome of a CFP study.

3.1.4.8 *Impact category* **—** class representing environmental issues of concern to which life cycle inventory analysis results may be assigned.

3.1.4.9 *Waste* **—** substances or objects that the holder intends or is required to dispose of.

Note: This definition is taken from the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (22 March 1989), but is not confined in this document to hazardous waste.

3.1.4.10 *Critical review* **—** activity intended to ensure consistency between the CFP study and the principles and requirements of this document.

Note 1: Requirements for critical review are described in ISO/TS 14071.

3.1.4.11 *Area of concern* **—** aspect of the natural environment, human health or resources of interest to society.

EXAMPLE: Water, climate change, biodiversity.

3.1.5 *Organizations*

3.1.5.1 *Organization* **—** person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

Note: The concept of organization includes, but is not limited to, sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

3.1.5.2 *Supply chain* **—** those involved, through upstream and downstream linkages, in processes and activities relating to the provision of products to the user.

Note: In practice, the expression "interlinked chain" applies from suppliers to those involved in end- of-life processing, which may include vendors, manufacturing facilities, logistics providers, internal distribution centres, distributors, wholesalers and other entities that lead to the end user.

3.1.6 *Data and data quality*

3.1.6.1 *Primary data* **—** quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements.

Note 1: Primary data need not necessarily originate from the product system under study because primary data might relate to a different but comparable product system to that being studied.

Note 2: Primary data can include GHG emission factors and/or GHG activity data.

3.1.6.2 *Site-specific data* **—** primary data obtained within the product system.

Note 1: All site-specific data are primary data but not all primary data are site-specific data because they may be obtained from a different product system.

Note 2: Site-specific data include GHG emissions from GHG sources as well as GHG removals by GHG sinks for one specific unit process within a site.

3.1.6.3 *Secondary data* **—** data which do not fulfil the requirements for primary data.

Note 1: Secondary data can include data from databases and published literature, default emission factors from national inventories, calculated data, estimates or other representative data, validated by competent authorities.

Note 2: Secondary data can include data obtained from proxy processes or estimates.

3.1.6.4 *Uncertainty* **—** parameter associated with the result of quantification that characterizes the dispersion of the values that could be reasonably attributed to the quantified amount.

Note 1: Uncertainty can include, for example:

— *parameter uncertainty, e.g. GHG emission factor, activity data;*

— *scenario uncertainty, e.g. use stage scenario, end-of-life stage scenario;*

— *model uncertainty*.

Note 2: Uncertainty information typically specifies quantitative estimates of the likely dispersion of values and a qualitative description of the likely causes of the dispersion.

3.1.7 *Biogenic material and land use*

3.1.7.1 *Biomass* **—** material of biological origin, excluding material embedded in geological formations and material transformed to fossilized material.

Note 1: Biomass includes organic material (both living and dead), e.g. trees, crops, grasses, tree litter, algae, animals, manure and waste of biological origin.

Note 2: In this document, biomass excludes peat.

3.1.7.2 *Biogenic carbon* **—** carbon derived from biomass.

3.1.7.3 *Fossil carbon* **—** carbon that is contained in fossilized material.

Note 1: Examples of fossilized material are coal, oil and natural gas and peat.

3.1.7.4 *Land use LU* **—** human use or management of land within the relevant boundary.

Note 1: In this document, the relevant boundary is the boundary of the system under study

Note 2: Land use is often referred to as "land occupation" in life cycle assessment (LCA).

3.1.7.5 *Direct land use change dLUC* **—** change in the human use of land within the relevant boundary.

Note 1: In this document, the relevant boundary is the boundary of the system under study.

Note 2: Land use change happens when there is a change in the land-use category as defined by the IPCC (e.g. from forest land to cropland).

3.1.7.6 *Indirect land use change iLUC* **—** change in the use of land which is a consequence of direct land use change, but which occurs outside the relevant boundary.

Note 1: In this document, the relevant boundary is the boundary of the system under study.

Note 2: Land use change happens when there is a change in the "land-use category" as defined by the IPCC (e.g. from forest land to cropland).

EXAMPLE If land use on a particular parcel of land changes from food production to biofuel production, land use change might occur elsewhere to meet the demand for food. This land use change elsewhere is indirect land use change.

3.2 Abbreviated terms

CFP	carbon footprint of a product
CFP–PCR	carbon footprint of a product – product category rules
CO2e	carbon dioxide equivalent
dLUC	direct land use change
GHG	greenhouse gas
GTP	global temperature change potential
GWP	global warming potential
iLUC	indirect land use change
IPCC	Intergovernmental Panel on Climate Change
LCA	life cycle assessment
LCIA	life cycle impact assessment
LCI	life cycle inventory analysis
LU	land use
LUC	land use change
PCR	product category rules

4 APPLICATION

Possible applications of this document include the provision of information for research and development of products, improvement of technologies, CFP performance tracking and communication.

This document facilitates communication of a CFP and partial CFP in accordance with ISO 14026.

In applying this document, it is advisable to take into consideration societal, environmental, legal, cultural, political and organizational diversity, as well as differences in economic conditions. For the purposes of the Marrakech Agreement establishing the World Trade Organization (WTO), it is not intended to provide a basis for any presumption or finding that a measure is consistent with WTO obligations. Further, it is not intended to provide a basis for legal actions, complaints, defenses or other claims in any international, domestic or other proceeding, nor is it intended to be cited as evidence of the evolution of customary international law (adopted from ISO 26000).

5 PRINCIPLES

5.1 General

These principles are fundamental and are the basis for the subsequent requirements in this document.

5.2 Life cycle perspective

The quantification of a CFP takes into consideration the entire life cycle of a product, including acquisition of raw material, design, production, transportation/delivery, use and the end-of-life treatment.

NOTE: Through such a systematic overview and life cycle perspective, the shifting of a potential impact between life cycle stages or individual processes can be identified and possibly avoided.

5.3 Relative approach and functional or declared unit

The CFP study is structured around a functional unit (CFP) or a declared unit (partial CFP) and the results are calculated relative to this functional unit or declared unit.

5.4 Iterative approach

An iterative approach of reassessment is taken when applying the four phases of LCA (goal and scope definition, LCI, LCIA and life cycle interpretation, see **6.3** to **6.6**) to a CFP study. The iterative approach contributes to the consistency of the CFP study and the reported results.

5.5 Priority of scientific approach

Preference to natural science (such as physics, chemistry, biology, etc.) is given when making decisions in the CFP study. If this is not possible, other scientific approaches (such as social and economic sciences) or approaches contained in international or national conventions relevant and valid within the geographical scope as defined in **6.3.2** are used.

NOTE: For more information on the allocation procedure, see **6.4.6.2**.

5.6 Relevance

The selection of data and methods is appropriate to the assessment of the GHG emissions and removals arising from the system under study.

5.7 Completeness

All GHG emissions and removals that provide a significant contribution to the CFP or partial CFP of the product system under study are included. The level of significance is determined by the cut-off criteria (see **6.3.4.3**).

5.8 Consistency

Assumptions, methods and data are applied in the same way throughout the CFP study to arrive at conclusions in accordance with the goal and scope definition.

5.9 Coherence

Methodologies, standards and guidance documents that are already recognized internationally and adopted for product categories are applied, to enhance comparability between CFPs within any specific product category.

5.10 Accuracy

Quantification of the CFP and partial CFP is accurate, verifiable, relevant and not misleading, and bias and uncertainties are reduced as far as is practical.

5.10 Transparency

All relevant issues are addressed and documented in an open, comprehensive and understandable presentation of information.

Any relevant assumptions are disclosed and methodologies and data sources used are appropriately referenced. Any estimates are clearly explained and bias is avoided so that the CFP study report represents what it purports to represent.

5.12 Avoidance of double-counting

Double-counting of GHG emissions and removals within the studied product system is avoided when the allocation of the same GHG emissions and removals occurs only once (see **6.4.6.1**).

NOTE See the example given in **6.4.9.4.1**.

6 METHODOLOGY FOR QUANTIFICATION OF THE CFP AND PARTIAL CFP

6.1 General

A CFP study in accordance with this document should include the four phases of LCA, i.e. goal and scope definition (see **6.3**), LCI (see **6.4**), LCIA (see **6.5**) and life cycle interpretation (see **6.6**), for CFP or partial CFP. The unit processes comprising the product system should be grouped into life cycle stages, e.g. acquisition of raw material, design, production, transportation/delivery, use (see **6.3.7**) and end-of-life (see **6.3.8**). GHG emissions and removals from the product’s life cycle should be assigned to the life cycle stage in which the GHG emissions and removals occur. Partial CFPs may be added together to quantify the CFP, provided that they are performed according to the same methodology for the same timeframe and that no gaps or overlaps exist.

NOTE: As an example from the construction sector, it is possible to have a partial CFP for a substance or preparation (e.g. cement), for a bulk product (e.g. gravel), for a service (e.g. maintenance of a building) or for an assembled system (e.g. masonry wall).

An organization may develop a CFP systematic approach. If it does, it should be developed in accordance with **Annex C**.

6.2 Use of CFP–PCR

Where relevant PCR or CFP–PCR exist, they should be adopted. PCR or CFP–PCR are relevant provided:

— they have been developed in accordance with ISO/TS 14027, or a relevant sector-specific International Standard that applies the requirements of IS/ISO 14044;

— they conform to the requirements of this clause, **6.3**, **6.4** and **6.5**;

— they are considered proper (e.g. for system boundaries, modularity, allocation and data quality) by the organization applying this document and are in accordance with the principles in **Clause 5**.

NOTE: Examples of organizations that apply this document are providers of goods and services, practitioners and commissioners of the CFP study.

If more than one set of relevant PCR or CFP–PCR exist, the relevant PCR or CFP–PCR should be reviewed by the organization applying this document (e.g. for system boundaries, modularity, allocation, data quality). The choice of the PCR or CFP–PCR adopted should be justified.

When all requirements in this subclause are met by PCR, those PCR are equivalent to the CFP–PCR.

If CFP–PCR are adopted for the CFP study, the quantification should be conducted according to the requirements in these CFP–PCR.

Where no relevant CFP–PCR exist, the requirements and guidance of other internationally agreed sector-specific documents, related to specific product or material categories, should be adopted if they conform to the requirements of this document and are considered appropriate by the organization applying this document.

6.3 Goal and scope definition

6.3.1 Goal of a CFP study

The overall goal of conducting a CFP study is to calculate the potential contribution of a product to global warming expressed as CO2e by quantifying all significant GHG emissions and removals over the product's life cycle or selected processes, in line with cut-off criteria (see **6.3.4.3**).

NOTE: This quantification supports a range of objectives and applications, including, but not limited to, individual studies, comparative studies in accordance with **Annex B** and performance tracking over time, and is intended for a range of audiences.

In defining the goal of a CFP study, the following items should be unambiguously stated:

— the intended application;

— the reasons for carrying out the CFP study;

— the intended audience;

— the intended communication, if any, of the CFP or partial CFP information, in accordance with ISO 14026.

6.3.2 Scope of a CFP study

The scope of a CFP study should be consistent with the goal of the CFP study (see **6.3.1**).

In defining the scope of the CFP study, the following items should be considered and clearly described, taking into account the requirements and guidance given in the relevant subclauses of this document:

a) the system under study and its functions;

b) the functional or declared unit (see **6.3.3**);

c) the system boundary, including the geographical scope of the system under study (see **6.3.4**);

d) data and data quality requirements (see **6.3.5**);

e) the time boundary for data (see **6.3.6**);

f) assumptions, especially for the use stage and the end-of-life stage (see **6.3.7** and **6.3.8**);

g) allocation procedures (see **6.4.6**);

h) specific GHG emissions and removals (see **6.4.9**), e.g. due to LUC (see **6.4.9.5**);

i) methods to address issues occurring with specific product categories (see **6.4.9**);

j) the CFP study report (see **Clause 7**);

k) the type of critical review, if any (see **Clause 8);**

l) Limitations of the CFP study (see **Annex A**).

If a comparison is undertaken, the requirements in **Annex B** should be followed.

In some cases, the scope of the CFP study may be revised due to unforeseen limitations, constraints or as a result of additional information. Such modifications, together with their explanation, should be documented.

6.3.3 Functional or declared unit

A CFP study should clearly specify the functional or declared unit of the system under study. The functional or declared unit should be consistent with the goal and scope of the CFP study. The primary purpose of a functional or declared unit is to provide a reference to which the inputs and outputs are related. Therefore, the functional or declared unit should be clearly defined and measurable.

The declared unit should only be used in a partial CFP.

When CFP–PCR are adopted, the functional or declared unit used should be that defined in the CFP–PCR. Having chosen the functional or declared unit, the associated reference flow should be defined.

When a comparison is done between product systems, it should be made on the basis of the same functional unit(s). Comparisons based on partial carbon footprint (declared unit) are permitted if the omitted life cycle stages are identical (see **Annex B**). Comparison based on the declared unit may only be used for business-to-business purposes. If additional functions of any of the product systems are not taken into account in the comparison of functional units, then these omissions should be explained and documented. As an alternative to this approach, systems associated with the delivery of these functions may be added to the boundary of the other product system to make the product systems more comparable. In these cases, the processes selected should be explained and documented.

NOTE: the choice of the functional or the declared unit and the associated reference flow require special attention, e.g. in order to allow comparisons without bias (see also **Annex B**).

EXAMPLE 1: in the function of drying hands, both a paper towel and an air-dryer system are studied. The selected functional unit can be expressed in terms of the identical number of pairs of hands dried for both systems. For each system, it is possible to determine the reference flow, e.g. the average mass of paper or the average volume of hot air required to dry one pair of hands, respectively. For both systems, it is possible to compile an inventory of inputs and outputs on the basis of the reference flows. At its simplest level, in the case of paper towel, this would be related to the paper consumed. In the case of the air-dryer, this would be related to the volume and temperature of hot air needed to dry the hands.

EXAMPLE 2: The functional unit of a tonne of steel cannot be determined because a tonne of steel can be transformed to various products which can fulfil various functions. In this case, use of declared unit is appropriate.

6.3.4 System boundary

6.3.4.1 General

The system boundary should be the basis used to determine which unit processes are included within the CFP study.

Where CFP–PCR are used (see **6.2**), their requirements on the processes to be included should also apply.

The selection of the system boundary should be consistent with the goal of the CFP study. The criteria, e.g. cut-off criteria (see **6.3.4.3**), used in establishing the system boundary should be identified and explained.

Decisions should be made regarding which unit processes to include in the CFP study and to which level of detail these unit processes should be studied. The exclusion of life cycle stages, processes, inputs or outputs within the system under study is only permitted if they do not significantly change the overall conclusions of the CFP study. Any decisions to exclude life cycle stages, processes, inputs or outputs should be clearly stated and the reasons and implications for their exclusion should be explained. The threshold for significance should be stated, e.g. as cut-off criteria (see **6.3.4.3**), and justified.

EXAMPLE Capital goods can be excluded in accordance with the goal and scope if their exclusion is not expected to significantly alter the conclusions according to specified criteria.

Decisions made regarding which unit processes, inputs and outputs should be included and the level of detail of the quantification of the CFP should be clearly stated.

The CFP and the partial CFP should not include carbon offsetting.

NOTE: GHG removals that are not linked to carbon offsetting can occur within the system boundary of the product system.

6.3.4.2 Setting the system boundary

Quantification carried out in accordance with this document should include all GHG emissions and removals of those unit processes that are part of the product system that have the potential to make a significant contribution to the CFP or the partial CFP (see **6.3.4.1**).

Within the goal and scope definition phase, consistent criteria should be defined:

— for which unit processes a detailed assessment is needed due to an expected significant contribution to the CFP or the partial CFP;

— for which unit processes the quantification of GHG emissions may be based on secondary data if the collection of primary data are not possible or practicable (see **6.3.5**);

— which unit processes may be merged, e.g. all transport processes within a plant.

6.3.4.3 Cut-off criteria

In general, all processes and flows that are attributable to the analysed system should be included. If individual material or energy flows are found to be insignificant for the carbon footprint of a particular unit process, these may be excluded for practical reasons and should be reported as data exclusions. Consistent cut-off criteria that allow the exclusion of certain processes of minor importance should be defined within the goal and scope definition phase.

The effect of the selected cut-off criteria on the outcome of the study should also be assessed and described in the CFP study report (see **6.4.5** and **6.6**).

NOTE: For additional guidance on cut-off criteria, see IS/ISO 14044:2006, 4.2.3.3.3.

6.3.5 Data and data quality

Site-specific data should be collected for individual processes where the organization undertaking the CFP study has financial or operational control. The data should be representative of the processes for which they are collected. Site-specific data should also be used for those unit processes that are most important and not under financial or operational control.

NOTE 1 the most important processes are those which together contribute at least 80 % to the CFP, starting from the largest to the smallest contributions after cut-off.

NOTE 2 Site-specific data refer to either direct GHG emissions (determined through direct monitoring, stoichiometry, mass balance or similar methods), activity data (inputs and outputs of processes that result in GHG emissions or removals) or emission factors. Site-specific data can be collected from a specific site, or can be averaged across all sites that contain the process within the system under study. They can be measured or modelled, as long as the result is specific to the process in the product’s life cycle.

Primary data that are not site-specific data, and which have undergone third-party review, should be used when the collection of site-specific data is not practicable.

Secondary data should only be used for inputs and outputs where the collection of primary data is not practicable, or for processes of minor importance.

NOTE 3 in some cases, default emission factors as secondary data are not life cycle based emission factors and might require adaptation or modification.

Secondary data should be justified and documented with references in the CFP study report.

A CFP study should use data that reduce bias and uncertainty as far as practical by using the best quality data available. Data quality should be characterized by both quantitative and qualitative aspects. Characterization of data quality should address the following:

a) time-related coverage: age of data and the minimum length of time over which data should be collected;

b) geographical coverage: geographical area from which data for unit processes should be collected to satisfy the goal of the CFP study;

c) technology coverage: specific technology or technology mix;

d) precision: measure of the variability of each data value expressed (e.g. variance);

e) completeness: percentage of total flow that is measured or estimated;

f) representativeness: qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);

g) consistency: qualitative assessment of whether or not the study methodology is applied uniformly to the various components of the sensitivity analysis;

h) reproducibility: qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the CFP study;

i) sources of the data;

j) uncertainty of the information.

A two-step approach should be taken for the data quality evaluation:

— the data quality requirements according to items a) to d) above should be characterized for the CFP study;

— data should be assessed with respect to the requirements for items a) to d) above.

NOTE 4 Data quality requirements are a mandatory part of CFP–PCR (see **6.2**).

NOTE 5 Data quality requirements might differ for different types of data.

Organizations undertaking a CFP study should have a system to manage and retain data. They should seek to continuously improve the consistency and quality of their data and control of documented information.

6.3.6 Time boundary for data

The time boundary for data is the time period for which the quantified figure for the CFP is representative.

The time period for which the CFP is representative should be specified and justified.

The choice of the time period for data collection should consider intra- and inter-annual variability and, when possible, use values representing the trend over the selected period. Where the GHG emissions and removals associated with specific unit processes within the life cycle of a product vary over time, data should be collected over a time period appropriate to establish the average GHG emissions and removals associated with the life cycle of the product.

If a process within the system boundary is linked to a specific time period (e.g. seasonal products such as fruit and vegetables), the assessment of GHG emissions and removals should cover that particular period in the life cycle of the product. Any activity (or activities) occurring outside that period should also be included provided that it is within the product system (e.g. GHG emissions related to a tree nursery). These data on GHG emissions and removals should be related to the functional or declared unit.

6.3.7 Use stage and use profile

When the use stage is included within the scope of the CFP study (see **6.3.2**), GHG emissions and removals arising from the use stage of the product should be included. The user of the product and the use profile of the product should be specified in the CFP study.

NOTE: The use stage starts when the specified user takes possession of the finished product and ends when the product is ready for disposal, reuse for a different function, recycling or energy recovery.

Service life information should be verifiable. It should refer to the intended use conditions and to the related functions of the product. The use profile should seek to represent the actual usage pattern in the selected market.

Where not otherwise justified, the determination of the use profile (i.e. scenarios for service life and the selected market) should be based on published technical information, such as:

a) CFP–PCR (see **6.2**);

b) published International Standards that specify guidance and requirements for development of scenarios and service life for the use stage for the product being assessed;

c) published national guidelines that specify guidance for development of scenarios and service life for the use stage for the product being assessed;

d) published industry guidelines that specify guidance for development of scenarios and service life for the use stage for the product being assessed;

e) use profiles based on documented usage patterns for the product in the selected market.

Where no method for determining the use profile of products has been established in accordance with

a) to e) above, the assumptions made in determining the use profile of products should be established by the organization carrying out the CFP study. A sensitivity analysis should be undertaken if the use stage assumption is shown to be significant for the conclusions of the CFP study.

The manufacturer's recommendation for proper use (e.g. cooking in an oven at a specified temperature for a specified time) might provide a basis for determining the use profile of a product. The actual usage pattern might, however, differ from those recommended. Any difference should be explained.

All relevant assumptions for the use stage should be documented in the CFP study report.

6.3.8 End-of-life stage

NOTE 1 The end-of-life stage begins when the used product under study is ready for disposal, recycling, reuse for different purposes or energy recovery.

All the GHG emissions and removals arising from the end-of-life stage of a product should be included in a CFP study, if this stage is included in the scope (see **6.3.2**). End-of-life processes may include:

a) collection, packaging and transport of end-of-life products;

b) preparation for recycling and reuse;

c) dismantling of components from end-of-life products;

d) shredding and sorting;

e) material recycling;

f) organic recovery (e.g. composting and anaerobic digestion);

g) energy recovery or other recovery processes;

h) incineration and sorting of bottom ash;

i) landfilling, landfill maintenance and promoting emissions from decomposition, such as methane.

NOTE 2 For end-of-life processes, CFP–PCR can provide additional guidance.

All relevant assumptions regarding end-of-life treatment, should be:

— based on best available information;

— based on current technology;

— Documented in the CFP study report.

End-of-life scenarios should reflect the current market and be representative of one of the most likely alternatives, or more than one scenario (including future scenarios) may be assessed. The scenarios will allow users to scale the results to assess realistic options.

6.4 Life cycle inventory analysis for the CFP

6.4.1 General

LCI is the phase of LCA involving the compilation and quantification of inputs and outputs for a product throughout its life cycle.

After the goal and scope definition phase, the LCI of a CFP study should be conducted. This consists of the following steps, adapted from IS/ISO 14044, which should apply when relevant:

a) data collection;

b) validation of data;

c) relating data to unit process and functional or declared unit;

d) refining the system boundary;

e) allocation.

Special provisions in this document apply for:

— CFP performance tracking;

— the time period for the assessment of GHG emissions and removals;

— the treatment of specific GHG emissions and removals.

If CFP–PCR are adopted for the CFP study, the LCI should be conducted according to the requirements in the CFP–PCR.

6.4.2 Data collection

The qualitative and quantitative data for inclusion in the life cycle inventory should be collected for all unit processes that are included in the system under study. The collected data, whether measured, calculated or estimated, are used to quantify the inputs and outputs of a unit process. Significant unit processes should be documented in the CFP study report.

For those data that might be significant for the conclusions of the CFP study, details about the relevant data collection process, the time when data have been collected, and further information about data quality should be referenced. If such data do not meet the data quality requirements, this should be stated.

Since data collection can span several locations and published references, a representative and consistent data set for the system under study should be used.

NOTE: For data and data quality, see **6.3.5**.

6.4.3 Validation of data

A check on data validity should be conducted during the process of data collection to confirm and provide evidence that the data quality requirements specified in **6.3.5** have been met.

Validation should involve establishing mass balances, energy balances and/or comparative analyses of emission factors or other appropriate methods. As each unit process obeys the laws of conservation of mass and energy, mass and energy balances provide a useful check on the validity of the description of a unit process.

6.4.4 Relating data to unit process and functional or declared unit

An appropriate flow should be determined for each unit process. The quantitative input and output data of the unit process should be calculated in relation to this flow.

Based on the flow chart and the flows between unit processes, the flows of all unit processes are related to the reference flow. The calculation should relate system input and output data to the functional or declared unit.

Care should be taken when aggregating the inputs and outputs in the product system. The level of aggregation should be consistent with the goal of the CFP study. If more detailed aggregation rules are required, they should be explained in the goal and scope definition phase of the CFP study or should be left to a subsequent LCIA phase.

6.4.5 Refining the system boundary

Reflecting the iterative nature of the quantification of the CFP, if no CFP–PCR are used, decisions regarding the data to be included or excluded should be based on a sensitivity analysis to determine the significance. The initial system boundary should be revised, as appropriate, in accordance with the cut- off criteria established in the goal and scope definition phase. The results of this refining process and the sensitivity analysis should be documented in the CFP study report.

The refining of the system boundary based on a sensitivity analysis as described above may result in

a) exclusion of life cycle stages or unit processes when lack of significance can be shown,

b) exclusion of inputs and outputs that lack significance to the results of the CFP study, or

c) inclusion of new unit processes, inputs and outputs that are shown to be significant.

The refining of the system boundary serves to limit the subsequent data handling to those input and output data that are determined to be significant to the goal of the CFP study.

6.4.6 Allocation

6.4.6.1 General

The inputs and outputs should be allocated to the different products according to the clearly stated and justified allocation procedure.

The sum of the allocated inputs and outputs of a unit process should be equal to the inputs and outputs of the unit process before allocation.

Whenever several alternative allocation procedures are applicable, a sensitivity analysis should be conducted to illustrate the consequences of the departure from the selected approach.

When PCR or CFP–PCR are developed in accordance with ISO/TS 14027, no further sensitivity analysis should be required.

6.4.6.2 Allocation procedure

The CFP study should include the identification of the processes shared with other product systems and deal with them in accordance with the stepwise procedure presented below.

NOTE 1: Formally, step 1 is not part of the allocation procedure.

a) Step 1: Wherever possible, allocation should be avoided by

1) dividing the unit process to be allocated into two or more sub-processes separately and collecting the input and output data related to these sub-processes, or

2) expanding the product system to include the additional functions related to the co-products.

b) Step 2: Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them.

c) Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and the functions in a way that reflects other relationships between them. For example, input and output data might be allocated between co- products in proportion to the economic value of the products.

When outputs include both co-products and waste, the ratio between co-products and waste should be identified and the inputs and outputs should be allocated to the co-products only. Allocation procedures should be uniformly applied to similar inputs and outputs of the product under study. For example, if allocation is made to usable products (e.g. intermediate or discarded products) leaving the system, then the allocation procedure should be similar to the allocation procedure used for such products entering the system.

The life cycle inventory is based on material balances between input and output. Allocation procedures should therefore approximate, as much as possible, such fundamental input/output relationships and characteristics.

NOTE 2 For allocation procedures, CFP–PCR can provide additional guidance.

6.4.6.3 Allocation procedure for reuse and recycling

The allocation principles and procedures in **6.4.6.1** and **6.4.6.2** also apply to reuse and recycling situations.

Changes in the inherent properties of materials should be taken into account. In addition, particularly for the recovery processes between the original and subsequent product system, the system boundary should be identified and explained, ensuring that the allocation principles are observed as described in **6.4.6.2**.

However, in these situations, additional elaboration is needed for the following reasons:

— reuse and recycling (as well as composting, energy recovery and other processes that can be assimilated to reuse/recycling) may imply that the inputs and outputs associated with unit processes for extraction and processing of raw material or final disposal of products are to be shared by more than one product system;

— reuse and recycling may change the inherent properties of materials in subsequent use.

Specific care should be taken when defining the system boundary with regard to recovery processes.

Several allocation procedures are applicable for reuse and recycling. The application of some procedures is distinguished in the following to illustrate how the above constraints can be addressed.

a) A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open- loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) material. However, the first use of virgin material in applicable open-loop product systems may follow an open-loop allocation procedure outlined in b).

b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.

The allocation procedures for the shared unit processes should use, as the basis for allocation, the following order, if feasible:

— physical properties (e.g. mass);

— economic value (e.g. market value of the scrap material or recycled material in relation to market value of primary material); or

— the number of subsequent uses of the recycled material.

NOTE: An example how to treat recycling in LCA studies is given in **Annex D**.

6.4.7 CFP performance tracking

When the CFP is intended to be used for CFP performance tracking, the following additional requirements for the quantification of the CFP should be met:

a) the assessments should be carried out for different points in time;

b) the change to the CFP over time should be calculated for products with an identical functional or declared unit;

c) the change to the CFP over time should be calculated using the same method and, if used, the same PCR, for all subsequent assessments (e.g. systems for selecting and managing data, system boundaries, allocation, identical characterization factors).

The time period between the points in time for which the CFP performance tracking is undertaken should not be shorter than the time boundary for data as described in **6.3.6**. It should be described in the goal and scope of the CFP study.

6.4.8 Assessing the effect of the timing of GHG emissions and removals

All GHG emissions and removals should be calculated as if released or removed at the beginning of the assessment period without taking into account an effect of delayed GHG emissions and removals.

Where GHG emissions and removals arising from the use stage (see **6.3.7**) and/or from the end-of-life stage (see **6.3.8**) occur over more than 10 years (if not otherwise specified in the relevant PCR) after the product has been brought into use, the timing of GHG emissions and removals relative to the year of production of the product should be specified in the life cycle inventory. The effect of timing of the GHG emissions and removals from the product system (as CO2e), if calculated, should be documented separately in the CFP study report. The method used to calculate the effect of timing should be stated and justified in the CFP study report.

NOTE: the time period of 10 years has been selected to avoid undue burden in data collection and additional reporting of GHG emissions and removals over shorter time periods and to achieve comparability in reporting. This value might be revised in future based on experience or improved scientific knowledge.

6.4.9 Treatment of specific GHG emissions and removals

6.4.9.1 General

For the sake of consistency of quantification, requirements and guidance specific to treatment of GHG emissions and removals from specific sinks and sources are provided in the following sub-clauses. However, different approaches need to be taken due to different scenarios at national situations which shall take precedence over this guidance and could seldom lead to different results.

More detailed guidance and data available in relevant CFP-PCR, other sector guidance documents or other applicable CFP communication programme rules shall also be applied to arrive to the conclusions.

6.4.9.2 Fossil and biogenic carbon

Fossil GHG emissions and removals should be included in the CFP or the partial CFP and documented separately as a net result. Biogenic GHG emissions and removals should be included in the CFP or the partial CFP and should each be expressed separately (see **Figure 3**).

NOTE 1 an example of fossil GHG removals is capture of fossil emissions from a power plant through a non- biological process followed by storage through geo sequestration.

All relevant unit processes of the life cycle of biomass-derived products should be included in the system under study, including, but not limited to, cultivation, production and harvesting of biomass.

NOTE 2 Treatment of GHG emissions and removals associated with land use change and land use are described in **6.4.9.5** and **6.4.9.6**.

NOTE 3 See **Annex E** for guidance related to agricultural and forestry products.

6.4.9.3 Biogenic carbon in products

NOTE 1 Biomass-derived carbon contained in a product is referred to as the biogenic carbon content of the product.

When biogenic carbon is stored in a product for a specified time, this carbon should be treated in accordance with the provisions in **6.4.8**. If a product's biogenic carbon content is calculated, it should be documented separately in the CFP study report but it should not be included in the result of CFP or partial CFP.

Information on biogenic carbon content should be provided when performing cradle to gate studies, as this information may be relevant for the remaining value chain. For reporting requirements, see **Clause 7**.

NOTE 2 In the case of products containing biomass, the biogenic carbon content is equal to the carbon removal during plant growth. This biogenic carbon can be released in the end-of-life stage.

6.4.9.4 Electricity

6.4.9.4.1 General

The GHG emissions associated with the use of electricity should include:

— GHG emissions arising from the life cycle of the electricity supply system, such as upstream emissions (e.g. the mining and transport of fuel to the electricity generator or the growing and processing of biomass for use as a fuel);

— GHG emissions during generation of electricity, including losses during transmission and distribution;

— Downstream emissions (e.g. the treatment of waste arising from the operation of nuclear electricity generators or treatment of ashes from coal fired electricity plants).

NOTE The same approach applies to purchased and sold heating and cooling energy and compressed air.

This document includes the principle of avoidance of double-counting in **5.12** and guidance concerning electricity in **6.4.9.4.2** to **6.4.9.4.4**.

EXAMPLES: No double-counting occurs:

— where the process that used the electricity and no other process may claim the generator-specific emission factors for that electricity;

— where the generator-specific electricity production does not influence the emission factors of any other process or organization.

6.4.9.4.2 Internally generated electricity

When electricity is internally generated (e.g. on-site generated electricity) and consumed for a product under study and no contractual instruments have been sold to a third party, then the life cycle data for that electricity should be used for that product.

6.4.9.4.3 Electricity from a directly connected supplier

A GHG emission factor obtained from the organization's supplier for the consumed electricity may be used if there is a dedicated transmission line between the organization and the generation plant from which the emission factor is derived, and no contractual instruments have been sold to a third party for that consumed electricity.

6.4.9.4.4 Electricity from the grid

Life cycle data from a supplier-specific electricity product should be used when the supplier is able to guarantee through a contractual instrument that the electricity product:

— conveys the information associated with the unit of electricity delivered together with the characteristics of the generator;

— is assured with a unique claim (see **5.12**);

— is tracked and redeemed, retired or cancelled by or on behalf of the reporting entity

— is as close as possible to the period to which the contractual instrument is applied and comprises a corresponding timespan;

— is produced within the country, or within the market boundaries where consumption occurs if the grid is interconnected.

If processes within the system under study are located in small island developing states (SIDS), the CFP or the partial CFP may additionally be quantified using contractual instruments for such processes, irrespective of grid inter-connectivity.

NOTE 1 SIDS are defined by the United Nations [20].

When information on supplier specific electricity is not available, GHG emissions associated with the relevant electricity grid from which the electricity is obtained should be used. The relevant grid should reflect the electricity consumption of the related region, excluding any previously claimed attributed electricity. In case no electricity tracking system is in place, the selected grid should reflect the electricity consumption of the region.

NOTE 2 Contractual instruments are any type of contract between two parties for the sale and purchase of energy bundled with attributes about the energy generation, or for unbundled attribute claims.

EXAMPLE Contractual instruments can include energy attribute certificates, renewable energy certificates (RECs), guarantee of origin (GOs) or green energy certificates.

NOTE 3 Examples of the characteristics of a generator include the registered name of the facility, the owners and the nature of the energy generated, the generation capacity and the renewable energy supplied.

NOTE 4 If specific life cycle data on a process within the electricity supply system are difficult to access, data from recognized databases (e.g. through the UNEP or UNFCCC) can be used.

Some electricity attributes, such as green certificates are sold without direct coupling to the electricity itself. In some countries, parts of the electricity from renewable energy sources might be sold/exported as renewable electricity without being excluded from the supplied mix. For this reason, in such cases a sensitivity analysis applying the relevant consumption grid mix should be conducted and reported in the CFP study report to demonstrate the difference in results of the electricity tracking instruments.

6.4.9.5 Land use change

GHG emissions and removals occur as a result of direct land use change (dLUC). Land use change that happened in past should be assessed in accordance with national or international methods.

Once these emissions are found significant, the methods, data and GHG emissions and removals should be documented separately in the CFP study report. (See Clause 7)

This standard recognizes that there is an on-going research to develop methodology and data for the inclusion of iLUC in GHG reporting. Indirect land use change (iLUC) should be considered in CFP studies, once an internationally agreed procedure exists.

6.4.9.6 Land use

GHG emissions and removals occurring as a result of land use through changes in soil and biomass carbon stocks that are not the result of changes to management of land should be assessed and included in the CFP. If changes in soil and biomass carbon stocks are not assessed, this decision should be justified in the CFP study report. Where included, these emissions and removals should be assessed in accordance with internationally recognized methods, such as the IPCC Guidelines for National Greenhouse Gas Inventories [17] and should be documented separately in the CFP study report.

When changes in management of land cause changes in soil and biomass carbon stocks, compared with the reference land use, the GHG emissions and removals should be documented and assigned to the system under study.

NOTE 1 Changes in management of land within the same land-use category are not considered land use change.

The net changes in soil and biomass carbon stocks should be assigned to the system under study across the selected time period.

The time period selected for analysis should be documented and justified. At a minimum, it should include at least one full rotation period for processes that involve growing crops or trees.

If there is a net increase of soil or biomass carbon due to modified land use practices, the net increase should be included in the CFP and the partial CFP only if measures are in place to address its permanence. If a national approach is used, the data should be based on a verified study, a peer reviewed study or similar scientific evidence and should be documented in the CFP study report.

NOTE 2 National approaches can include government-recognized and published methods and calculators.

NOTE 3 Ongoing land use can lead to a net increase or decrease of soil carbon, e.g. decrease during drought.

NOTE 4 There is ongoing research to develop methodology and models, and provide data for the inclusion of soil carbon change in GHG reporting.

NOTE 5 There are various ways to mitigate the risks of non-permanence of soil and biomass carbon, such as buffers and reserve accounts.

NOTE 6 If detection of soil carbon change involves direct field measurement, results depend on variables, including the location of sampling sites, the number of replicate soil samples, the timing of sampling, the depth of the soil profile and the sampling techniques. The principles and rules for designing soil sampling strategies and techniques are provided in ISO 10381 (all parts).

NOTE 7 For further guidance on land use, see **Annex E**.

6.4.9.7 Aircraft GHG emissions

Aircraft transportation GHG emissions should be included in the CFP and documented separately in the CFP study report.

Where an aviation multiplier is used, the effect of this multiplier should not be included in the CFP and should be reported separately together with the source.

NOTE Aircraft GHG emissions under certain circumstances in high altitudes have additional climate impacts as a result of physical and chemical reactions with the atmosphere. For more information on GHG emissions from aircraft, see the IPCC Guidelines for National Greenhouse Gas Inventories [17] and the IPCC Special Report on Aviation [18].

6.4.9.8 Summary of requirements and guidance in 6.4.9

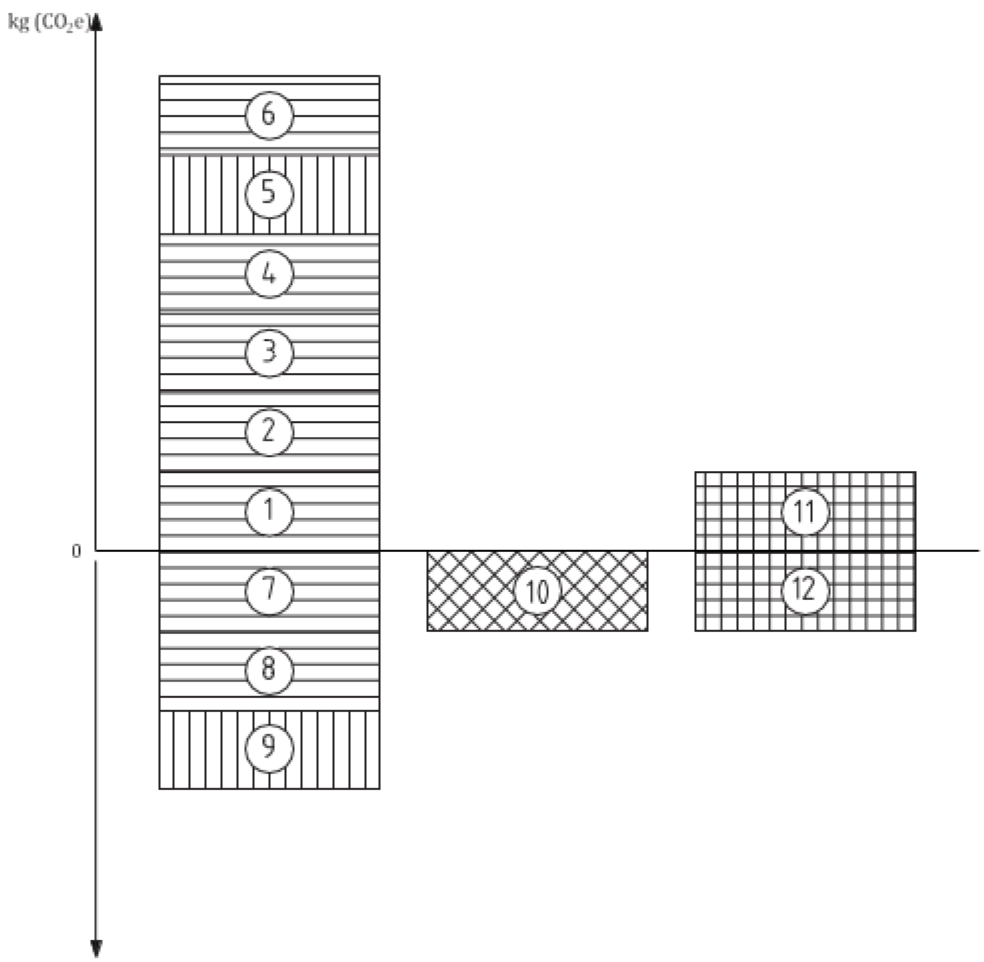
Table 1 provides an informative summary of the requirements and guidance given in **6.4.9. Figure 3** shows an informative illustration of the specific components of the CFP. Refer to **6.4.9.2** to **6.4.9.7** for the full requirements and guidance.

Table 1 Specific GHG emissions and removals treatment in the CFP or the partial CFP and documented separately in the CFP study report

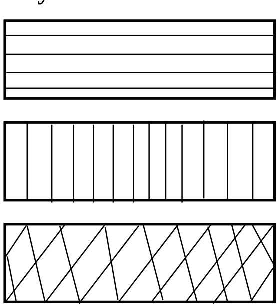
(Clause 6.4.9.8)

Sub-clause	Specific GHG emissions and removals[a]	Treatment in the CFP or the partial CFP			Documentation in the CFP study report	
		Shall be included	Should be included	Should be considered for inclusion	Should be documented separately in the CFP study report	Should be documented separately in the CFP study report, if calculated
6.4.9.2	Fossil and biogenic GHG emissions and removals[a]	X			X	
6.4.9.5	GHG emissions and removals occurring as a result of dLUC[a]	X			X	
6.4.9.5	GHG emissions and removals occurring as a result of iLUC[a]			X		X
6.4.9.6	GHG emissions and removals from land use[a]		X			X

6.4.9.3	Biogenic carbon in products[a]					X
6.4.9.7	Aircraft GHG emissions	X			X	
[a] For reporting of timing of emissions and removals, see 6.4.8.						



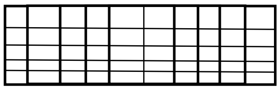
Key



shall be included in the CFP or the partial CFP

should be included in the CFP or the partial CFP

shall be documented separately in the CFP study report if calculated, not included in the CFP



should be considered separately

1	GHG emissions other than specified	7	biogenic GHG removal
2	aircraft emissions	8	Removal from dLUC and change in the management of land
3	biogenic GHG emissions	9	Removal from LU excluding change in the management of land
4	Emissions from dLUC and change in the management of land	10	Biogenic carbon in the product
5	Emissions from LU excluding change in the management of land	11	iLUC emissions
6	Net fossil GHG emission and removal	12	iLUC removals

FIG 1 ILLUSTRATION OF THE SPECIFIC COMPONENTS OF THE CFP AND THE PARTIAL CFP

NOTE: Fossil emissions and removals, dLUC and iLUC can have a positive or negative contribution to the CFP.

6.5 Impact assessment for CFP or partial CFP

6.5.1 General

In the LCIA phase of a CFP study, the potential climate change impact of each GHG emitted and removed by the product system should be calculated by multiplying the mass of GHG released or removed by the 100-year GWP given by the IPCC in units of kg CO2e per kg emission (with carbon feedbacks, according to IPCC).

NOTE 1 The CFP is the sum of these calculated impacts.

Where GWP values are amended by the IPCC, the latest values should be used in the CFP calculations if not otherwise stated and justified.

GWP for other time horizons and GTP, as given by the IPCC, may be used in addition to GWP 100 but should be reported separately.

NOTE 2 100-year global warming potential (GWP 100) is used to represent shorter-term impacts of climate change, reflecting the rate of warming. 100-year global temperature potential (GTP 100) is used as an indicator for the longer-term impacts of climate change, reflecting the long-term temperature rise. There is no scientific basis for choosing a 100-year time horizon compared to other time horizons. The time horizon is a value judgement of international convention that weighs the effects that are likely to occur over different time horizons. This text has been adapted from Reference [17].

6.5.2 Impact assessment of biogenic carbon

Removals of CO2 into biomass should be characterized in the LCIA as −1 kg CO2e/kg CO2 in the calculation of the CFP when entering the product system.

Emissions of biogenic CO2 should be characterized as +1 kg CO2e/kg CO2 of biogenic carbon in the calculation of the CFP.

NOTE the amount of CO2 taken up in biomass and the equivalent amount of CO2 emissions from the biomass at the point of complete oxidation results in zero net CO2 emissions integrated over time, except when biomass carbon is not converted into methane, non-methane volatile organic compounds (NMVOC) or other precursor gases.

For fossil and biogenic methane, the characterization factors in accordance with the most recent IPCC report should be used.

6.6 Interpretation of CFP or partial CFP

The life cycle interpretation phase of a CFP study should comprise the following steps:

a) identification of the significant issues based on the results of the quantification of the CFP and partial CFP in accordance with LCI and LCIA phases;

NOTE 1 Significant issues can be life cycle stages, unit processes or flows.

b) an evaluation that considers completeness, consistency and sensitivity analysis;

c) the formulation of conclusions, limitations and recommendations.

The results of the quantification of the CFP and partial CFP according to the LCI or LCIA phases should be interpreted according to the goal and scope of the CFP study. The interpretation should:

— include an assessment of uncertainty, including the application of rounding rules or ranges;

— identify and document the selected allocation procedures in the CFP study report in detail;

— identify the limitations of the CFP study (in accordance with, but not limited to, **Annex A**).

The interpretation should include:

— a sensitivity analysis of the significant inputs, outputs and methodological choices, including allocation procedures, in order to understand the sensitivity and uncertainty of the results;

— an assessment of the influence of alternative use profiles on the final result;

— an assessment of the influence of different end-of-life scenarios on the final result;

— an assessment of the consequences of recommendations [see **6.6** c)] on the final result.

NOTE 2 For more information, see IS/ISO 14044:2006, 4.5, and IS/ISO 14044:2006, Annex B.

7 CFP STUDY REPORT

7.1 General

The purpose of the CFP study report is to describe the CFP study, including the CFP or the partial CFP, and to demonstrate that the provisions of this document have been met.

Results reported in the CFP study report may be used in footprint communications (see ISO 14026).

NOTE "CFP study report" is a specific term relating to the carbon footprint of products. Other standards use different terminology for the same type of document (e.g. "third-party report" used in IS/ISO 14044:2006 and "footprint study report" used in ISO 14026).

The results and conclusions of the CFP study should be documented in the CFP study report without bias. The results, data, methods, assumptions and the life cycle interpretation (see **6.6**) should be transparent and presented in sufficient detail to allow the reader to comprehend the complexities and trade-offs inherent in the CFP study.

The type and format of the CFP study report should be defined in the goal and scope definition phase of the CFP study. The CFP study report should also allow the results and life cycle interpretation to be used in a manner consistent with the goals of the CFP study.

7.2 GHG values in the CFP study report

Results of the quantification of the CFP or the partial CFP should be documented in the CFP study report in mass of CO_2e per functional or declared unit.

The following GHG values should be documented separately in the CFP study report:

a) GHG emissions and removals linked to the main life cycle stages in which they occur, including the absolute and the relative contribution of each life cycle stage;

b) net fossil GHG emissions and removals (see **6.4.9.2**);

c) biogenic GHG emissions and removals (see **6.4.9.2**);

d) GHG emissions and removals resulting from dLUC (see **6.4.9.5**);

e) GHG emissions resulting from aircraft transportation (see **6.4.9.7**).

The following GHG values should be documented separately in the CFP study report, if calculated:

— GHG emissions and removals occurring as a result of iLUC (see **6.4.9.5**);

— GHG emissions and removals occurring as a result of land use (see **6.4.9.6**);

— results of the sensitivity analysis applying the relevant consumption grid mix, when applicable;

— biogenic carbon content of products;

— CFP calculated using GTP 100.

In cases of processes located in SIDS, an additional CFP or partial CFP, if calculated using contractual instruments for such processes, should be reported as additional information (see **6.4.9.4.4**).

7.3 Required information for the CFP study report

The following information on CFP quantification should be included in the CFP study report:

a) functional or declared unit and reference flow (see **6.3.3**);

b) system boundary, including

  — the type of inputs and outputs of the system as elementary flows, and

  — decision criteria concerning treatment of unit processes, considering their importance for the conclusions of the CFP study;

c) list of important unit processes;

d) data collection information, including data sources (see **6.4.2**);

e) the list of GHGs taken into account;

f) the selected characterization factors;

g) the selected cut-off criteria and cut-offs (see **6.3.4.3**);

h) the selected allocation procedures (see **6.4.6**);

i) timing of GHG emission and removals (see **6.4.8** and **6.4.9.6**), if applicable;

j) description of data (see **6.3.5**), including

  — decisions concerning data, and

  — assessment of data quality;

k) results of sensitivity analyses and uncertainty assessments;

l) treatment of electricity (see **6.4.9.4**), which should include information on the grid emission factor calculation and relevant grid specific constraints;

m) results of the life cycle interpretation (see **6.6**), including conclusions and limitations (see **Annex A**);

n) disclosure and justification of value choices that have been made in the context of decisions within the CFP study;

o) scope, and modified scope, if applicable, along with justifications and exclusions (see **6.3.2**);

p) description of the stages of the life cycle, including a description of the selected use profiles and end-of-life scenarios, when applicable;

q) the assessment of influence of alternative use profiles and end-of-life scenarios on the final results;

r) time period for which the CFP is representative (see **6.3.6**);

s) reference of the PCR applied or other supplementary requirements used in the study;

t) description of performance tracking (see **6.4.7**), when applicable.

7.4 Optional information for the CFP study report

In addition to the items above, the following items should be considered for inclusion in the CFP study report:

a) conformity with **Annex B**;

b) a graphical presentation of results of the CFP study.

8 CRITICAL REVIEW

In compiling the CFP study, a critical review facilitates understanding and enhances the credibility of CFP. A critical review of CFP studies, if any, should be performed in accordance with ISO/TS 14071.

ANNEX A

(Clause 6.3.2, 6.6, 7.3)

LIMITATIONS OF THE CFP

A-1 GENERAL

Limitations of CFPs affect the quantification of the CFP. The two most important inherent limitations are

— focus on climate change as the single impact category, and

— limitations related to the methodology.

— difficulty to ascertain whether double counting has been avoided in CFP results.

The consequences of these limitations should be reflected in the CFP study report (see 7.3).

EXAMPLE: For decision making (e.g. design options), the following considerations should be undertaken to identify trade-offs and avoid unintended consequences:

a) the whole product life cycle should be included;

b) other impacts (e.g. health and safety, environmental) should be considered;

c) limitations as identified in this annex should be considered.

A-2 FOCUS ON A SINGLE ENVIRONMENTAL ISSUE

The CFP reflects the potential effect on the global radiative energy balance over time from the sum of GHG emissions and removals of a product system, expressed as CO_2e, which are associated with acquisition of raw material, design, production, transportation/delivery, use and end-of-life treatment. The CFP can be an important environmental aspect of the life cycle of a product affecting the area of concern “climate change”. A product’s life cycle can have impacts related to other areas of concern (e.g. resource depletion, air, water, soil and ecosystems). An LCA can cover further areas of concern in addition to climate change, relevant for the product life cycle.

An objective of LCA is to allow an informed decision regarding environmental impacts. Climate change attributable to the CFP is only one of a variety of environmental impacts that can arise from a product’s life cycle, and the relative importance of different impacts can vary with different products. In some cases, action to minimize a single environmental impact can result in greater impacts arising from other environmental aspects (e.g. activities to reduce water pollution can result in increased GHG emissions from the life cycle of a product, while the use of biomass to reduce GHG emissions can negatively affect biodiversity). Decisions about product impacts that are only based on a single environmental issue can be in conflict with goals and objectives related to other environmental issues. CFP or partial CFP should not be the sole component of a decision-making process.

A-3 LIMITATIONS RELATED TO THE METHODOLOGY

The CFP is calculated based on LCA methodology. ISO 14040 and ISO 14044 address its inherent limitations and trade-offs. These include the establishment of a functional or declared unit and the system boundary, the availability and selection of appropriate data sources, allocation procedure and assumptions regarding the transport, user behaviour and end-of-life scenarios. Some of the chosen data might be limited to a specific geographical area (e.g. national electricity grid) and/or might vary in time (e.g. seasonal variations). Value choices (e.g. for the selection of the functional or declared unit or allocation procedure) are also needed to model a life cycle.

These methodological constraints can have an influence on the outcome of the calculations. As a result, the accuracy of quantifying the CFP is limited and is also difficult to assess. Hence, other approaches, such as an energy-consumption-in-use assessment might be preferable in certain circumstances: However, establishing the importance of use stage GHG emissions is not possible without first assessing the life cycle GHG emissions of a product.

Because of these limitations, the results of a quantification of the CFP in accordance with this document are often not a sound basis for comparisons. However, these results may be used for comparisons provided that, at a minimum, the requirements of **Annex B** and requirements for a separate footprint communication programme for the CFP or partial CFP information are met.

ANNEX B

(Clause 6.3.2, 6.3.3, 7.4)

COMPARISON BASED ON THE CFP OF DIFFERENT PRODUCTS

The methodology for quantification can be applied for comparative studies. If a comparison is undertaken, the requirements in this annex should be followed.

An example for the use of comparative studies is internal decision making. While this document does not include any requirements for communication, the results of any CFP studies, including comparative studies, may be used for comparative footprint communication in accordance with ISO 14026.

The calculation of CFPs of the products to be compared should follow identical CFP quantification requirements.

Comparative CFP studies should include the full life cycle unless the function of the product is included in a partial CFP and the omitted processes of the product system are identical for all compared products.

If CFP–PCR are adopted, the same CFP–PCR should be used for all products assessed in the comparative CFP study. The CFP–PCR should be in accordance with ISO/TS 14027.

The following criteria should be applied for the goal and scope definition phase:

a) the product category definition and description (e.g. function, technical performance and use) are identical;

b) the functional unit is identical;

c) the system boundary is equivalent;

d) the description of data is equivalent;

e) the criteria for inclusion of inputs and outputs are equivalent;

f) the data quality requirements (e.g. coverage, precision, completeness, representativeness, consistency and reproducibility) are the same;

g) assumptions especially for the use stage and the end-of-life stage are the same;

h) specific GHG emissions and removals (e.g. due to LUC or electricity use) are treated identically;

i) the units are identical.

The following criteria should be applied for the life cycle inventory and LCIA phase:

— the methods of data collection and data quality requirements are equivalent;

— the calculation procedures are identical;

— the allocation of the flows is equivalent;

— the applied GWPs are identical.

ANNEX C

(Clause 6.1)

THE CFP SYSTEMATIC APPROACH

C-1 GENERAL

If an organization decides to develop a CFP systematic approach, it should follow the requirements given in this annex.

The CFP systematic approach is a series of activities developed by an organization through a set of procedures, in order to facilitate the development of CFPs for more products within the same organization. This is applicable when the same set of data and allocation procedures are applicable for all its products.

The implementation of the CFP systematic approach should also simplify any verification activities, avoiding any redundancy in the verification of the data set.

C-2 GENERAL REQUIREMENT

The organization should describe its CFP systematic approach, including the sequence and interaction of activities that are part of this process, and establish procedures to ensure that the operation, control and monitoring of the CFP systematic approach are effective.

Top management should ensure that responsibilities and authorities related to the CFP systematic approach are defined and communicated within the organization. The organization should determine and provide the resources and competences needed to implement and maintain the CFP systematic approach.

The organization should determine, provide and maintain the infrastructure needed to achieve conformity to the CFP systematic approach requirements. Infrastructure includes, where applicable:

a) workspace and associated utilities;

b) process equipment (both hardware and software);

c) supporting services (i.e. information systems);

d) LCA competence.

The CFP systematic approach should be able to develop the CFP of a single product in accordance with this document and with any further requirements contained in the PCR and in the rules established by the programme operator, where applicable.

The CFP systematic approach should contain measures able to identify changing conditions that increase the risk of making the CFPs out of date or not representative. Efficient control and applicable action should be applied to such identified risks.

C-3 DESCRIPTION OF THE CFP SYSTEMATIC APPROACH

C-3.1 General

The description of the CFP systematic approach should cover the following groups of activities:

a) data and information collection;

b) data and information management;

c) validation of the CFP systematic approach;

d) use the systematic approach to perform the CFP for any product.

C-3.2 Data and information collection

The organization should describe the data collection activity in order to have full data coverage and to minimize errors due to incorrect sampling (e.g. collection of double data, loss of data).

C-3.3 Data and information management

The organization should describe how to obtain a CFP from the starting data as, for example, allocation procedures, construction of models for the activities of the supply chain, procedures to overcome data gaps, use and end-of-life scenarios. Review of the CFP systematic approach should be performed when significant changes apply to the models, assumptions or allocation procedures.

C-3.4 Validation of the CFP systematic approach

The CFP systematic approach should be validated in terms of correctness and representativeness before being implemented in the development of a specific CFP. The validation should be performed through the development as a pilot test of a CFP for a specific product.

The organization should conduct internal CFP systematic approach assessments at planned intervals, to ensure its continuous suitability, adequacy and effectiveness.

C-3.5 Use the CFP systematic approach to perform the CFP for any eligible products

The obtained and validated procedures should be implemented by the organization to achieve the CFP of its products that have the same set of data and allocation procedures.

C-4 PROCEDURE

The procedure should specify the following aspects:

a) source and version of PCR adopted;

b) any additional requirements of the programme operator, where applicable;

c) specific activities within the CFP systematic approach, such as data collection, CFP quantification, critical review or external CFP verification (if any), maintenance of the CFP validity and representativeness.

ANNEX D

(*Informative*)

POSSIBLE PROCEDURES FOR THE TREATMENT OF RECYCLING IN CFP STUDIES

D-1 GENERAL

Based on the requirements and guidelines given in ISO 14040 and ISO 14044 and the examples as shown in ISO/TR 14049, this annex presents possible procedures for how to treat recycling in CFP studies. This annex does not preclude alternative procedures for how to treat recycling in CFP studies, provided they are in line with ISO 14040 and ISO 14044.

D-2 RECYCLING AS AN ALLOCATION ISSUE

IS/ISO 14044: 2006, 4.3.4.3.1, states:

“The allocation principles and procedures in 4.3.4.1 and 4.3.4.2 also apply to reuse and recycling situations.

Changes in the inherent properties of materials should be taken into account. In addition, particularly for the recovery processes between the original and subsequent product system, the system boundary should be identified and explained, ensuring that the allocation principles are observed as described in 4.3.4.2.”

Furthermore, ISO 14044:2006, 4.3.4.3.2, states:

“However, in these situations, additional elaboration is needed for the following reasons:

— reuse and recycling (as well as composting, energy recovery and other processes that can be assimilated to reuse/recycling) may imply that the inputs and outputs associated with unit processes for extraction and processing of raw material and final disposal of products are to be shared by more than one product system;

— reuse and recycling may change the inherent properties of materials in subsequent use;

— specific care should be taken when defining system boundary with regard to recovery processes.”

This means that recycling is considered as an allocation issue, which might imply that the GHG emissions associated with unit processes for extraction and processing of raw material, and for the final disposal of products, including recycling, are to be shared by more than one product system, i.e. the product system that delivers the recycled material and the subsequent system that uses the recycled material.

D-3 CLOSED-LOOP ALLOCATION PROCEDURE

IS/ISO 14044: 2006, 4.3.4.3.3, a), states:

> "a) A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open- loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials."

This addresses the case of the closed-loop system, where the recycled material is recovered in the end-of- life stage of a product system and is reused for the same product system again. In this case, allocation can be avoided, because the recycled material substitutes the primary material in the same product system.

IS/ISO 14044 states that the closed-loop procedure can also be applied to open-loop product systems, when the recycled material has the same inherent properties as the primary material. In this case, the GHG emissions of the unit processes for the final disposal of products, including recycling, are allocated to the product that delivers the recycled material, but the recycled material that leaves the product system carries a recycling credit that corresponds to the GHG emissions of the relevant primary material acquisition.

If material is lost within the product's life cycle, then the GHG emissions of the production of this lost material from natural resources are completely charged to the product system that delivers the recycled material.

In the case of the closed-loop allocation procedure, the product system under study includes, as end- of-life operations, all processes from the end-of-life product to the recycled material, up to the point where it fulfils the same quality requirements as the primary material that it substitutes. As no further pre-processing of the recycled material is required, all unit processes for the final disposal of products, including recycling, are allocated to the product system that generates the recycled material.

For closed-loop allocation, each GHG emission tied to raw material acquisition and end-of-life operations can be calculated in accordance with Formula (D.1):

$$E_M = E_V + E_{EoL} - R \cdot E_V \qquad \text{(D.1)}$$

Where,

E_M is the GHG emissions tied to raw material acquisition and end-of-life operations;

E_V is the GHG emissions tied to extracting or producing the raw material needed for the product, from natural resources, as if it were all primary material;

E_{EoL} is the GHG emissions tied to end-of-life operations (being part of the product system that delivers the recycled material);

R is the recycling rate of the material;

$R \cdot E_V$ is the recycling credit.

NOTE: This method is equivalent to the closed loop approximation method in the GHG protocol Product Life Cycle Accounting and Reporting Standard [19].

D-4 OPEN-LOOP ALLOCATION PROCEDURE

IS/ISO 14044:2006, 4.3.4.3.3, b), states:

> "b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties."

This means that recycled material, compared with primary material, might have a different chemical composition, a different structure (e.g. length of fibres in recycled paper) or a higher concentration of dissolved impurities.

IS/ISO 14044:2006, 4.3.4.3.4, states:

"The allocation procedures for the shared unit processes mentioned in 4.3.4.3 should use, as the basis for allocation, if feasible, the following order:

— physical properties (e.g. mass);

— economic value (e.g. market value of the scrap material or recycled material in relation to market value of primary material); or

— the number of subsequent uses of the recycled material (see ISO/TR 14049)."

The text that follows is one possible interpretation of the above provisions from IS/ISO 14044: 2006.

The "shared unit processes" for the open-loop recycling are the processes for extraction and processing of raw material and the end-of-life operations of products as mentioned in IS/ISO 14044: 2006, 4.3.4.3.2 (see D-2).

As for the GHG, emissions of the unit processes of final disposal/recycling, allocation can be avoided by process subdivision. In practice, such a process subdivision depends on the relevant product and material categories. Further guidance can be found in sector guidance documents and PCR. One possible way of process subdivision is for the GHG emissions tied to final disposal/recycling to be split into a component E_{EoL} charged to the product system under study and a component E_{PP} charged to the product system that uses the recycled material. E_{PP} are the GHG emissions tied to the pre-processing of the recycled material in order to fulfil the quality requirements of the substituted primary material.

The remaining allocation issue is to share the GHG emissions associated with unit processes for extraction and processing of raw material between the system under study and the subsequent systems that use the recycled material. The first step is to try to avoid allocation, e.g. by system expansion. If allocation cannot be avoided, the provisions of ISO 14044:2006, 4.3.4.3.4, apply.

When the first option, allocation based on physical properties, is applied, the choice of a physical parameter needs justification, i.e. a physical relationship between the product system that delivers the recycled material and the (usually unknown) subsequent product system needs to be demonstrated [see ISO 14044:2006, 4.3.4.2, b)].

The option of ISO 14044:2006, 4.3.4.3.4, second bullet, includes the choice of an allocation factor, A, which is determined as the ratio between the global market price of the scrap material or the recycled material and the global market price of the primary material, typically as an average over a longer time period, e.g. five years. This option can be used if such global market prices exist. If the recycled material has the same market value as primary material, then an allocation factor $A = 1$ results, even if the inherent properties differ from those of the primary material. If the recycled material is given away free of charge, then the allocation factor $A = 0$. The application of market value allocation needs justification.

The market value allocation is sometimes difficult to apply because market price ratios might change significantly. The use of different possible ratios in a sensitivity analysis can be helpful.

The number of subsequent uses of the recycled material can be applied for the allocation if this number can be determined and justified. Further guidance is given in ISO/TR 14049.

In the literature, an arbitrary allocation factor, e.g. $A = 0.5$, is sometimes proposed for all materials without further justification. According to ISO 14044, such a factor is justified if the criteria for allocation mentioned in ISO 14044 (e.g. physical properties, economic value, number of subsequent uses) are neither feasible nor applicable.

When a product consists of 100 % primary material, then, in the case of open-loop recycling, the GHG emissions related to raw material acquisition and end-of-life operations can be calculated in accordance with Formula (D.2):

$$E_M = E_V + E_{EoL} - R \cdot A \cdot E_V \qquad \text{(D.2)}$$

Where,

E_M is the GHG emissions tied to raw material acquisition and end-of-life operations;

E_V is the GHG emissions tied to extracting or producing all the raw material needed for the product from natural resources;

E_{EoL} is the GHG emissions tied to end-of-life operations (being part of the product system which delivers recycled material);

R is the recycling rate;

A is the allocation factor;

$R \cdot A \cdot E_V$ is the recycling credit.

In the case of $A = 0$, i.e. complete down-cycling, no recycling credit is given.

When recycled material enters a product system, it carries an environmental burden if a recycling credit has previously been given to the product system where the recycled material comes from [see Formulae (D.1) and (D.2) regarding recycling credit].

When a product consists of 100 % recycled material, then, in the case of open-loop recycling, the GHG emissions related to raw material acquisition and end-of-life operations can be calculated in accordance with Formula (D.3) or Formula (D.4):

$$E_M = E_V \cdot A + E_{PP} + E_{EoL} - R \cdot A \cdot E_V \qquad (D.3)$$

$$E_M = E_{PP} + E_{EoL} + (1 - R) \cdot A \cdot E_V \qquad (D.4)$$

Where, E_{PP} are the GHG emissions tied to pre-processing of the recycled material in order to fulfil the quality requirements of the substituted primary material.

When a product consists of both primary and recycled material, then, in the case of open-loop recycling, the GHG emissions related to raw material acquisition and end-of-life operations can be calculated in accordance with Formula (D.5) or Formula (D.6):

$$E_M = C \cdot A \cdot E_V + C \cdot E_{PP} + (1 - C) \cdot E_V + E_{EoL} - R \cdot A \cdot E_V \qquad (D.5)$$

Or

$$E_M = C \cdot E_{PP} + (1 - C) \cdot E_V + E_{EoL} + (C - R) \cdot A \cdot E_V \qquad (D.6)$$

Where C is the recycled content of the product.

Formula (D.3)/Formula (D.4) and Formula (D.5)/Formula (D.6) only apply if the allocation factor for the recycled material that enters the product system is identical with the allocation factor of the recycled material that leaves the product system. Otherwise, the calculation needs to be extended, using two different allocation factors.

ANNEX E

(*Informative*)

GUIDANCE ON QUANTIFYING GHG EMISSIONS AND REMOVALS FOR AGRICULTURAL AND FORESTRY PRODUCTS

E-1 GENERAL

This annex is intended to assist users of this document to quantify GHG emissions and removals related to the product systems of agricultural and forestry products. Agriculture involves the production of crops, livestock, poultry, fungi, and insects for food, feed, fibre, pharmaceuticals, bioenergy and other products. Forestry involves management of forests to produce pulp, solid wood and other products derived from biomass.

NOTE: Biomass-derived products are also known as bio-based products.

The use of land to produce agricultural and forestry products results in GHG emissions and removals. The following are examples of activities that result in GHG emissions and removals:

— raising livestock;

— manure management;

— application of synthetic fertilizer, organic amendments, lime to soils;

— drainage of soils;

— open burning of biomass residues;

— weed management;

— land clearing;

— afforestation;

— land preparation for crop and forest establishment;

— thinning, pruning and harvesting forests;

— establishment and maintenance of farm and forest roads.

Sources of non-CO_2 GHG emissions can include:

— enteric fermentation (CH_4);

— application of mineral and organic nitrogen-containing fertilizers (N_2O);

— manure handling and application (CH_4) and (N_2O);

— rice cultivation (CH_4).

Other relevant biogenic GHG emissions and removals include the CO_2 emissions and removals from biomass and soil.

E-2 ASSIGNING BIOGENIC GHG EMISSIONS AND REMOVALS FROM LAND USE CHANGE AND LAND USE TO PRODUCTS

NOTE: See 6.4.9.2, 6.4.9.5 and 6.4.9.6.

E-2.1 General

Carbon stocks represent the quantity of carbon stored in different pools, including the soil organic matter, above- and below-ground biomass, dead organic matter, and harvested wood products. By definition, an increase in carbon stocks is a biogenic CO_2 removal and a decrease in carbon stocks is a biogenic CO_2 emission. The net change in carbon stock within a biogenic carbon pool corresponds with the sum of CO_2 emissions to and removals from the atmosphere. Changes in biomass carbon stocks can also result from the physical or chemical transfer of biogenic carbon from one pool to another.

Variations in management of land can have ongoing influence on carbon stocks for decades, until a new equilibrium soil carbon level is reached.

EXAMPLE: Tillage frequency and crop residue management are examples of management of land.

Land use changes, such as land clearing can result in large pulses of emissions.

Biogenic GHG emissions and removals due to land use and dLUC, whether occurring as a pulse or a gradual change, are divided amongst the products produced over a specified period.

Typically, carbon stock changes are distributed linearly over a specified time period. The appropriate time period can be the length of the average rotation period for harvested wood products, the lifetime of the product, project or processing plant, or duration defined in a programme under which the CFP information is supplied, or the default time horizon for LUC emission and removals in national GHG inventories submitted to the United Nations Framework Convention on Climate Change (UNFCCC). Wood from forest land that remains forest land has zero emissions from LUC. Forest land remains forest land, if regrown after harvest. The cycle of forest growth, harvest and regrowth is not LUC.

Land use will result in zero net CO_2 emissions if the average carbon stock in biomass and soil at the landscape level does not change over time.

If soil carbon stock change is quantified by repeated measurement, the same soil depth should be used, except where changes in management of land are likely to change the soil bulk density, in which case soil carbon stock should be calculated for equivalent soil mass.

E-2.2 Reference land use

NOTE: See 6.4.9.5 and 6.4.9.6.

The reference land use can be:

a) "business-as-usual": continuation of current practice based on historic data, considering a time period that is similar in extent and conditions to the time period selected for analysis;

b) projected future: projecting future changes using, e.g. knowledge of changing underlying drivers for land use and land use change, relative to business-as-usual, such as anticipated changes in intensity of production, technology or other relevant variables;

c) target: reference land use based on, e.g. policy targets for land use;

d) potential natural regeneration: vegetation that would potentially become established in the absence of human activity;

e) historic baseline: using land use patterns at a specific point in time as the reference land use.

The choice of reference land use should be based on the goal and scope of the study and should be documented and justified.

The description of a reference land use can rely on understanding of past trends and natural variability, as well as projections of the future with and without the product system. The choice of the reference land use has implications for the level of uncertainty.

E-3 BIOGENIC CARBON STORAGE IN PRODUCTS

NOTE: See 6.4.9.3.

Most agricultural food products, including grains, fruits, vegetables, livestock, poultry and related products, are short-lived and consumed soon after production. On the other hand, some products have the potential to store carbon for longer periods of time, such as wood or other biomass-derived construction products. For all products, GHG emissions and removals are included as if released or removed at the beginning of the assessment period.

This document also permits a supplementary calculation that acknowledges the impact of biogenic carbon storage in products due to the effect of timing (see 6.4.8). Several methodological approaches have been proposed to address delayed emissions resulting from temporary carbon storage in the quantification of the CFP or the partial CFP, for example, approaches based on discounting or time- dependent characterization factors. Such calculations are not part of the quantification of the CFP or the partial CFP but may be documented separately in the CFP study report.

In the case of products from biomass, carbon storage is calculated as carbon removal during plant growth and subsequent emission if the biogenic carbon is released in the use or end-of-life stages. If carbon removal from the atmosphere is included within the system boundary, the flows of biogenic carbon into and out of biomass-derived materials that are combusted as the end-of-life scenario will result in zero net contribution to the CFP, except for any portion of biogenic carbon converted to CH_4. If the product is reused or recycled as the end-of-life scenario, this can also result in zero net contribution to the CFP, when biogenic carbon flows are transferred to subsequent product systems.

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