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TECHNICAL REPORT

colour inside

Analysis of quantification methodologies for greenhouse gas emissions for electrical and electronic products and systems

IEC/TR 62725:2013(E)

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Analysis of quantification methodologies for greenhouse gas emissions for electrical and electronic products and systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ANALYSIS OF QUANTIFICATION METHODOLOGIES FOR GREENHOUSE GAS EMISSIONS FOR ELECTRICAL AND ELECTRONIC PRODUCTS AND SYSTEMS

FOREWORD

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC/TR 62725, which is a technical report, has been prepared by IEC technical committee 111: Environmental standardization for electrical and electronic products and systems.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
111/266/DTR	111/291/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Electrical and electronic products and systems (hereinafter referred to as “EE products”) are widely used in our society, hence raising awareness of their environmental impacts. Consequently customers in the market and other stakeholders are requiring or requesting that the electronics sector take actions to address the quantification and reduction of environmental impacts through environmental conscious design during the product development phase.

Among those environmental impacts, climate change is an important issue. A number of initiatives at local, national, regional, and international levels are being developed and implemented, aiming to curb the concentration of greenhouse gas (GHG) emissions which is understood to be a major contributing factor.

A basic and generic methodology to quantify Carbon Footprint of Products (hereinafter referenced as “CFP”) is under development in ISO 14067. It specifies principles and requirements for studies to quantify CFP, based on the methodology of life cycle assessment (LCA) specified in ISO 14040 and ISO 14044. In addition, major standardisation activities, and private, government and industry driven initiatives have started work on establishing methodologies for CFP, quantifying GHG emissions and related issues.

This plurality of initiatives highlights the necessity of developing guidance, which facilitates the understanding of existing methodologies and suggests workable and implementable options that address the specific characteristics of EE products, for example;

- Supply chains can be dynamic, long, complicated and global. Some product categories are associated with significant impacts from raw material acquisition, production stage, or end-of-life. Reasonable and consistent methodologies are needed to be shared with all the relevant actors along the global supply chain.
- Many products have relatively long lives, extending over many years, with associated energy consumption, which underlines the significance of the use stage. For such product categories, specific attention is paid to energy efficiency. It should be noted that the assumptions behind use scenarios are critical to achieve consistency.
- In addition to associated CO_2 emissions, some products use substances that have the potential for additional GHG emissions (e.g. SF_6 used in switchgear).

These characteristics support the market relevance for providing generic guidance in the form of this Technical Report (hereinafter referred to as TR) for the quantification, documentation and communication of GHG along the life cycle of EE products.

The contents and features of this TR are as follows:

- A study and review of relevant standards, regional initiatives and practices are provided to clarify and compare the differences and similarities in multiple existing methodologies for CFP studies.
- This Technical Report, based on relevant International Standards, Draft International Standards, especially ISO/DIS 14067, and other standards, gives a comprehensive additional guidance which enable readers to carry out CFP study for EE products.

It should be also emphasized that CFP addresses the single impact category of climate change and does not assess other potential social, economic or environmental impacts. Therefore CFPs do not provide an indicator of the overall environmental impact of products.

The information in this TR is entirely informative in nature and does not establish nor is it intended to imply any normative requirements.

NOTE 1 This TR may be used as quantification guidance for GHG emissions as a part of the environmental impact categories in a multi-criteria environmental assessment.

NOTE 2 This TR is not directly intended for electrical and electronic equipment (EEE) as defined by EU regulation therefore this TR uses the term "electrical & electronic products (EE products)."

ANALYSIS OF QUANTIFICATION METHODOLOGIES FOR GREENHOUSE GAS EMISSIONS FOR ELECTRICAL AND ELECTRONIC PRODUCTS AND SYSTEMS

1 Scope

This Technical Report is intended to provide users with guidance to understand methodologies and to evaluate carbon footprint of products (hereinafter referred to as CFP), by quantifying the greenhouse gases (GHG) emissions (hereinafter referred to as CFP study) for Electrical and Electronic products (hereinafter referred to as EE products) based on life-cycle thinking.

This TR is applicable to any type of EE products, which are new or modified (e.g. reconditioned, upgraded, etc.).

This TR is based on the result of a comparative study on existing methodologies published or under discussion in representative international organizations.

This TR is intended to be used by those involved in design and development of EE products, and their supply chains regardless of industry sectors, regions, types, activities and sizes of organizations. This TR may also be used as guidance to prepare a PCR of each product category in EE sector.

NOTE 1 In this TR, ISO/DIS 14067, ITU-T L.1400 and L.1410, GHG Protocol Product Life Cycle Accounting and Reporting Standard (hereinafter referred to as (GHG Protocol Product Standard), BSI PAS 2050, and other international, regional and national initiatives are studied and compared since these documents and initiatives are regarded as the most influential ones worldwide at the moment.

NOTE 2 This TR refers to requirements relevant to EE products in the existing documents and quotes them with boxes. The boxes are followed by guidance applicable to EE products. The documents which this TR refers to (e.g. ISO/DIS 14067) may be revised in the future. These boxes do not capture the full text of the standards referred to and readers are encouraged to read these standards for thorough understanding of their requirements.

NOTE 3 This TR is programme-neutral. If a programme (e.g. a specific Carbon Footprint of Products (CFP) Initiative) is applicable, some requirements of that programme may be additional to the guidance provided in this TR.

2 Normative reference

There are no normative references. Informative references are noted in the bibliography.

NOTE This clause is included so as to respect IEC clause numbering.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
allocation
partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems

[SOURCE: ISO 14040:2006, 3.17]

3.2
attributional approach
an approach to LCA where GHG emissions and removals are attributed to the unit of analysis of the studied product by linking together attributable processes along its life cycle

[SOURCE: GHG Protocol Product Life Cycle Accounting & Reporting Standard: 2011]

3.3
biogenic carbon
carbon derived from biomass

[SOURCE: ISO/DIS 14067:–, 3.8.2]

3.4
carbon dioxide equivalent
CO2 equivalent, CO2e
unit for comparing the radiative forcing of a greenhouse gas to that of carbon dioxide

Note 1 to entry: The carbon dioxide equivalent is calculated by multiplying the mass of a given greenhouse gas by its global warming potential.

[SOURCE: ISO 14064-1:2006, 2.19]

3.5
carbon footprint of a product-product category rules
CFP-PCR
set of specific rules, requirements and guidelines for quantification and communication on the CFP for one or more product categories

[SOURCE: ISO/DIS 14067:–, 3.4.12]

3.6
consequential approach
an approach to LCA where processes are included in the life cycle boundary to the extent that they are expected to change as a consequence of a change in demand for the unit of analysis.

[SOURCE: GHG Protocol Product Life Cycle Accounting & Reporting Standard: 2011]

3.7
functional unit
quantified performance of a product system for use as a reference unit

Note 1 to entry: As the CFP treats information on a product, the functional unit can be a product unit, sales unit or service unit.

[SOURCE: ISO/DIS 14067:–, 3.4.7]

3.8
global warming potential
GWP
characterization factor (ISO 14050:2009, 7.2.2.2) describing the mass of carbon dioxide that has the same accumulated radiative forcing over a given period of time as one mass unit of a given greenhouse gas

[SOURCE: ISO/DIS 14067:–, 3.3.4]

3.9
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 to entry: Greenhouse gases include, among others, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

[SOURCE: ISO 14064-1:2006, 2.1]

3.10
greenhouse gas emission
GHG emission
total mass of a greenhouse gas released to the atmosphere over a specified period of time

[SOURCE: ISO 14064-1:2006, 2.5]

3.11
greenhouse gas removal
GHG removal
total mass of a greenhouse gas removed from the atmosphere over a specified period of time

[SOURCE: ISO 14064-1:2006, 2.6]

3.12
intermediate product
output from a unit process that is input to other unit processes that require further transformation within the system

[SOURCE: ISO 14044:2006, 3.23]

3.13
life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to the final disposal

[SOURCE: ISO 14040:2006, 3.1]

3.14
life cycle assessment
LCA
compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

[SOURCE: ISO 14040:2006, 3.2]

3.15
life cycle stage
element of a life cycle

Note 1 to entry: The phrase 'life cycle phase' is sometimes used interchangeably with 'life cycle stage'.

Note 2 to entry: Examples of life cycle stages are: Raw material acquisition and production; manufacturing; packaging and distribution; installation and use, maintenance and upgrading; and end of life.

[SOURCE: IEC 62430:2009, 3.10]

3.16
life cycle thinking
LCT
consideration of all relevant environmental aspects during the entire life cycle of products

[SOURCE: IEC 62430:2009, 3.11]

3.17
organization
group of people and facilities with an arrangement of responsibilities, authorities and relationships

[SOURCE: ISO 9000:2006, 3.3.1]

3.18
primary data
data collected from specific processes in the studied product's life cycle

[SOURCE: GHG Protocol Product Life Cycle Accounting & Reporting Standard: 2011]

3.19
process
set of interrelated or interacting activities which transform inputs into outputs

Note 1 to entry: Inputs to a process are generally outputs of other processes.

Note 2 to entry: Processes in an organization are generally planned and carried out under controlled conditions to add value.

[SOURCE: ISO 9000:2006, 3.4.1]

3.20
product
any goods or service

Note 1 to entry: This includes interconnected and / or interrelated goods or services.

[SOURCE: IEC 62430:2009, 3.14]

3.21
product category
group of technologically or functionally similar products where the environmental aspects can reasonably be expected to be similar

[SOURCE: IEC 62430:2009, 3.15]

3.22
product category rules
PCR
set of specific rules, requirements and guidelines for developing Type III environmental declarations (ISO 14050:2009, 8.5) for one or more product categories

Note 1 to entry: PCR include quantification rules compliant with ISO 14044.

[SOURCE: ISO/DIS 14067:–, 3.4.11]

3.23
product system
collection of unit processes with elementary and product flows, performing one or more defined functions and which models the life cycle of a product

[SOURCE: ISO 14044:2006, 3.28]

3.24
reference flow
measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit

Note 1 to entry: GHG Protocol Product Standard uses the term in a slightly different way: “The reference flow is the amount of studied product needed to fulfil the function defined in the unit of analysis.” However, GHG Protocol regards that these are meant to be the same.

[SOURCE: ISO 14040:2006, 3.29]

3.25
secondary data
process data that are not from specific processes in the studied product’s life cycle.

[SOURCE: GHG Protocol Product Life Cycle Accounting & Reporting Standard: 2011]

3.26
uncertainty
parameter associated with the result of quantification which characterizes the dispersion of the values that could be reasonably attributed to the quantified amount

Note 1 to entry: Uncertainty information typically specifies quantitative estimates of the likely dispersion of values and a qualitative description of the likely causes of the dispersion.

[SOURCE: ISO 14064-1:2006, 2.37]

3.27
verification
systematic, independent and documented process for the assessment of a greenhouse gas assertion against agreed validation criteria.

[SOURCE: ISO 14064-1:2006, 2.35]

4 Principles

4.1 General

The following principles should be applied in the quantification, documentation and reporting of product GHG emissions of EE product’s under assessment.

4.2 Life Cycle Thinking (LCT)

In the development of methodology to quantify the GHG emissions throughout EE product’s life cycle, take all stages of the life cycle of a product into consideration.

4.3 Relevance

Select and use data, methods, criteria and assumptions that are appropriate to the assessment of GHG emissions and removals from the goal and scope definition being studied.

4.4 Completeness

Include all GHG emissions and removals that provide a significant contribution to the assessment of GHG emissions and removals arising from the goal and scope definition being studied.

4.5 Consistency

Apply assumptions, methods and data in the same way throughout the GHG emissions for EE product's life cycle to arrive at conclusions in accordance with the goal and scope definition.

4.6 Accuracy

Reduce bias and uncertainties as far as is practical.

4.7 Transparency

Address and document all relevant issues in an open, comprehensive and understandable presentation of information. Fully disclose any relevant assumptions and limitations and make appropriate references to the methodologies and data sources used. Clearly explain any estimates and avoid bias so that the GHG emissions throughout EE product's life cycle study report faithfully represent what it purports to represent.

NOTE The above principles (4.3 to 4.7) are adapted from ISO 14064-1:2006, Clause 3 with modification.

5 Comparative study on the existing relevant documents

Annex B summarizes the results of a comparative study on existing relevant documents including International Standards and regional and national initiatives which specify the methodology of CFP study and LCA, and which are referred to widely around the world.

A basic and generic methodology relevant to a CFP study is under development in ISO/DIS 14067. It specifies principles and requirements for studies to quantify Carbon Footprint of Products and GHG emissions assessments respectively, based on the methodology of life cycle assessment (LCA) as specified in ISO 14040 and ISO 14044. ISO/DIS 14067 also sets rules related to use of CFP study for different purposes and related communication.

GHG Protocol Product Life Cycle Accounting & Reporting Standard (hereinafter GHG Protocol Product Standard), which is a forum/industry standard, was developed in parallel with the GHG Protocol Corporate Value Chain (Scope 3) Accounting & Reporting Standard (hereinafter GHG Protocol Scope 3 Standard). The GHG Protocol Scope 3 Standard is written as a supplement to GHG Protocol Corporate Accounting & Reporting Standard. It accounts for value chain emissions at the corporate level, whereas the GHG Protocol Product Standard accounts for life cycle GHG emissions at the individual product level. The CFP study specified in the GHG Protocol Product Standard is for the most part based on the life cycle assessment methods specified in ISO 14044 and the communication requirements specified in the ISO 14020 series of standards.

Methodologies for environmental impact assessment specific to ICT sector are developed by ITU-T. Among them is ITU-T L.1410 which specifies methodologies for ICT goods, networks and services (GNS) and provides practical guidance for a CFP study in the sector. ITU-T L.1410 is composed of a framework and guidance for life cycle assessment based on the methodology specified in ISO 14040 and ISO 14044. It is organized in two parts, part 1 deals with the LCA methodology applied to ICT GNS and part 2 deals with comparative analysis based on LCA results of an ICT GNS product system and a referenced product system.

Annex B of this TR also presents compiled summaries of regional standards/initiatives such as EC Product Environmental Footprint and ETSI EE TS 103 199, national ones such as

PAS 2050 (UK), TS-Q 0010 (Japan) and Korean CFP guidance, etc., in addition to the standards and draft standards discussed above.

All the existing relevant documents and initiatives adopt a life cycle approach for calculating GHG emissions. Most of them base their calculation methodologies on ISO 14040 and ISO 14044, including ISO/DIS 14067 which was described above. ISO 14040 and ISO 14044 allow for LCA studies of GHG emissions and practitioners are encouraged to carefully consider the representativeness of results in the interpretation phase.

In a CFP study of a product, treatment of the comparative analysis between products needs attention. ISO 14040 and ISO 14044 are stringent regarding product comparisons. In contrast, CFP related assessments of GHG emissions according to ISO/DIS 14067 are often expected to deliver single values to be used as a basis for product comparisons. However, such values are only representative of the preconditions of the study and will provide limited information about the actual GHG emissions due to the complexities of many EE products, their value chains and uses. ISO/DIS 14067 acknowledges the need for CFP-PCRs to achieve comparability. This Technical Report can therefore not be used as a sole basis for product comparisons as comparable conditions could not be defined at a sector level with sufficient level of details.

6 Quantification framework

6.1 General

6.1.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding a CFP study:

A CFP study according to this International Standard shall include the four phases of LCA, i.e. goal and scope definition, LCI, LCIA and life cycle interpretation.

[Source: ISO/DIS 14067, 6.1]

The necessity of a sector specific approach applicable to EE products is recognized by considering the specific characteristics of EE products which could include a large quantity of components/materials in a product, dynamic, long and complicated supply chains, rapidly evolving technology, the complexity of production processes and use/end-of-life scenarios, etc., which can lead to considerable challenges in performing CFP.

The CFP consists of the GHG emissions and removals in the life cycle of a product (i.e. product system). The unit processes comprising the product system are grouped into life cycle stages; e.g., raw material acquisition, production, distribution, use and end-of-life. Accordingly the data of GHG emission and removals collected over the product’s life cycle are assigned to the life cycle stages. Partial CFP studies that account for only specific life cycle stages can be combined to form the full CFP covering the entire life cycle provided that they are performed according to the same methodology, and the time frame for relevant activities is viewed as equivalent.

To set specific GHGs to be calculated, this TR recommends considering relevance and international framework/studies. For example, 6 gases are recognized in the international framework (Kyoto Protocol): CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. For gases other than CO_2, the CO_2 equivalent (CO_2e) is obtained by multiplying each GHG emissions by the GWP of those gases.

In a CFP study, Life Cycle Inventory (LCI) is calculated through the specific processes outlined in this document.

At the Life Cycle Impact Assessment (LCIA) phase of a CFP study, this TR recommends use of the current 100-year GWP given by the Intergovernmental Panel on Climate Change (IPCC), which is used for quantification of each nation's emission under Kyoto Protocol, for calculating CO_2 equivalent.

It should be documented which version of IPCC Assessment Report was used for the CFP Study.

The GHGs to be taken into account should be reviewed periodically, with future international studies, etc. taken into due consideration. For example, all the gases (more than six, e.g. NF_3) specified in the latest IPCC Assessment Report may be selected for CFP study.

At the interpretation phase of a CFP study, this TR recommends consideration of uncertainty, identification of allocation method and documentation including their details.

6.1.2 Electrotechnical industry guidance for basic steps of CFP study

The goal of carrying out CFP study on EE products is to quantify the contribution of a product to global warming expressed in CO_2e by quantifying the GHG emissions and removals, over its life cycle. A workable and simple way to conduct CFP study for EE products based on the analysis of CFP and LCA standards and initiatives is summarized into the following nine steps.

- Step 1 - Defining the goal and scope (See 6.2 "Goal and scope definition" for details)
- Step 2 - Defining the unit of analysis (See 6.3 "Unit of analysis" for details)
- Step 3 - Setting the system boundary (See 6.4 "System boundary" for details)
  a) Defining the life cycle stage (See 6.4.1)
  b) Developing a process map (See 6.4.1 and 6.4.2)
  c) Describing the time boundary (See 6.4.3)
  d) Considering specific GHG sources and sinks (See 6.4.4)
  e) Defining the options to develop cut-off criteria (See 6.4.5)
- Step 4 – Trial estimation and decision on boundary to be cut-off (See 6.5 "Trial estimation and decision on boundary to be cut-off" for details)
- Step 5 – Data collection and quality assessment (See 6.6 "Data collection and quality assessment" for details)
- Step 6 – Calculating GHG emissions (See 6.7 "Calculating GHG emissions")
- Step 7 – Assessing uncertainty (See 6.8 "Uncertainty")
- Step 8 – Documentation (See 8 "Documentation")
- Step 9 – Communication and verification (See 9 "Communication and verification")

NOTE Figure 1 refers these 9 steps to the widely adopted phases of an LCA study as outlined in ISO 14040 and ISO 14044.

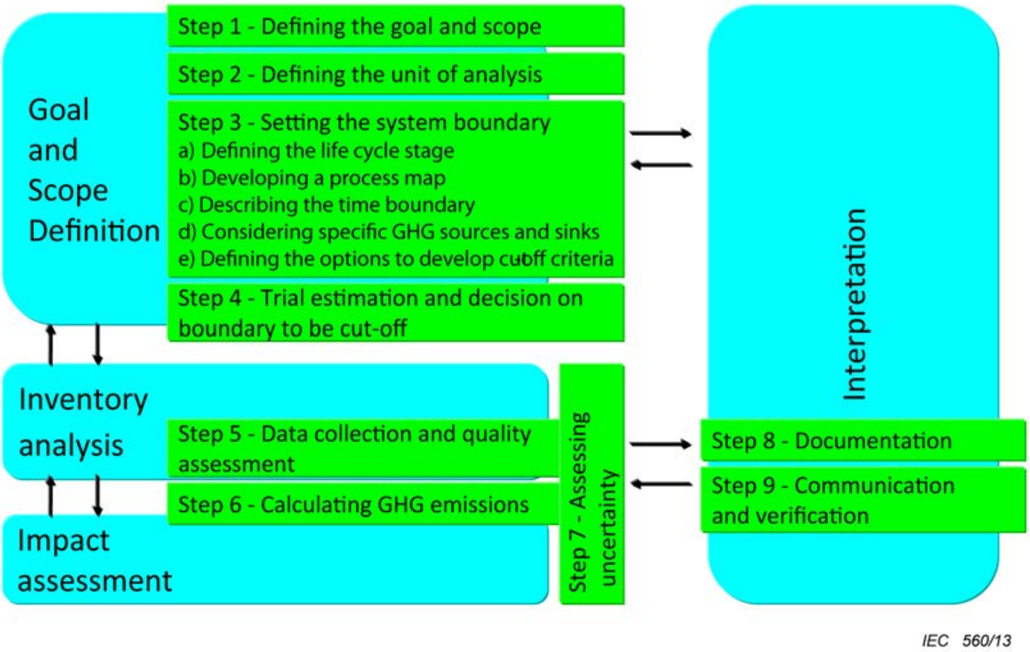


Figure 1 – Basic steps of CFP study related to LCA framework

6.2 Goal and scope definition

6.2.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding "defining the goal of a CFP study":

> *In defining the goal of a CFP study, the following items shall be unambiguously stated:*
>
> – the intended application;
>
> – the reasons for carrying out the study;
>
> – the intended audience, i.e. to whom the results of the study are intended to be communicated.
>
> NOTE Adapted from ISO 14044:2006, 4.2.2.
>
> *[Source: Summary of ISO/DIS 14067]*

6.2.2 Electrotechnical industry guidance

In accordance with ISO 14040 provisions for an LCA, ISO/DIS 14067, on CFP study for EE products identifies the considerations described below. In addition, provisions in the GHG Protocol Product Standard identify important considerations regarding the choice of the studied product.

Examples of the goal of the study may include but are not limited to:

- Illustrate performance of the product in terms of GHG emissions for decision making;
- Provide CFP results to the customer upon request;
- Include CFP results into the product declaration on the web page disclosed to the public.

When determining which product to study, the organization should take the key relevant considerations into account, for example:

- Design or progress of technology;
- Product function and characteristics;
- User, use/service conditions and site infrastructure;
- Normal duration of use/service time;
- Consumables, other supportive products and maintenance requirements;
- Scheme of end of life.

Grouping of a product series or product family where the impact of GHG emissions can reasonably be expected to be similar, based on similar function or technology, can be recognized as one product category. In that case, a CFP study can be implemented for the group of product series as one product category.

6.3 Unit of analysis

6.3.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “functional unit” and “product unit”:

> *6.2.3 Functional unit*
>
> *A CFP study shall clearly specify the functions of the product system being studied. The functional unit shall be consistent with the goal and scope of the CFP study. […] Therefore the functional unit shall be clearly defined and measurable.*
>
> *When PCR or CFP-PCR are adopted, the functional unit used shall be that defined in the PCR or the CFP PCR and be consistent with the goal and scope.*
>
> *Having chosen the functional unit, the reference flow shall be defined. Comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit(s) in the form of their reference flows. If additional functions of any of the systems are not taken into account in the comparison of functional units, then these omissions shall be explained and documented.*
>
> *As an alternative, systems associated with the delivery of these functions may be added to the boundary of the other system to make the systems more comparable. In these cases, the processes selected shall be explained and documented.*
>
> *[…]*
>
> *Results of the quantification of the CFP shall be documented in the CFP study report in mass of CO_2e per functional unit.*
>
> *[…]*
>
> *When CFP-PCR are adopted, the functional unit used shall be that defined in the CFP-PCR and be consistent with the goal and scope of the CFP study.*
>
> *[Source: ISO/DIS 14067]*

For all final products, companies shall define the unit of analysis as a functional unit.

[…]

For intermediate products where the eventual function is unknown, companies shall define the unit of analysis as the reference flow.

[Source: GHG Protocol Product Standard:2011]

6.2.4 Product unit

Exceptionally, a CFP may be reported on a self-selected product unit basis, e.g. one item of product, provided that a functional unit is also presented and the relationship of the functional unit to the product unit is documented and explained.

[Source: ISO/DIS 14067]

6.3.2 Electrotechnical industry guidance

Provisions in ISO/DIS 14067 require clearly specifying the functions of the product system being studied. Reporting a CFP on a self-selected product unit basis is accepted provided that a functional unit is also presented and the relationship of the functional unit to the product unit is documented and explained.

On the other hand, provisions in the GHG Protocol Product Standard indicate that the unit of analysis is defined as a functional unit for all final products. The unit of analysis is defined as the reference flow for intermediate products where the eventual function is unknown.

It is to be noted that the GHG Protocol Product Standard further clarifies the definition in ISO 14040, and that the meaning is the same and interchangeable.

In case of EE products, the functional unit of a final or intermediate product can be too complicated to simply identify. For example, a highly customised TV set can have a number of various functional units that cannot be uniformly defined. This TR regards such a case of EE products as one of the exceptions under which ISO/DIS 14067 allows reporting a CFP on a product unit basis.

Based on the analyses above, this TR suggests the following:

Functional unit is easily applicable to a product whose function can be uniformly identified.

Examples of defining functional unit and reference flow

The following functional units may be applied

- Performance index (indicator) with the function of a product;
  - Rated value (volume, weight, size, processing speed, memory capacity, hard disc capacity, etc.);
- Condition of the utility duration
  - Normal duration of use/service time (per hour, day), and lifetime.

Example – transformer

- The functional unit of the product system can be defined as “to transform the electricity supply voltage from X to Y for Z applications with a rated capacity (XXX kVA) in 30-year-lifetime” determined as the specification of a transformer.

NOTE 1 For some products, such as switchgear or transformers, a specification applicable to the functional unit can be defined by reference to the related IEC TCs or product standards.

"Product unit" is applicable to many EE products that perform multiple or complex functions, whether it is a final product or an intermediate product (e.g. one laptop computer, one LED luminaire, one functional semiconductor device, etc.).

Example – multifunctional TV set

- A unit of multifunctional TV set having different functions such as recording, internet access, etc.

In a CFP study on a "product unit" basis, identifying the “utility duration (lifetime)” is a necessary item for the interpretation of the results of the study. Therefore, this TR recommends documenting lifetime when presenting CFP results on this basis. (See 6.9 Use and maintenance scenario.)

6.4 System boundary

6.4.1 General

6.4.1.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “system boundary”:

6.2.5 System boundary

6.2.5.1 General

The system boundary determines which unit processes shall be included within the CFP study.

Where PCR or CFP-PCR are used (see 6.1), their provisions on the processes to be included shall apply.

The selection of the system boundary shall be consistent with the goal of the study. The criteria used in establishing the system boundary shall be identified and explained.

Decisions shall be made regarding which unit processes to include in the study and the level of detail to which these unit processes shall be studied. [...] Any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated, and the reasons and implications for their omission shall be explained. The threshold for significance shall be stated and justified.

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

[...]

The CFP and the partial CFP shall not include offsetting.

[Source: ISO/DIS 14067]

The boundary of the product GHG inventory shall include all attributable processes.

An inventory consists of service, material, and energy flows that become the product, make the product, and carry the product through its life cycle. These are defined as attributable processes. Examples include the studied product's components and packaging, processes that create the product, materials used to improve its quality (e.g., fertilizers and lubricants), and energy used to move, create, or store the product.

[Source: GHG Protocol Product Standard:2011]

6.4.1.2 Electrotechnical industry guidance

The system boundary defines the unit processes from the life cycle of the studied EE product that are to be assessed in terms of data collection and calculation of GHG emissions and removals.

Setting the system boundary should be consistent with the goal of the study. This TR recommends following "6.2 Goal and scope definition" for items to be considered when defining the goal and scope.

Examples of aspects when setting the system boundary

The following items are examples of aspects which may be useful to consider when setting the system boundary and are used as a checklist to help capture all activities associated with the life cycle impact of the assessed product system. The applicability of these aspects should be considered for each life cycle stage outlined in 6.4.1. However, some of the aspects may be more relevant to certain electrotechnical products and systems than to others.

These items are considered as useful for system boundary setting, but it is not required to structure data or reporting based on these categories (e.g. many studies prefer to structure the reported emissions based on life cycle stages).

- Hardware

  This item refers to the life cycle impact of EE product hardware, (e.g. printed circuit boards and mechanical parts) the use of materials and the energy consumption should be considered at each life cycle stage.

- Software

  This item refers to the life cycle impact (including design, development and use) of EE product software (e.g. individual software, packages, middleware and operating systems). Examples of software impact are the use of electricity and paper by the designers.

  In practice it may be preferred not to distinguish between Hardware and Software when assessing the use stage.

- Consumables, peripherals and other support products

  This item refers to life cycle impact of consumables and other peripheral products that may be needed or provided for the utilization of the EE products. These include for instance, information media (e.g., CDs and DVDs) and printer cartridges and may also include cooling and power supply equipment and information printouts (e.g. instruction manuals).

- Packing/Shipping materials

  This item refers to life cycle impact of packing or shipping materials needed for the transport of the EE products.

  All packing materials (primary, secondary, and tertiary) including retail packaging for end consumers should be considered.

- Storage of goods

This item refers to storage of EE products such as finished systems, components, materials etc., in an applicable storage place. This implies in particular that the energy consumption for cooling and lighting should be considered.

- Transport (movement of goods)

  This item refers to the impact from transportation related to the life cycle of EE products such as finished systems, components, materials, etc. This also includes use of fuels as well as fuel supply chains of cars, trains, buses, etc.

  The fuel supply chain should be considered, in contrast embedded emissions for vehicles are considered as non-attributional. Transport is a is a reoccurring activity which forms part all life cycle stages described in 6.4.1, i.e. the distribution of a product is not the only transport of relevance.

The intention of identifying the items above is to ensure that all relevant impacts are considered for each life cycle stage when defining the goal and scope and setting the system boundaries of a product system

6.4.2 Life cycle stage and process map

6.4.2.1 Defining life cycle stages

6.4.2.1.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “life cycle stage”:

> *A CFP study assesses the GHG emissions and removals in the life cycle of a product. The unit processes comprising the product system shall be grouped into life cycle stages; e.g., raw material acquisition, production, distribution, use and end-of-life. GHG emissions and removals from the product’s life cycle shall 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.*
>
> *[…]*
>
> *Where relevant PCR or CFP-PCR exist, they shall be adopted. […]*
>
> *[Source: ISO/DIS 14067.3]*

> *Companies shall report the life cycle stage definitions and descriptions.*
>
> *Interconnected stages make up a product’s life cycle, and these are a useful way to organize processes, data collection, and inventory results.*
>
> *[…]*
>
> *[Source: GHG Protocol Product Standard:2011]*

6.4.2.1.2 Electrotechnical industry guidance

This TR recommends that the life cycle be defined by considering the following typical stages, since they are applicable to most of the EE products.

- Raw material acquisition;
- Production and assembling of components;
- Distribution (including warehousing, retail and installation);

- Use and maintenance;
- End-of-life (recycling and disposal).

NOTE 1 These stages are relevant to the quantification and the identical stages are not necessarily relevant to communication.

The following guidance provides examples of life cycle stage boundaries, description, and attributable processes:

- Raw material acquisition

This includes extraction of materials from minerals, extraction of fossil fuels, conversion of fossil fuels, etc., to petrochemicals and plastics, etc. This is likely to involve both direct and indirect energy usage.

- Production and assembling of components

Given the complexity of some components within modern electronic devices, production of components could be quite substantial in terms of both direct and indirect emissions.

The primary drivers of impact within production and assembly will vary as function of the focal system/product under study (and as technology shifts). With this in mind, however, previous work within several industry collaborations for EE products have consistently quantified the following components as having low overall impact within a larger device/product: solder, individual plastic components (beyond the casing material), resistors, diodes, and switches. These items, therefore, do not typically require detailed focus or detailed data collection when a larger device that contains such components is being investigated. Sudden changes in manufacturing impact could shift this focus.

For electronic on a printed circuit board equipped with components, it is often deemed that the amount of GHG emissions from production of an individual electronic component has only a minor contribution to the overall evaluation, at a level where variations in the calculation results can be ignored. The GHG emissions may be calculated for the single item of 'populated circuit boards/electronic parts'.

Exceptional cases include some complex electronic parts with high partial CFP contributions that will be significant in low power applications.

NOTE 2 In trial estimation and decision on the boundary cut-off, this TR encourages performing an initial estimation of the contribution of specific electronic parts to determine whether the contributions are significant. (See 6.5)

- Distribution (including warehousing, retail and installation)

Based on the feature of EE products, it is necessary to specify distribution (retail) scenario. This may be based on the average approach to distribution (retail) over the regions where the product is put into the market.

For distribution stage, this TR recommends considering GHG emissions associated with transportation. Basically, the amount of GHG emissions should be calculated in accordance with the transportation method (such as airplanes, ships, vehicles, etc.).

NOTE 3 The elements that are involved in distribution may include warehouse electricity use, materials used in warehousing such as pallets. Especially for final products, considering the impact of the activities associated with the facility where the product is sold and may enhance the completeness of the CFP study.

- Use and maintenance

If the CFP study results are intended to be compared, a set of standardised profile (scenario) and values should be used, e.g., the amount of carbon emitted to produce a kWh of electricity.

Based on the feature of EE products, it is of great importance to specify the use scenario (see 6.9).

The maintenance phase may have significant impact on GHG emissions of EE products and should be considered. However, for some categories of EE products, there can be significant data gaps in the maintenance scenario.

As stated in 6.4.1, operation and maintenance activities may make a significant contribution to the life cycle GHG emissions of an EE product and should therefore be considered in a CFP study. Maintenance usually includes attributable processes, such as energy using processes (e.g. transport), chemical materials using processes. Maintenance, however, may also include processes such as human activities in a call centre which are common in the area of ICT services, or, the use of buildings. Non-attributable processes can be excluded from the “maintenance” life stage if they are insignificant (see 6.4.2).

- End-of-life (reuse, recycling and disposal)

EE products have to comply with the relevant legal and regulatory requirements of each country associated with their end-of-life.

If the product can be recycled and reused as a material, etc., the amount of material or energy recovered and dissipated in the recycling process may also be taken into consideration and included in the calculation.

For refrigerants and other materials such as isolation materials containing blowing agents, the amount of GHG emissions should be calculated after taking collection into account (6.10)

This TR recommends when calculating the amount of GHG emissions to include the transportation of used products at end-of-life stage.

Many EE products influence energy usage of other products, which are not included in their system boundaries. For example, Variable Frequency Drives (VFDs) significantly reduce the amount of energy a motor uses in an industrial facility.

6.4.2.2 Selecting life cycle stages

6.4.2.2.1 Provisions in CFP and LCA standards

For selecting life cycle stages inside the system boundary, this TR identifies two typical options:

- Whole life cycle, i.e. cradle-to-grave;
- Partial life cycle, e.g. cradle-to-gate or gate-to-gate.

The setting of the system boundary can be different depending on the intended use of the CFP study. Where the assessment of the CFP is intended to be communicated to consumers, the quantification of the CFP shall comprise all stages of the life cycle, if not otherwise specified in 9.6.2.

For “supply chain business-to-business” use, except for a partial CFP representing gate-to-gate, a partial CFP shall as a minimum, represent the cradle-to-gate GHG emissions and removals arising from all stages, processes/modules up to the point where the product leaves the production site (the ‘gate’). Any gate-to-gate partial CFP shall be justified.

For internal applications (e.g. internal business use, supply chain optimisation or design support), a partial CFP may be based on GHG emissions and removals arising from a restricted number of stages within the life cycle of the product. […]

[Source: ISO/DIS 14067]

The boundary for final products shall include the cradle-to-grave removals and emissions *from material acquisition through to end-of-life.*

For intermediate products, if the function of the corresponding final product is known, companies should complete a cradle-to-grave inventory.

[…]

The boundary of cradle-to-gate partial life cycle inventory shall not include product use or end-of-life processes in the inventory results. Companies shall disclose and justify when a cradle-to-gate is defined in the inventory report.

[Source: GHG Protocol Product Standard:2011]

6.4.2.2.2 Electrotechnical industry guidance

In EE products, the whole life cycle (cradle-to-grave) should be studied for a final product. On the other hand, an intermediate product may be studied on its partial life cycle (cradle-to-gate). For example:

The whole life cycle (cradle-to-grave) is applicable to final products, e.g. a household refrigerator, etc.

The partial life cycle (cradle-to-gate) is applicable to intermediate products, e.g. a transformer, etc. Downstream customers may better understand the full life-cycle impacts of intermediate products, especially as energy consumed in the use phase of EE often predominates the lifecycle GHG footprint calculation.

NOTE 1 When selecting the partial life cycle, the GHG Protocol does not allow including the use-stage or end-of-life stage in the partial CFP.

Even in the case of an intermediate product, the customer can request GHG emission from end-of-life processes for the product from the viewpoint of recyclability. Such data should be separately reported and not included in the CFP result based on the partial life cycle.

The organisation manufacturing an intermediate product may work with its customers to assess the cradle-to-grave life cycle based on the contribution of its intermediate product(s) to the use and end of life phases, in order to better understand the CFP associated with its product and to help focus its own environmentally conscious design efforts.

6.4.2.3 Drawing a process map

6.4.2.3.1 Provisions in CFP and LCA standards

A process map illustrates the services, materials, and energy needed by a product throughout its life cycle. CFP and LCA standards provide the following requirements regarding “process map”:

6.3.4 Relating data to unit process and functional unit

An appropriate flow shall be determined for each unit process. The quantitative input and output data of the unit process shall 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 shall relate system input and output data to the functional unit.

Care should be taken when aggregating the inputs and outputs in the product system. The level of aggregation shall be consistent with the goal of the CFP study. […]

[Source: ISO/DIS 14067]

Companies shall report attributable processes in the form of a process map.

[Source: GHG Protocol Product Standard:2011]

6.4.2.3.2 Electrotechnical industry guidance

This TR recommends that the following be considered when developing a process map and identifying the processes for which to collect primary data:

- Include in the process map only attributable processes by each life cycle stage that was defined.
- Then, identify the processes under the organisations' ownership or control.

NOTE An organization owns or controls a process if it is under its operational or financial control. Existing relevant documents define two types of control: financial control and operational control. For further information, see: ISO 14064-1; GHG Protocol Corporate Value Chain (Scope 3) Standard; etc.

In the development of process maps, this TR recommends taking the following into consideration:

- Identify component inputs and upstream processes;
- Identify directly connected energy and material flows;
- Identify downstream processes and energy/material flows;
- Relate each process to the respective life cycle stage;
- Relate inputs and outputs to the respective process;
- Illustrate the attributable processes and their inputs and outputs, locating processes with respect to each life cycle stage so that their mutual relationship can be clearly identified

In developing data, information on the flow of mass of components and materials is helpful. Therefore, it is recommended to develop a "material flow" showing inputs and outputs in mass.

This TR recommends describing a reference flow, by utilising a bill of material (BOM). A bill of material (BOM) shows the components, materials, and sub-assemblies used in the product and are available in most cases of EE products. When a BOM is available, it may be the easiest index to direct the determination of the attributable processes relevant to the product. This TR recommends identifying the components and materials used in manufacturing, and surveying the mass of each component or material.

Table 1 – An example of BOM

Process	Parts	Material	Number	Weight	
				Kg/number	Kg/unit
Process A	WWWW	Steel (plated sheet steel)	1		
	XXXXXX	Stainless steel	1		
	YYYYYY	Stainless steel	2		
	ZZZZZZ	Copper	1		
Process B	WWWW	Aluminum	1		
	XXXXXX	Aluminum	1		
	YYYYYY	Stainless steel	1		
	ZZZZZZ	Other metals	2		
Process C	WWWW	Stainless steel	1		
	XXXXXX	PP	1		
	YYYYYY	ABS	1		
	ZZZZZZ	ABS	2		
Process D	WWWW	Glass	1		
	XXXXXX	Other material	1		
	YYYYYY	Circuit boards/ electronic parts	1		
Process ...		...	...	...	...
Total weight per one unit of product X.					

6.4.3 Attributional and consequential approaches

6.4.3.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding "attributional approach":

> *A GHG product inventory shall follow the life cycle and attributional approaches.*
>
> *[…]*
>
> *The requirements and guidance in this standard follow the attributional approach to life cycle accounting.*
>
> *The attributional approach is defined as a method in which GHG emissions and removals are attributed to the unit of analysis of the studied product by linking together attributable processes along its life cycle.*
>
> *[…]*
>
> *[Source: GHG Protocol Product Standard:2011]*

CFP and LCA standards describe "non-attributable processes" as follows:

Some service, material, and energy flows are not directly connected to the studied product during its lifecycle because they do not become the product, make the product, or directly carry the product through its life cycle. These are defined as non-attributable processes.

Examples include service, material, and energy flows due to:

- Capital goods (e.g., machinery, trucks, infrastructure)

- Overhead operations (e.g., facility lighting, air conditioning)

- Corporate activities and services (e.g., research and development, administrative functions, company sales and marketing)

-Transport of the product user to the retail location

-Transport of employees to and from works

[…]

Companies are not required to include non-attributable processes. However, if non-attributable processes are included in the boundary, companies shall disclose this in the inventory report.

[Source: GHG Protocol Product Standard:2011]

CFP and LCA standards describe a "consequential approach" as follows:

The consequential approach is defined as an approach in which processes are included in the life cycle boundary to the extent that they are expected to change as a consequence of a change in demand for the unit of analysis.

The consequential approach makes use of data that is not constrained and can respond to changes in demand (e.g., marginal technology information), where change in demand can occur as a result of changes in production volumes, production technologies, public policies, and consumer behaviors. Although not followed in this standard, the consequential approach can provide valuable insight in certain applications such as evaluating reduction projects or making public policy decisions.

[Source: GHG Protocol Product Standard:2011]

6.4.3.2 Electrotechnical industry guidance

Except for special cases the attributional approach is sufficient for the CFP study of EE products.

When it is not enough to just follow the attributional approach to the CFP study for EE products, the study may include non-attributable processes in the boundary, or take another approach, e.g. a "consequential approach" into consideration (see 3.17).

6.4.4 Time boundary

6.4.4.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding "time boundary":

6.2.7 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 shall be specified and justified. Where the GHG emissions and removals associated with specific unit processes within the life cycle of a product vary over time, data shall be collected over a period of time appropriate to establish the average GHG emissions and removals associated with the life cycle of the product.

If the production of a product is linked to a specific time period[...], the assessment of GHG emissions and removals shall cover that particular period in the life cycle of the product. Any activities occurring outside that period shall also be included provided that they are associated with the production of the product [...]. These data on GHG emissions and removals shall be properly linked to the functional unit.

[Source: ISO/DIS 14067]

Companies shall report the time period of the inventory.

The time period of the inventory is the amount of time a studied product takes to complete its life cycle, from when materials are extracted from nature until they are returned to nature at the end-of-life (e.g., incinerated) or leave the studied product's life cycle (e.g., recycled).

[Source: GHG Protocol Product Life Cycle Accounting & Reporting Standard]

6.4.4.2 Electrotechnical industry guidance

When setting the system boundary, it is necessary to also describe the time boundary for data or the time period for which the CFP study is relevant.

The time boundary for a CFP study is usually determined by summing up the production period from cradle-to-gate, the use stage period based on the design specification and actual experience, and an estimated end-of-life treatment period.

Within the time boundary the fraction for each life cycle stage should also be documented separately and transparently, especially when a product's life cycle extends over many years.

Time boundaries are very important for comparison purposes and should be considered in the development of product category rules.

6.4.5 Specific GHG sources and sinks

6.4.5.1 Provisions in CFP and LCA standards

Both ISO/DIS 14067 and GHG Protocol Product Standard pay special attention to the following items:

- Biogenic Carbon
- Land Use Change (LUC)
- Soil Carbon Change
- Carbon Storage of products
- Carbon Capture and Storage (CCS)

- Electricity

6.4.5.2 Electrotechnical industry guidance

Consideration of the above listed GHG sources and sinks is generally not needed for EE products with some exceptions:

Biogenic carbon should be considered if e.g. bio-plastics originating from plants are used in EE products. When bio-plastic is used in the EE product, GHG emissions which are emitted upon combustion of bio-plastic in the disposal/recycling stages, and GHG removals during its origin, i.e. plant growing, should be documented separately from fossil carbon source when applicable.

GHG emissions from direct and indirect land use changes (dLUC and iLUC) should be considered if e.g. bio-polymers or bio-fuels are used, significant green field investment is carried out, etc.

Carbon storage of products should be considered if e.g. a product uses wood and it will be landfilled. In such case, carbon storage of products may be calculated and documented separately.

For soil carbon change no example has been identified for this TR.

Carbon capture and storage (CCS) should be considered e.g. if GHG is not emitted within lifecycle of power plant because they are sequestrated in the carbon storage for more than hundreds of years. Even in such a case, CCS contribution should be documented additionally and separately.

For electricity, ISO/DIS 14067 recommendation is of special importance for EE products and should be applied. Deviation is only acceptable under the condition that enough transparency is provided. When acquiring a “green certificate” without using grid electricity, justification is necessary for avoiding double-counting.

NOTE For further information on consideration of electricity, see ISO/DIS 14067, 6.3.9.3.

6.4.6 Cut-off criteria

6.4.6.1 Provisions in CFP and LCA standards

CFP and LCA standards describe “cut-off criteria” as follows:

> *4.2.3.3.3 The cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly described. The effect on the outcome of the study of the cut-off criteria selected shall also be assessed and described in the final report.*
>
> *Several cut-off criteria are used in LCA practice to decide which inputs are to be included in the assessment, such as mass, energy and environmental significance. Making the initial identification of inputs based on mass contribution alone may result in important inputs being omitted from the study. Accordingly, energy and environmental significance should also be used as cut-off criteria in this process.*
>
> *[…]*
>
> *Similar cut-off criteria may also be used to identify which outputs should be traced to the environment, e.g. by including final waste treatment processes. Where the study is intended to be used in comparative assertions intended to be disclosed to the public, the final sensitivity analysis of the inputs and outputs data shall include the mass, energy and environmental significance criteria so that all inputs that cumulatively contribute more than a*

defined amount (e.g. percentage) to the total are included in the study.

[...]

cut-off criteria for initial inclusion of inputs and output, including

i) description of cut-off criteria and assumptions,

ii) effect of selection on results,

iii) inclusion of mass, energy and environmental cut-off criteria

[Source: ISO 14044:2006]

Consistent cut-off criteria that allow the omission of certain processes of minor importance shall be defined within the goal and scope definition phase. The effect of the selected cut-off criteria on the outcome of the study shall also be assessed and described in the CFP study report.

[Source: ISO/DIS 14067]

To determine insignificance, a company should estimate the process's emissions using data with upper limit assumptions to determine whether, in the most conservative case, the process is insignificant based on either mass, energy, or volume, as well as GHG relevance criteria.

To determine whether an estimate is insignificant or not, a company needs to establish a definition of insignificance which may include a rule of thumb threshold. For example,

a rule of thumb for insignificance may be material or energy flows that contribute less than one percent of the mass, energy, or volume and estimated GHG significance

over a process, life cycle stage, or total inventory.

[Source: GHG Protocol Product Standard:2011]

6.4.6.2 Electrotechnical industry guidance

Cut-off criteria should be defined and applied depending on the study's goal and scope definition and boundary setting. When CFP-PCR is adopted, the cut-off criteria used should be that defined in the CFP-PCR.

Where the goal and scope of a CFP study is intended for a comparative analysis of the current product and its former models, the identical cut-off criteria should be applied to both.

In the existing documents/initiatives including the ones identified above, cut-off criteria are usually composed of one or more elements.

Examples of cut-off criteria elements

- Qualitative constraint, e.g.
  - All printed circuit boards cannot be excluded.

- Quantitative threshold
  - Quantitative threshold for outputs, e.g.

    Less than 5 % of the total estimated emission can be excluded.
  - Quantitative threshold for inputs, e.g.

    Less than 5 % of the total mass or amount input to the process map can be excluded.

Any combination of the above may be used to define appropriate cut-off criteria.

Examples – Cut-off criteria applicable to CFP study of EE products

Criteria in the Korean PCF scheme are based on the mass of materials in general (cut-off by weight), but also require identification of selected significant materials and components that are not to be cut off;

Criteria in the Japanese JIS TS Q 0010 are based on LCA analysis. Those parts and materials whose emission is properly assumed to be less than a certain standard level can be omitted from the calculation;

In the PAIA pilot project, by attempting to comprehensively include activities there is a cut-off approach which avoids the need for a quantitative threshold. A rough estimate for all activities including a high level of uncertainty is made, followed by determination of a priority list for data gathering. More detail on this approach is provided in the trial estimation approach, see 6.5 below;

In the ITU-T L 1410, cut-off criteria is considering mass, energy and environmental significance. Environmental significance refers to contribution of for instance GHG emissions.

NOTE For details of the Korean PCF scheme, TS Q 0010 and the PAIA, see Annex B.

6.5 Trial estimation and decision on boundary to be cut-off

6.5.1 Electrotechnical industry guidance

Use of trial estimation informs the appropriate cut-off criteria in view of the workability and availability of the process data. In order to check the appropriateness, the organization may need an estimate of the total life cycle emissions. The trial provides an approximation of this value and whether the cut-off can be applied based on it. If the data remaining (not cut-off) are practically difficult to obtain, it means the cut-off criteria is not appropriate and to be changed. Before beginning data collection, this TR recommends to:

Check the availability of data and feasibility of data collection.

This TR recommends collecting available data e.g. primary data, secondary data, proxy data by each reference flow. Then, identify which data are feasible to collect.

Estimate GHG emissions.

For trial estimation and decision-making related to the cut-off boundary, this TR encourages performing an initial estimation of the relative contribution of specific electronic parts to determine whether the contributions are significant.

Define the cut-off criteria and identify the unit processes or product system to be cut-off.

This TR recommends completing this iteration before proceeding with data collection, which could be excessively costly and time consuming if it is conducted with inappropriate cut-off criteria.

Example of trial estimation approach

A high level statistical analysis using simulations is performed to determine the lifecycle activities that are the biggest contributors to impact and uncertainty.

Targeted data collection is then performed, based on this analysis, to confirm impacts and further reduce uncertainty to desired levels.

NOTE Annex D provides additional information.

6.6 Data collection and quality assessment

6.6.1 General

6.6.1.1 Provisions in CFP and LCA standards

Many of the CFP and LCA standards and initiatives provide requirements regarding collection of site-specific data or primary data. However, the definition of such terms varies.

3.7.1

primary data

quantified value of a unit process (3.4.6) or an activity within the product system (3.4.2) obtained from a direct measurement or a calculation based on direct measurements at its original source

Note 1 to entry: Primary data need not necessarily originate from the product system (3.4.2) under study.

Note 2 to entry: Primary data may include GHG emission factors (3.3.7) and/or GHG activity data (ISO 14050:2009, 9.3.3).

3.7.2

site-specific data

data obtained from a direct measurement or a calculation based on direct measurement at its original source within the product system (3.4.2)

Note 1 to entry: All site-specific data are "primary data" (3.7.1) but not all primary data are site-specific data because they may also relate to a different product system (3.4.2).

3.7.3

secondary data

data obtained from sources other than a direct measurement or a calculation based on direct measurements at the original source within the product system (3.4.2)

Note 1 to entry: Such sources can include databases, published literature, national inventories and other generic sources.

[Source: ISO/DIS 14067]

6.2.6 Data and data quality

Site-specific data shall be collected for all individual processes under the financial or operational control of the organization undertaking the CFP study, and shall be representative of the processes for which they are collected. Site-specific data should be used for those unit processes that contribute considerably to the CFP, as determined in the sensitivity analysis. Site-specific data includes both, GHG emissions and GHG sources as well as GHG removals and GHG sinks contributing to:

- data from one specific unit process within a site;

[…]

- site-average data, i.e. representative averages of site-specific data collected from organizations within the product system which operate equivalent processes.

[…]

Secondary data shall only be used for inputs where the collection of site-specific data is not possible or practicable, or for processes of minor importance and may include literature data, calculated data, estimates or other representative data. Secondary data shall be documented.

[Source: ISO/DIS 14067]

primary data

data collected from specific processes in the studied product's life cycle

secondary data

Process data that are not from specific processes in the studied product's life cycle.

[Source: GHG Protocol Product standard: 2011]

Companies shall collect primary data for all processes under their ownership or control.

[Source: GHG Protocol Product Standard:2011]

6.7 Specific data collection

[…]

REQUIREMENT: Specific data (including average data representing multiple sites whether internally or provided by a supplier) must be obtained for all significant/relevant foreground processes and for significant background processes where possible.

[…]

6.8 Generic data collection

[…]

REQUIREMENT: Generic data shall be used only if data for a specific process are unavailable, not environmentally significant, or refer to a process outside of the defined system boundary. Generic data shall, as far as possible, fulfil the data quality requirements specified in this guidance document. Subject to data quality requirements, generic data should be preferentially sourced according to the specified hierarchy.

[Source: European Commission DG Environment & Joint Research Centre, Product Environmental Footprint Guide, 2nd Draft]

6.6.1.2 Electrotechnical industry guidance

This TR basically follows the direction provided by the GHG Protocol to collect “primary data”. ISO/DIS 14067 identifies the collection of “site-specific data”.

According to ISO/DIS 14067 all site-specific data are “primary data” but not all primary data are site-specific data. ISO/DIS 14067 gives no guidance on addressing primary data which are not site-specific data. Therefore, ISO/DIS 14067 is difficult to apply.

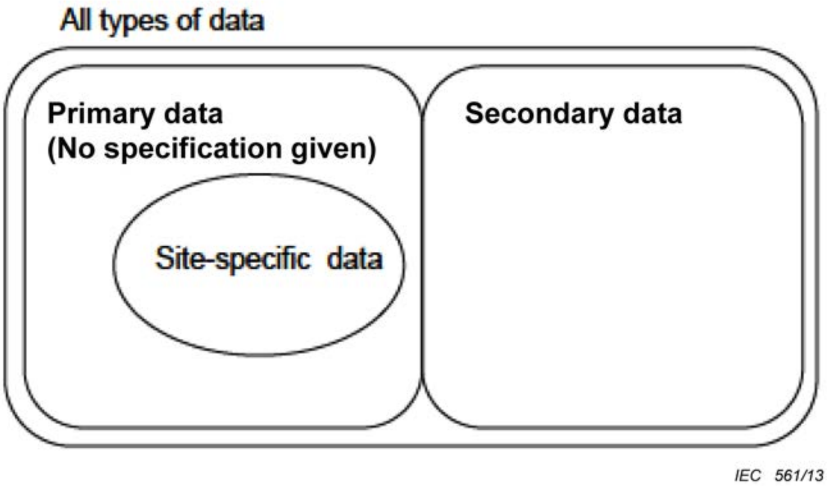


Figure 2 – Analysis of relationship of three types of data according to ISO/DIS 14067

NOTE 1 For many EE products a comprehensive set of primary data may be virtually impossible to collect. This perspective is acknowledged by the GHG Protocol.

NOTE 2 For many ICT sub-sectors, detailed recommendations on data quality requirements based on representative sub-sector specific data, are provided in applicable standards (ITU-T, ETSI).

Data collection is needed for the unit processes and items identified during the system boundary definition.

For data collection, this TR recommends the following:

- Collect primary data for all the processes under the organisation’s ownership or control.

Example of primary data

Reference flow of the studied product (e.g., mass of finished product) may be used as primary data to be multiplied by emission factors when the yield ratio of the EE product is high.

- Collect secondary data for the other processes, if their data quality is satisfactory.

Example of secondary data

The life cycle databases (public database) currently available in a number of countries may be used as secondary data if the data is relevant for the study (See Annex A).

The GHG Protocol indicates that “using the reference flow of the studied product (e.g., mass of finished product) as process activity data is not considered primary data.” Rather, each input to the process is contrasted to output (reference flow), while taking into account the yield of the process. As is the case of the assembly process of EE products, reference flow may be used as primary data when the yield is sufficiently high. The use of reference flow should be assessed in terms of uncertainty.

6.6.2 Primary data

6.6.2.1 Electrotechnical industry guidance

Primary data for all the processes under an organisation’s ownership or control should be collected. This process may be challenging for some small and medium enterprises (SMEs), or other organizations when there is a lack of dedicated research units and resources.

NOTE 1 Site-average data may be available, and may offer a viable alternative to the collection of data from one specific unit process at a site.

If a design change from the similar past product should be slight, it is likely that a calculation almost free from an error may be made in some cases based on the past product data. It is also possible to envisage those mechanisms which allow for a tentative calculation based on the data available in prototype/design stages, and for a reassessment in a certain time, based on the primary data accumulated after a certain period.

Organizations will often not be able to collect sufficient primary data immediately after placing a new product or an improved product on the market, or while repetitively remodelling a product in a short period of time.

On the other hand, this TR encourages communicating with suppliers on possible supply-chain cooperation for obtaining primary data even if the suppliers are not under an organisation’s ownership or control. One common approach for an organization dealing with supplier data for the purposes of CFP studies would include the following:

- Identification of a bill of materials by the organization;
- Requesting material declarations from suppliers based on the bill of materials;

This TR recommends that an organisation work with its suppliers of parts, materials, and services to obtain partial CFP based on suppliers’ primary data that are specific to the suppliers when possible. An organisation should encourage their suppliers to calculate their CFP contributions based on applicable CFP standards, product category rules, and guidance. The partial CFP would then be declared to the organisation.

NOTE 2 Management and analysis of supplier data for EE products can be complicated, e.g. when a part or component are manufactured or assembled over two- three levels of the supply chain.

6.6.3 Secondary data

6.6.3.1 Electrotechnical industry guidance

The organization may use process data that are not from specific processes in the product’s life cycle as secondary data, for example:

- Data from external sources (e.g. lifecycle databases, industry associations, etc.);
- Data from another and similar process or activity in the organization’s or supplier’s control.

Annex A provides a list of the life cycle database (public database) currently available in a number of countries.

Example of collecting secondary data for material production

- Identify a material with its mass used for a refrigerator: for example, xx kg of steel plate; yy kg of plastic; zz kg of components, etc.
- Then, in this example, collect secondary data for the steel plate, the plastic, the components, etc.
- Collect emission factors to be multiplied by the mass identified by the primary data or secondary data collected.

NOTE There is a need for specific secondary data applicable to EE products, such as high purity and specialty chemicals. In this case, generic data are not sufficient.

6.6.4 Data quality

6.6.4.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “data quality”:

> *Data quality shall be characterized by both quantitative and qualitative aspects.*
>
> *[…]*
>
> *Data quality requirements shall be specified to enable the goal and scope of the CFP study to be met. The data quality requirements should address the following:*
>
> *time-related coverage; geographical coverage; technology coverage; precision; completeness; representativeness; consistency; reproducibility; sources of the data; and uncertainty of the information.*
>
> *The relevant CFP-PCR shall give guidance on the data requirements, in particular under which conditions site-specific data shall be used and when the use of secondary data is acceptable.*
>
> *Organizations undertaking a CFP study should have a data management system and should seek to continuously improve the consistency and quality of their data and retention of relevant documents and other records.*
>
> *[Source: Summary of ISO/DIS 14067]*

> *For significant processes, companies shall report a descriptive statement on the data sources, the data quality, and any efforts taken to improve data quality*
>
> *[GHG Protocol Product Standard:2011]*

6.6.4.2 Electrotechnical industry guidance

This TR provides guidance to assess relevance of collected data associated with each process, to fill data gaps and to continuously improve data quality.

This TR recommends assessing the data’s relevance to goal and scope for each attributable process. The aspects to assess the relevance include: time-related coverage; geographical coverage; technology coverage; precision; completeness; representativeness; consistency;

reproducibility; sources of the data; and uncertainty of the information as illustrated in ISO/DIS 14067.

This TR also recommends documenting the result of an assessment including a description of the types of data available for each attributable process, e.g. primary data, secondary data, literature-based data, etc. If secondary data are used, an organization should document the source, and keep a record of the data sources and relevant literature, especially when barriers to assessing data quality existed.

NOTE The GHG Protocol requires not only reporting a descriptive statement on the data sources, the data quality, and any efforts taken to improve data quality for significant processes, but also making a public report.

During the assessment, an organisation may identify data gaps. Data gaps exist when there is no primary or secondary data that is sufficiently representative of the given process in the product's life cycle. Where necessary, an organisation may fill data gaps with proxy or estimated data.

The data collection process may be improved by integrating it within existing management systems if available, e.g. environmental management system (EMS), quality management system (QMS), etc.

6.7 Calculating GHG emissions

6.7.1 General

6.7.1.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding "inventory analysis":

6.3 Life cycle inventory analysis for the CFP

6.3.1 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 shall be performed, which consists of the following steps, for which the following pertinent provisions, adapted from ISO 14044:2006, listed below shall apply. If CFP-PCR are adopted for the CFP study, the LCI shall be conducted following the requirements in the CFP-PCR (see 6.1).

6.3.2 Data collection

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

When data have been collected from public sources, the sources shall be referenced in the CFP study report. For those data that may 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 shall be referenced. If such data do not meet the data quality requirements, this shall be stated.

[Source: ISO/DIS 14067]

6.7.1.2 Electrotechnical industry guidance

GHG emissions are quantified in each elementary process as referred to in the system boundary, and summed up according to the expression given below.

GHG emissions per life cycle stage/unit process can be quantified by multiplying activity data by emission factors, or by direct measurement. Direct measurement is needed for a few cases within the EE industry, e.g. for refrigerants and other materials, including any leakage of HFC, PFC and SF_6.

Activity data that is to be multiplied by GHG emission factors should be collected by the organization calculating GHG emissions (material consumption, electricity consumption for production, etc.), or be estimated based on the assumed scenario (electricity consumption of usage, reclaimed mass, etc.)

This table shows an example of applicable data types (primary data and secondary data) by activity, for each life cycle stage/unit processes:

Table 2 – Example of applicable data types

Stage	Activity	Applicable data types
a) Raw material acquisition	Quantity of material consumption	Secondary data
b) Production and component manufacturing	Weight of assembly	Secondary data
	Consumption of electricity	Primary data
c) Distribution (retail)	Vehicle loadings(kg・km) = transport distance x load ratio x loading capacity	Primary or secondary data
d) Use and maintenance	Electricity consumption of usage	Primary or product's specific secondary data
e) End-of-life (recycling and disposal)	Reclaimed mass/recycled mass	Primary or product's specific secondary data

The organization should collect applicable emission factors to be multiplied by the activity data.

Table 3 – Example of applicable emission factors for each life cycle stage/unit processes

Stage	Activity	Emission factor
a) Raw material acquisition	Quantify of material consumption	GHG emission factor to produce material/kg
b) Production and component manufacturing	Weight of assembly	GHG emission factor to assemble material and component/kg
	Consumption of electricity	GHG emission factor to generate electricity/kWh
c) Distribution (retail)	Vehicle loadings(kg・km) = transport distance ×load ratio × loading capacity	GHG emission factor to product transport/kg・km
d) Use and maintenance	Electricity consumption of usage	GHG emission factor to generate electricity/kWh
e) End-of-life (recycling and disposal)	Reclaimed mass/recycled mass	GHG emission to reclaim/kg GHG emission factor to recycle/kg

Examples of an emission factor for electricity

When feasible, the most current and local electricity emission factors should be used.

An alternative would be to use, the latest world-average emission factors provided by International Energy Agency (IEA) may be used.

NOTE Emission factors from IEA, eGrid or other sources are associated with some degree of uncertainty. However, the effect of the errors in the average emission factors can be addressed in information addressing uncertainty. In order to reflect the impact of where the product is made and where it is used in the CFP study, it is preferable to use locally relevant emission factors, if available. This will allow the calculation, to highlight the impact that electricity-related emissions have on the CFP study, and enable an analysis of potential opportunities to reduce that impact.

After collecting activity data and emission factors, the organization may quantify GHG emissions for each life cycle stage/unit process as follows:

GHG emissions = Σ (activity $_i$ × GHG emission factor $_i$)

6.7.2 Allocation

6.7.2.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding allocation:

6.3.6.2 Allocation procedure

The CFP study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below.

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

1) dividing the unit process to be allocated into two or more sub-processes 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; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.

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 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.

Some outputs may be partly co-products and partly waste. In such cases, it is necessary to identify the ratio between co-products and waste since the inputs and outputs shall be allocated to the co-products part only.

Allocation procedures shall be uniformly applied to similar inputs and outputs of the product system under consideration. For example, if allocation is made to usable products (e.g. intermediate or discarded products) leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system. […]

[Source: ISO/DIS 14067]

Companies shall allocate emissions and removals to accurately reflect the contributions of the studied product and co-product(s) to the total emissions and removals of the common process.

[…]

Companies shall avoid allocation wherever possible by using process subdivision, redefining the functional unit, or using system expansion.

[…]

If allocation is unavoidable, companies shall allocate emissions and removals based on the underlying physical relationships between the studied product and co product(s). When physical relationships alone cannot be established or used as the basis for allocation, companies shall select either economic allocation or another allocation method that reflects other relationships between the studied product and co-product(s).

[Source: GHG Protocol Product Standard:2011]

6.7.2.2 Electrotechnical industry guidance

This TR recommends avoiding allocation to the extent feasible. If allocation is unavoidable, the organization allocates emissions and removals based on the underlying physical relationships associated with the product. When physical relationships alone cannot be established or used as the basis for allocation, the organization may select allocation procedure based on:

- Products' economic value;
- Products’ mass;
- Products’ volume; or
- Duration of product turnover.

Example – Allocation of emissions associated with warehousing

The elements that are involved in distribution would include warehouse electricity use, and materials used in warehousing such as pallets. Typically, for warehousing, allocation is performed by units of goods or as a function of shelf space in the retail context given a typical duration of product turnover within the warehouse or retail facility.

Attention should be given to the fact that allocation significantly increases uncertainty.

Caution is needed when making allocation based on economic value.

There can be a need for an allocation procedure based on the EE product’s functional contribution.

6.8 Uncertainty

6.8.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding evaluation of “uncertainty”:

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

- *include a quantitative or qualitative assessment of uncertainty, including the application of rounding rules or ranges; […]*

Uncertainty is covered under "data and data quality"

6.2.6(j) – uncertainty of the information.

NOTE 3 Uncertainty can include e. g.

- *parameter uncertainty, e.g. emission factors, activity data,*
- *scenario uncertainty, e.g. use phase scenario or end-of-life scenario,*
- *model uncertainty.*

[Source: ISO/DIS 14067]

Defines three categories of uncertainty:

Parameter,

Scenario,

Model

[Source: ITU-T, GHG protocol has the same three categories of uncertainty]

Companies shall report a qualitative statement on sources of inventory uncertainty and methodological choices.

[…]

Uncertainty is divided into three categories: parameter uncertainty, scenario uncertainty and model uncertainty, which are defined in the following section.

[Source: GHG Protocol Product Standard:2011]

6.8.2 Electrotechnical industry guidance

Uncertainty can be quite significant in electronic and electrical products due to the following:

– Dynamics of supply chains (which leads to changes in transport distance, manufacturing facility efficiencies, and carbon-intensity of relevant electrical grids, etc.);

– Rapid technology evolution (which makes allocation of facility data between products and processes challenging);

– Decentralized supplier base that leads to complex information flow about bills of materials and manufacturing processes; and

– Complex products with multiple configurations.

Studies have estimated that the average variation of GHG emissions for an individual product can be upwards of 30 % or greater. Therefore, while uncertainty analyses can be difficult to execute it is important to perform at least a sensitivity analyses on critical assumptions and those parameters contributing most to the impact based on data quality.

ISO 14044 defines uncertainty analysis as a systematic procedure to quantify the cumulative effects of model imprecision, input uncertainty and data variability using ranges or probability distributions. Uncertainty calculation within EE products is an area that would benefit from on-going study.

Example of uncertainty analysis

A CFP study can assess data uncertainty (associated with measured or observed data), scenario uncertainty (associated with choices within the analysis) and model uncertainty (associated with mathematical relationships). Details on the analysis of these three sources of uncertainty are found in Annex D.

6.9 Use and maintenance scenario

6.9.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding evaluation of the "use and maintenance scenario":

6.2.8 Use stage and use profile

When the use stage is included within the scope of the CFP study (see 6.2.2), GHG emissions and removals arising from the use stage of the product during the product's service life shall be included. Service life information shall be verifiable and it shall refer to the intended us 670 e 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. the related scenarios and assumed service life for the use stage of products) shall be based on published technical information such as:

a) CFP-PCR (see 6.1);

b) published international standards […];

c) published national guidelines […];

d) published industry guidelines […];

Where no method for determining the use stage of products has been established in accordance with any of the bullet points above, the assumptions made in determining the use stage of products shall be established by the organization carrying out the CFP study.

The manufacturer's recommended method to be applied in the use stage (e.g. cooking in an oven at a specified temperature for a specified time) might provide a basis for determining the use stage of a product. […]

All relevant assumptions for the use stage shall be documented.

[Source: ISO/DIS 14067]

6.9.2 Electrotechnical industry guidance

For EE products, including supportive equipment (e.g. data centre cooling), at least the following items should be considered for the use stage when relevant for the product category and the goal and scope of the CFP study:

- Product energy consumption during service life considering
  - Use profile based on the actual or estimated usage patterns;
  - Energy consumption corresponding to the different modes;
  - External conditions influencing power consumption (e.g. temperature, etc.).
- Use of consumables
  - Consumption of consumables e.g. toner, paper, battery, etc.
- Operation and maintenance, including installation
  - Frequency of repair/maintenance;
  - Use of a spare part;
  - Associated service personnel (e.g. travelling, etc.).

The use phase, i.e. the product's service life should be estimated under realistic conditions of use, based, to the extent possible, on relevant data. When data are not available, less accurate sources or estimations are acceptable.

NOTE 1 For use and maintenance, the typical or various type of usage of a product may be modelled. Some industry groups have collaboratively developed or are developing software modules that can be used to model the use scenario assumptions for CFP study of specific EE products or services.

For refrigerants and other materials (e.g. isolation material blowing agents), GHG emissions including HFC, PFC, NF_3, SF_6, etc. from leakage during the use and maintenance stage should be included in end-of-life stage calculations.

Quantification of GHG emissions from use and maintenance stage may be based on the design specification prepared by organisations. Where there is such published technical information as a legal standard, a PCR, a sector-specific standard, etc. exists, it should be evaluated for use.

NOTE 2 While data from a customer or consumer questionnaire may be useful, this TR does not assume that a questionnaire survey of customers or consumers is necessary.

6.10 End-of-life stage scenario

6.10.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding evaluation of the "end-of-life stage scenario":

6.2.9 End-of-life stage

The end-of-life stage begins when the used product is ready for disposal, recycling, reuse, etc.

All the GHG emissions and removals arising from the end–of-life stage of a product shall be included in a CFP study, if this stage is included in the scope (see 6.2.2).[…]

All relevant assumptions regarding end-of-life treatment, e.g. GHG emissions 703 and removals, shall be based on best available information and based on current technology and shall be documented in the CFP study report.

[Source: ISO/DIS 14067]

For allocation due to recycling, companies shall use either the closed loop approximation method or the recycled content method as defined by this standard.

[Source: GHG Protocol Product Standard:2011]

6.10.2 Electrotechnical industry guidance

This TR recommends defining the end-of-life scenario of EE products by including the following:

Scenario necessary to quantify GHG emissions from preparation for disposal, recycling, reuse

- collection, packaging and transport of end-of-life products;
- dismantling of components from end-of-life products;
- shredding and sorting.

Scenario necessary to quantify GHG emissions from disposal, recycling, reuse

- material recycling processes;
- energy recovery processes;
- incineration and sorting of bottom ash;
- landfilling, landfill maintenance.

In the raw material acquisition stage, recycled and reused products may be effectively utilized as a raw material, in addition to the recycling of used products in the end-of-life stage. GHG may be emitted during recycling processes utilized to collect and regenerate used products. Identification of those processes for which GHG should be calculated in the raw material acquisition stage, as well as those processes in the disposal/recycling stages, should be considered.

Fundamentally, preparatory steps of recycling such as collecting and sorting are included in the end-of-life stage of used products. Other processes after sorting such as smelting are included in the raw material acquisition stage of products which use recycled material.

NOTE Other approaches for allocation between life cycle stages which affect where to draw the boundary between end-of-life treatment and raw material acquisition exist, and may be applied as an alternative.

However, if the recycling process of each product is different, then the allocation of process may need to be decided for each product. In this case, there should be an incentive to procure recycled raw materials (that is, using a recycled raw material would lead to a decrease in GHG emissions), and recycling used products is also an incentive by itself (putting a used product onto an appropriate recycling route would allow for a decrease in GHG emissions as compared with the disposal by incineration or reclamation.)

Where "recycling" is already being carried out, for example for the toner of a copy machine, home appliances, etc., it can be deemed that the amount of material or energy recovered and dissipated in the recycling process may also be taken into consideration and included in the calculation.

For refrigerants and other materials (e.g. isolation material blowing agents), GHG emissions including HFC, PFC, NF_3, SF_6, etc., from leakage during the end-of-life stage should be included in end-of-life stage calculations. Additionally, GHG emissions from leakage during the use and maintenance stage should also be included in end-of-life stage calculations.

Examples

Existing documents describe several methods for allocation of recycling:

- 0/100 method

> *Closed loop approximation method*
>
> *The closed loop approximation method accounts for the impact that end-of-life recycling has on the net virgin acquisition of a material. Its name derives from the assumption that the material being recycled is used to displace virgin material input with the same inherent properties. […]*
>
> *Since the closed loop approximation method is defined as a method to allocate recycled materials that maintain the same inherent properties as its virgin material input, the properties (e.g., chemical, physical) of the recycled material have to be similar enough to the properties of the virgin material input to be used interchangeably without any additional changes to the product's life cycle.*
>
> *[…]*
>
> *[Source: GHG Protocol Product Standard:2011]*

- 100/0 method

> *Recycled content method*
>
> *The recycled content method allocates the recycling process emissions and removals to the life cycle that uses the recycled material. The recycled content method can be used in open loop situations that include recycled material inputs and outputs. […] The recycled content method is also referred to as the cut–off method or the 100-0 method.*
>
> *[…]*
>
> *Reducing the amount of waste entering waste treatment reduces the GHG emissions from waste treatment in the end-of-life stage. Reducing upstream virgin material acquisition reduces the GHG emissions and removals from material acquisition if the recycling processes are less GHG intensive than virgin extraction. If this is not the case (e.g., recycling processes are more GHG intensive than virgin inputs), it is possible that using virgin inputs would result in a lower total product inventory than using recycled inputs. This is an example of when focusing on one impact category may drive companies to make product decisions that are desirable for one impact (e.g., GHG emissions) but unfavourable to another (e.g., material depletion).*
>
> *[…]*
>
> *[Source: GHG Protocol Product Standard:2011]*

- Other method

> *9.3.7 Choosing between closed loop approximation and the recycled content method*
>
> *In cases where both the closed loop approximation and recycled content methods are equally applicable to the studied product, the following guidance provides insight on which method is most appropriate in certain situations.*
>
> *[…]*
>
> *There may be situations where a company feels neither method is appropriate for a given*

recycled material input or output. In these cases the method used should abide by the specifications given in the requirements section and be referenced from available sector guidance, product rules, technical reports, journal articles, or other standards.

[…]

When it is not obvious which method is most appropriate, companies should perform a scenario uncertainty assessment (e.g., sensitivity analysis) on the potential methods and include the results in the inventory report[…].

[Source: GHG Protocol Product Standard:2011]

NOTE For recycling, the 50/50 method is applied by some ICT sub-sector standards.

7 CFP-PCR

7.1 Provisions in CFP standards

CFP standards require "PCR" as follows:

9.5.1 General

When a CFP claim, CFP label or CFP declaration is intended to be available to the public, CFP-PCR shall be used. If relevant CFP-PCR exists (see 6.1) they shall be adopted. If no relevant CFP-PCR exist, CFP-PCR shall be established by an entity according to 9.5.

When a CFP external communication report or a CFP performance tracking report is intended to be available to the public and where relevant CFP-PCR exist they shall be adopted.

CFP-PCR shall only be valid if their requirements are consistent with the requirements of this International Standard.

9.5.2 Content of CFP-PCR

The CFP-PCR shall identify and document the goal and scope of the CFP information for the product category according to 6.2 and the rules for producing additional information for the product category together with the CFP. The CFP-PCR shall also determine the life cycle stages to be included, the parameters to be covered, and the way in which the parameters shall be collated and documented.

The CFP-PCR shall include, as a minimum, the following:

a) instructions on the content and format(s) of the CFP communication;

b) information on and justification for which life cycle stages are covered and which are not, if the communication is not based on a CFP covering all life cycle stages;

c) product category definition and description (e.g. function, technical performance and use);

d) goal and scope definition for the CFP […]

e) LCI […]

f) period of validity.

NOTE List adopted from ISO 14025:2006, 6.7.1.

The CFP-PCR may include additional guidance for e.g. use and end-of-life stages.

[Source: ISO/DIS 14067]

7.2 Electrotechnical industry guidance

PCR may be used for a CFP study for EE products.

The existence of this TR does not preclude particular sectors from generating their own, more specific, standards or guidelines. Where such documents are produced it is recommended that they use this TR as the reference in order to ensure consistency throughout the EE sector.

Where it is necessary to develop a PCR for a specific product or a product category, this TR recommends considering guidance given in Clause 6 as well as requirements given in ISO/DIS 14067.

NOTE 1 Further guidance on developing the contents of a PCR document is given in ISO 14025:2000.

NOTE 2 For examples of PCRs, see Annex C where summaries are shown.

8 Documentation

8.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “documentation”:

General

The results and conclusions of the CFP study shall be documented in the CFP study report without bias. The results, data, methods, assumptions and the life cycle interpretation (see 6.5) shall 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 shall be defined in the goal and scope definition phase of the CFP study. The CFP study report shall also allow the results and life cycle interpretation to be used in a manner consistent with the goals of the CFP study. The selected allocation methods shall be documented in the CFP study report in detail and the GHGs taken into account shall be clearly stated.

Items to be documented

At least the following items shall be documented or be clearly stated:

- *The results and conclusions of the CFP study without bias (see 7 “CFP study report” and 8.3.6 “CFP results”)*
- *Secondary data (See. 6.2.6 “Data and data quality”);*
- *All relevant assumptions for the use stage (see 6.2.8 “Use stage and use profile”);*
- *All relevant assumptions regarding end-of-life treatment (see 6.2.9 “End-of-life stage”);*
- *The results of the refining process and the sensitivity analysis (see 6.3.5 “Refining the system boundary”);*
- *Disclosure and justification of the methods used to avoid or perform allocation due to co-products or recycling (See 8.3.4 “Allocation”)*
- *the selected allocation methods in detail (see 6.5 Interpretation);*
- *GHGs taken into account (see 7 CFP study report);*

Items to be documented separately

The following items shall 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) GHG emissions and removals arising from fossil carbon sources and sinks (see 6.3.9.2);

c) GHG emissions and removals arising from biogenic carbon sources and sinks (see 6.3.9.2);

d) GHG emissions resulting from dLUC (see 6.3.9.4);

e) GHG emissions resulting from aircraft transportation (see 6.3.9.8).

Items to be documented separately, if calculated

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

f) soil carbon change (see 6.3.9.5);

g) GHG emissions and removals occurring as a result of iLUC (see 6.3.9.4);

NOTE There can be an additional requirement on documentation in case the CFP study is intended for comparison or communication.

[Source: Summary of ISO/DIS 14067]

Documentation of Data Interpretation Issues:

The results of the LCI or LCIA phases shall be interpreted according to the goal and scope of the study, and the interpretation shall include an assessment and a sensitivity check of the significant inputs, outputs and methodological choices in order to understand the uncertainty of the results.

4.5.1.2 The interpretation shall also consider the following in relation to the goal of the study:

- *the appropriateness of the definitions of the system functions, the functional unit and system boundary;*
- *limitations identified by the data quality assessment and the sensitivity analysis.*

The documentation of the data quality assessment, sensitivity analyses, conclusions and any recommendations from the LCI and LCIA results shall be checked.

[Source: ISO 14044: 2006]

Records:

Records shall be kept for a minimum of three years.

[Source: PAS 2050:2011]

8.2 Electrotechnical industry guidance

CFP documentation can serve a number of important purposes including but not limited to:

- Providing supporting data for identification of a process with significant GHG emissions and prioritizing reduction efforts across the product life cycle;
- Creating a basis for quantifying and reporting CFP performance over time; etc.

Documentation is best when it is unambiguous in identifying the product(s), unit of analysis, system boundary, collected data, calculation methodologies, scenario, assessment of the uncertainty and other parameters associated with a CFP study, and when it allows for traceability of the information. For example, the process and procedure(s) used to determine a calculated or modelled result may be described and documented.

In regards to documentation, attention should be given to recording and maintaining data from a CFP study in a format that will support the analysis, verification and communications of the results. For this, this TR recommends the following:

– Document procedures, methodologies, assumptions, evidences of all data, etc., for each step of CFP Study;
– Compile the calculation results as a record, including at least the items required in the standards with which the calculation is intended to be compliant.

When a management system exists in an organization, the principles found in that management system may be used as guidance for addressing data traceability and evidence management, as long as those principles comply with international CFP and LCA standards.

NOTE 1 Requirements in ISO/DIS 14067 on documentation (as listed in the box) are not necessarily compliant with the GHG Protocol Product Standard, which requires an organisation to make a public report.

NOTE 2 The GHG Protocol Product Standard gives no specific requirements on documentation beyond requirements for public reporting and disclosure and justification.

9 Communication and verification

9.1 General

9.1.1 Provisions in CFP and LCA standards

CFP and LCA standards generally provide the following requirements regarding “communication”:

8 Preparing for CFP communication

8.1 General

When an organization decides to make a CFP communication publicly available there are two options to conform with this International Standard. CFP communication according to 9.1 intended to be available to the public shall:

a) be verified by an independent third-party (see 8.2), or

b) be reported completely and accurately without bias to the intended audience in a CFP disclosure report (see 8.3.) […]

9.1 Options for CFP communication

9.1.1 General

[…]

CFP communication includes communication of a CFP or a partial CFP (see Clause 6).

[Source: ISO/DIS 14067]

Companies shall publicly report the following information:

- *General Information and Scope;*
- *Boundary Setting;*
- *Allocation;*
- *Data Collection and Quality;*
- *Uncertainty;*
- *Inventory Results;*
- *Assurance;*
- *Setting Reduction Targets and Tracking Inventory Changes, in case a company reports a reduction target and/or track performance over time*

[Source: GHG Protocol Product Standard]

NOTE A more detailed list of items to be reported is given in the GHG Protocol Product Standard.

Principles for Communication:

The following principles are the basis for, and shall be used to guide the application of, the requirements related to communication in this International Standard.

Participation: Apply an open, participatory process with interested parties when developing and implementing CFP communication programmes.

Transparency: Ensure that CFP communication and its intended meaning is presented in a way that is clear and meaningful for the target audience to understand. Include information on functional unit, data assumptions, calculation methods and other characteristics to make limitations in the comparisons of CFPs transparent and clear to the target group.

Fairness: Make clear that the CFP communication is based on a CFP study which assesses the single impact category of climate change and does not imply overall environmental superiority nor examine broader environmental implications. Avoid misconception by not confusing quantified GHG emissions with reductions in GHG emissions.

[Source: ISO/DIS 14067]

9.1.2 Electrotechnical industry guidance

It is not a requirement of ISO/DIS 14067 to communicate the CFP, while the GHG Protocol Product Standard requires that organisations make a public report of specific information to claim compliance with that standard.

An organization may perform a CFP study that is intended only for quantification, not for communication.

Therefore, in accordance with ISO/DIS 14067, this TR recognises that organizations may choose, or not choose to communicate the results of their CFP studies.

The typical unit used for reporting the results of CFP studies is mass of carbon dioxide equivalent (CO_2e).

While a total product carbon footprint can be calculated and expressed as a single (aggregate) number, it is helpful to also express the breakdown of the footprint by life cycle stages of separate (disaggregate) numbers. Separately expressing emissions associated with the product's or service's use and maintenance stage and those from other life stages will help prevent any confusion in regards to what exactly is being communicated, considering that data quality varies by life cycle stage, and that the use stage often accounts for a large part of the life cycle GHG emission of a EE product.

9.2 Options of communication

9.2.1 Provisions in CFP and LCA standards

CFP and LCA standards establish "communication options" as follows:

Communication of CFP may take the form of a CFP external communication report, a CFP performance tracking report, a CFP claim, a CFP label or a CFP declaration. For partial CFP communications the additional requirements in 9.6.2 apply.

[Source: ISO/DIS 14067]

Companies shall publicly report the following information:

- *General Information and Scope;*
- *Boundary Setting;*
- *Allocation;*
- *Data Collection and Quality;*
- *Uncertainty;*
- *Inventory Results;*
- *Assurance;*
- *Setting Reduction Targets and Tracking Inventory Changes, in case a company reports a reduction target and/or track performance over time*

[Source: GHG Protocol Product Standard]

NOTE The more detailed list of items to be reported is given in GHG Protocol Product Standard.

9.2.2 Electrotechnical industry guidance

When communicating the results of a CFP, an organisation should make its best efforts to avoid misleading the public or specific customers. Organizations should always consider the potential audience when communicating information about CFP studies.

To ensure an organization presents CFP information in a way that is accurate, clear, specific and unambiguous and that the audience understands the intended meaning, this TR recommends the following:

Ensure the whole communication (including imagery) is a truthful and accurate representation of the scale of the benefit or what is likely to happen in practice and does not overstate the benefit achieved. Even if literally true, a claim should not be easily misinterpreted or omit significant information.

Ensure the goal, scope and boundaries of the communication are clear. Communication should make clear whether it refers to the whole product or just one aspect. The single issue being evaluated, i.e. GHG emissions should also be clear.

Where necessary use clear, prominent and complementary supplementary information to qualify the communication.

NOTE 1 Understanding the regulatory requirements or standards that address public communications in countries where the EE product will be put on the markets is a key consideration.

This TR recommends that an organisation evaluate and choose communications options from existing documents according to the purpose of the CFP communication and careful consideration of the audience.

NOTE 2 For additional information on CFP communications including “public reporting” as is defined in the GHG Protocol Product Standard, refer to existing documents providing further requirements or recommendations on reporting the CFP study.

9.3 Verification and assurance

9.3.1 Provisions in CFP and LCA standards

CFP and LCA standards provide the following requirements regarding “verification”:

3.9.1

carbon footprint of a product verification

CFP verification

confirmation of the validity of an environmental claim (ISO 14050:2009, 8.2) using specific predetermined criteria and procedures with assurance of data reliability

[SOURCE: ISO 14021:1999, 3.1.4, modified — changed preferred term designation from environmental claim verification.]

[…]

8 Preparing for CFP communication

8.1 General

When an organization decides to make a CFP communication publicly available there are two options to conform with this International Standard. CFP communication according to 9.1 intended to be available to the public shall:

a) be verified by an independent third-party (see 8.2), or

b) be reported completely and accurately without bias to the intended audience in a CFP disclosure report (see 8.3)..

[…]

8.2 Third-party CFP verification

8.2.1 General

If the CFP communication is verified by an independent third-party, a verification statement shall be made available to the intended audience. The report of the verifier should be available on request. […]

Independent third-party verification shall provide confirmation that the relevant requirements *of this International Standard have been met, including the application of relevant CFP-PCR, if available.*

[…]

9.3 CFP communication not intended to be available to the public

When the CFP communication is not intended to be available to the public, requirements for a CFP communication programme, CFP-PCR and verification are optional with the exception of the CFP declaration where these elements are required. […]

[Source: ISO/DIS 14067]

Assurance is the level of confidence that the inventory results and report are complete, accurate, consistent, transparent, relevant, and without material misstatements. […]

The product GHG inventory shall be assured by a first or third party.

- First party assurance:

Person(s) from within the reporting company but independent of the GHG inventory determination process conducts internal assurance.

- Third party assurance: Person(s) from an organization independent of the product GHG inventory determination process conducts third party assurance.

Levels of assurance

[…] There are two levels of assurance: limited and reasonable. […]

The highest level of assurance that can be provided is a reasonable level of assurance. Absolute assurance is never provided as 100 percent of the inputs to the GHG Inventory are not tested due to practicality and feasibility limitations.

[Source: GHG Protocol Product Standard]

9.3.2 Electrotechnical industry guidance

This TR recommends that the organisation, at a minimum, performs an independent first party verification or assurance when making CFP communications. For this, this TR recommends the following:

– Assign personnel in the organisation, who are engaged in a business or a product other than the business or the product studied;

– Have the personnel verify the logic of calculation, traceability of the data used for calculation, and, conformity to the standard(s) with which the calculation is intended to be compliant.

A third-party verification or assurance can increase credibility of a CFP study but can be unaffordable for EE products because they usually have a long and complex supply chain and processes.

CFP claims can be made by the organization itself (e.g. as discussed in ISO 14021:2006) or based on a third party evaluation (e.g. as discussed in ISO 14025:2006).

NOTE 1 In some countries where an organisation performs comparative assertion, third-party verification or assurance can be required or recommended.

NOTE 2 For further information, refer to each relevant existing standards document and initiative.

Annex A
(informative)

Example of existing databases which can be used for quantification as secondary data

	EU	Commercial (Swiss Centre for Life Cycle Inventories)	Commercial (PE-International)
Database	European Reference Life Cycle (ELCD) Core Database II	Ecoinvent	Gabi data base
URL	http://lca.jrc.ec.europa.eu/lcainfohub/datasetCategories.vm	http://www.ecoinvent.org/database/	http://www.gabi-software.com/databases/
Description	The (free of charge) ELCD core database covers life cycle emissions and resource consumption data from EU-level business associations and other sources for the following processes: – End-of-life treatment – Energy carriers and technologies – Materials production – Systems – Transport Services Import into major LCA software is said to be possible (the site lists the following LCA software products: BRE EnvPro DB, CMLCA, ecoinvent, EDIP, EIME, eVerdEE, DIM, GaBi, KCL-ECO, LCA Evaluator, LEGEP, MIPS, openLCA, Sabento, SimaPro, Sirii/SPINE, TEAM/DEAM, trainEE, and UMBERT). For each data set a "General comment" is given, describing the overall data quality. Additionally data reviewers are mentioned for each set (e.g. "Dependent internal review by LBP-GaBi Ecobilan PE INTERNATIONAL").	The database “ecoinvent data” in its current version v 2.2 – the world’s leading database with consistent and transparent, up- to-date Life Cycle Inventory (LCI) data. With more than 4 000 LCI datasets in the areas of agriculture, energy supply, transport, bio-fuels and biomaterials, bulk and specialty chemicals, construction materials, packaging materials, basic and precious metals, metals processing, ICT and electronics as well as waste treatment, this database offer one of the most comprehensive international LCI database. High-quality generic LCI databases are based on industrial data and have been compiled by internationally renowned research institutes and LCA consultants. The data are available in the EcoSpold data format, and they are compatible with all major LCA and eco-design software tools.	Development of the Gabi life cycle databases began over 20 years ago and continues today with the same momentum and meticulous attention to detail. More than 60 life cycle experts contribute to the development of Gabi databases making PE INTERNATIONAL the largest life cycle data provider worldwide. With over 4000 ready-to-use LCI profiles within the Gabi professional and extension databases, as well as engineering capabilities to set up customized “data on demand”, major producers from every industry and research field across the globe choose PE INTERNATIONAL as their source of comprehensive, high-quality life cycle data. Even the European Commission’s Joint Research Council upon PE’s database expertise to generate the European Life Cycle Database (ELCD) in cooperation with more than 25 industry associations. PE also contributes and supports the development of national database projects in Australia, Brazil, Germany, Malaysia and United States. All LCI profiles are generated in compliance with the ISO 14044, ISO 14064 and ISO 14025 standards and include all parameters relevant for application in LCA, Design for Environment, Carbon footprints, Water footprints, Environmental Product Declarations, Energy Using Product.
Issue date	Various	Various	Various
Validity	No validity dates given. Many data sets refer to ~ 2005 timeframe (or older). Disclaimer quotation from website: "All data sets are carefully selected, of high quality and in line with ISO 14040 and 14044, but are not to be considered as official reference data sets. The data sets are provided 'as they are'."		

	EU	Commercial (Swiss Centre for Life Cycle Inventories)	Commercial (PE-International)
Coverage of EE products /components	Some might be relevant for EE products/components, but data is not up-to-date (see list below). Commercially available databases (e.g. GaBi) are much more detailed.	ICT and electronics as well as waste treatment.	Some might be relevant for EE products/components.

	US	Japan	China	China	Korea
Database	U.S. Life Cycle Inventory (LCI) database	Database of GHG Emission Factors for the CFP communication program	China Energy label Database	Carbon emission evaluation database for typical sections	Database of GHG emission factors and national LCI database
URL	http://www.nrel.gov/lci/database/	http://www.cfp-japan.jp/calculate/verify/data.html	Chinese version： http://www.energylabel.gov.cn/ English version： http://www.energylabel.gov.cn/en/	*The database is not issued yet, and there is not a website now.*	http://www.edp.or.kr/
Description	The US LCI database is publicly available and is housed by the U.S. National Renewable Energy Lab (NREL), High Performance Buildings group (along with several industry and government stakeholders, including an 11 member advisory committee).	Fundamental database of GHG emission factors for use in the CFP Communication Program.	Based on the Energy Label Management Mechanism of China, the database gathers the basic energy consumption data referring to final products, such as domestic appliances, luminaries, industrial equipments, commercial equipments, office equipments and vehicles.	In order to evaluate the carbon emission of typical products, the relevant data of general carbon emission and product carbon footprint data of typical sections would be gathered to support the product carbon footprint quantification of China.	For use in Korea CFP programme.
Issue date	Latest revision date is August 21, 2011. Electricity at various locations on US. Grid updated July 2011. Recycling dataset upgraded September 2010.	July 2012	2005	would be issued in 2014	Enacted: February 8, 2009 Amended: March 17, 2009 Amended: June 3, 2009 Amended: September 11, 2009 Amended: November 20, 2009 Amended: December 8, 2009 Amended: December 21, 2009 Amended: June 4, 2010 Amended: June 18, 2010 Amended: September 13, 2010
Validity	The data were critically reviewed following the project data review protocol, which is available in its full form on the USLCI website.		Data is updated with the renew of product each year, and should be verified by the third-party organization.		National LCI database has been critical reviewed by experts and GHG emission factors are available in CFP website

	US	Japan	China	China	Korea
Coverage of EE products /components	Some might be relevant for EE products/components, for example, wood products, chemicals including plastic resins. In general, chemical data does not appear to include specialty or high purity chemicals that are used in semiconductor manufacturing.	Coverage of more than 1,200 materials, services and approximately 100 components.	Domestic appliances, luminaries, industrial equipments, commercial equipments, office equipments.	General carbon emission data, material carbon emission data and some EE components data.	Over 300 materials, transformations, chemical reactions

Annex B
(informative)

Study results of comparison analysis on selected existing relevant documents including International Standards and regional and national initiatives

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in compliance with ISO 14025) (France]	EC Product Environmental Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Life cycle approach	Basis	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted	Adapted
Environmental Issues	Broad, i.e. GHG and many others	Only GHG	Only GHG	Mainly Energy consumption/ GHG emissions for current version	Multi-criterion, i.e. GHG (mandatory) and many others (selection depending on goal and scope)	Only GHG	Only GHG	Only GHG	Multi criterion – GHG – Water consumption – Biodiversity – Soil sealing	Multi-criterion, A single Life Cycle Analysis based to provide all the relevant indicators Mandatory indicators: – Global warming, – Ozone layer depletion – Water eutrophication – Photochemical ozone creation – Air acidification – Primary energy consumption – Water consumption Optional indicators: – Raw material depletion – Contribution to air toxicity – Contribution to water toxicity – Hazardous waste production	14 Default categories and other impacts might be added voluntarily	GHG and lifecycle energy; soon to include water footprint	Only GHG

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in complia-nce with ISO 14025) (France]	EC Product Environme ntal Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Unit of analysis	Functional unit – consistent with Goal & Scope.	Functional unit – preference for PCR; or Product unit may be used, exception-ally	Final product: Functional unit, consistent with Goal & Scope Intermediate product: Reference flow or amount of product (where the eventual function is unknown)	Consistent with Goal & Scope	Functional unit – Consistent with Goal & Scope	Functional unit – PCR, if available Supplementa-ry requir-ements can establish a preferred unit of analysis	Unit of sales basis – Preference for PCR	Sales unit	Preference for PCR	Functional Unit, specified in the PCR	Shall be defined according to the following aspects: – function(s) /service(s) provided: "what" – magnitude of the function or service: "how much" – duration of the service provided or service life time: "how long" – expected level of quality: "how well" Further details to be provided by PFCR	A standard laptop was used as the functional unit in this study (Other products under study)	Functional unit; – Applicable to a product whose function can be uniformly identified Product unit; – Applicable to many EE products whose function is too complicate d to be identified uniformly, whether they are final or interm-ediate products
Cut-off rules	Consistent with Goal & Scope	Consistent with Goal & Scope interms of omitting certain processes of minor importance	All attributable processes included. Attributable processes may be excluded if found to be insignificant and if the exclusion is disclosed and justified.	Cut-off criteria include mass, energy and environmenta l significance - only acceptable if allowed by all the above mentioned criteria	Cut-off criteria include mass, energy and environmenta l significance - only acceptable if allowed by all the above mentioned criteria	Specific rules; 1 % of GHG Emissions; 95 % complete	95 % cut-off criteria based on GHG emissions	95 % cut-off criteria based on mass	95 % cut-off criteria based on mass, energy, environmenta l significance of material input	95 % based on the mass of the reference flow	90 % per impact category PFCR might specify more stringent cut-off rules		Qualitative constraint and Quantitative threshold; – outputs (e.g. Less than 5 % of the total estimated emission can be excluded) – inputs(e.g. Less than 5 % of the total mass or amount input to the proce-ss map can be excluded)

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in complia-nce with ISO 14025) (France]	EC Product Environme ntal Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Use phase	Obligatory according to principle, but cradle-to-gate possible	Consistent with Goal & Scope	Obligatory for final products.	Obligatory according to principle, but cradle-to-gate possible	Obligatory according to principle The cradle-to-gate option is not mentioned	Obligatory for final goods; disclose use profile - Inclusion in B to B measurement depended on boundary	Included	Setting the guidance	Included	Obligatory, specified in the PCR (including relevant use scenario based on product standard)	Use phase to be specified by PFCR Setting the guidance	Based on information in the Energy Star PC specification There are several elements, including power, duty cycle, location, and lifetime The location of the grid was assumed to be US and the lifetime of the product was 4 years with a standard deviation of 1 year	Identify the scenario with each EE product categories Energy efficiency and consump-tion, each consumab-les and other supportive product, repair and maintena-nce, etc
End-of-life phase	Obligatory according to principle, but cradle-to-gate possible	Consistent with Goal & Scope	Cradle-to-Grave obligatory for all products is unknown, then Cradle-to-Gate allowed	Obligatory according to principle, but cradle-to-gate possible	Obligatory according to principle, but cradle-to-gate option is not mentioned	Obligatory for final goods; disclose use profile. - Inclusion in B to B measurement depended on boundary	Unclear	Setting the guidance	Setting the guidance - Annex A A.5.4	Obligatory, specified in the PCR	End-of-life scenarios to be specified by PFCR	Difficult to quantify due to the lack of information around the flow of materials into and out of this phase; more study needed	Identify the scenario with each EE product categories (disposal, recycling, reuse)
Data quality	Specific rules	Specific rules	Pedigree matrix	Specific rules	Specific rules	Specific rules	Specific rules	Specific rules	Specific rules	Primary data are recommended when available, otherwise LCI data modules can be used	Detailed semi-quantitative assessment of data quality (Chapter 6.6)	Statistical analysis	Guidance to assess relevance of collected data associated with each process, to fill data gaps and to continuously improve data quality

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in compliance with ISO 14025) (France]	EC Product Environmental Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Allocation	1. Dividing or, Expanding system boundary 2. Physical causality, 3. Socio economic	1. Dividing or, Expanding system boundary 2. Physical causality 3. Socio economic	Modified from ISO 14040/44 (without the inclusion of avoided burden for system expansion)	1. Dividing or, Expanding system boundary 2. Physical causality, 3. Socio economic Detailed allocation rules available for software	Detailed allocation rules given for a number of allocation situations	Modified from ISO14040/44 1. Subdivide unit processes into sub-processes 2. Expand system – special rules for End of Life	Preference for PCR	1.Dividing or,Expanding system boundary 2. Physical causality, 3. Socio economic	1.Dividing or, Expanding System boundary 2. Physical causality, 3. Socio economic	Physical allocation rule which describes at best the systems operating	Based on ISO 14044 - Default equation for recycling shall be applied -Default recycling rates and prices are given; other values might be used if justifiable.	Manufacturing burdens by unit –Transportation calculated by mass allocation – Storage allocated according to volume. – End-of-life processing allocated to the product – no credit for recycling	Recommends avoiding allocation as much as possible If allocation is unavoidable, the organization allocates emissions and removals based on the underlying physical relationships
Uncertainty	Either ranges or probability distributions are used	Can include e.g. three types: – parameter, – scenario, – model.	Consistent with ISO/DIS 14067	Consistent with ISO 14040/44	Consistent with ISO 14040/44	Addressed through data quality rules, specific sampling and averaging rules	Included if impacts are significant	Addressed through data quality rules	Preference for PCR	Addressed through data quality rules	Unclear	Addressed through statistical analysis	Consistent with ISO/DIS 14067 and considering sensitivity analysis
Emissions from capital goods	Sensitivity and consistency analysis	Unclear	Excluded, if it's included in system boundary, shall report	Included, described in boundaries setting	Use stage included, described in boundaries setting	Excluded, unless provided for in supplementary requirements	Unclear	Excluded	Unclear	Excluded	To be included if environmentally significant.	Included	This consideration is not needed for EE products except for some special cases
Comparative assertions	Permitted, but strict rules	Not permitted	Not permitted	Permitted, but strict rules	Permitted, but strict rules	Not permitted	Not permitted	Preference for ministry of Environment's notification	Permitted among the same product category	Permitted among similar products covered by the same Product Specific Rules	Comparisons are permitted but strict rules		Not commented (Based on ISO 14040/44)

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in complia-nce with ISO 14025) (France]	EC Product Environmental Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Communi-cation	Important rules	Important rules	Main goal of the standard is public reporting	Covered, sections describe reporting	Covered, sections describe reporting	Provisions for claims of conformity Guidance in Code of Good Practice (separate from PAS 2050)	Main goal of the standard is public reporting	Main goal of the standard is public reporting	Main goal of the standard is public reporting	Main goal is B to B reporting	Minimum: Executive Summary, Technical Summary, MainReport, Annexes + any other necessarysupporting information		Recommends evaluating and choosing communications options from existing documents according to the purpose of the CFP - communic-ation and careful considera-tion of the audience.
GHG offset	Consistent with Goal & Scope	Shall not be included	Shall not be included	Shall not be included but report separately	Not mentioned	Shall not be included	Shall not be included	Shall not be included	Shall not be included	Not allowed	Shall not be included	Not included	Not commented
Reduction	Important aim Consistent with Goal & Scope	Important aim	Important aim	Important aim	Not applicable. Focus is on the assessment methodology	Guidance in Code of good practice (Separate from PAS 2050)	May be included, if both CFP are certified	Important aim	Unclear	Focus is on the assessment methodology	Purpose of seeking to reduce the environmental impacts of goods and services	Important aim	Linkage between TR 62725 and TR 62726 (reduction will be addressed)

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in complia-nce with ISO 14025) (France]	EC Product Environme ntal Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Data accepted	Consistent with Goal & Scope	Site-specific data: processes under the financial or operational control	Primary data: transparent process operated or owned (incl. I/O) Secondary data: based on the data quality assessment	Consistent with Goal & Scope (Primary data is preferred) Detailed rules for quality per life cycle process available in Appendix.	Detailed rules for quality per life cycle process	Primary data: transparent processes owned, operated, controlled supplier requirements Secondary data: governed by data quality rules (incl. I/O)	Primary data: transparent process data Secondary data: accepted if there are no process data	Primary data: transparent process data Secondary data: governed by data quality rules (incl.IO)	Primary Data: transparent process data Secondary data: governed by data quality rules (incl.IO)	Primary Data: transparent process data Secondary data: governed by data quality rules (incl.IO)	Secondary ("generic") data shall be used only if primary ("specific") data is unavailable/ not environment ally significant All relevant resourceuse and emissions shall be documented using ILCD Nomencl-ature PFCR shall be based on classifica-tion of "Product"	Primary data using a questionnaire process data aggregation.	Consistent with Goal & Scope Recomme-nds Applicable data types – Primary data – Secondary data – Product's specific secondary data
Partial GHG reporting	Consistent with Goal & Scope	Consistent with Goal & Scope	When applicable cradle-to-gate reporting is allowed, guidance given	Yes	Not mentioned	Yes: Requirements for passing information through the chain	Shown as the additional information	Yes	Unclear	Not allowed	No		Yes (e.g. Intermediate product - may be studied for its partial life cycle [cradle to gate])
Modeling approach	Consistent with Goal & Scope, mainly attributional modeling	Attributional modeling	Attributional model, Non-attributional model, if system boundary including	Consistent with ISO 14040/44	Consistent with ISO 14040/44	Attributional modeling	Attributional modeling	Attributional modeling	Attributional modeling	Consistent with ISO 14040/44	All processes and flows that are attributable to the analyzed system within the defined system boundaries are to be considered	Applied	Except for special cases the attributional approach is sufficient for the CFP study of EE products

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in compliance with ISO 14025) (France]	EC Product Environmental Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Land use change	Consistent with Goal & Scope	Shall be assessed when significant	Describes process for determining		Refer to ISO	Specifies procedure and provides default values soil emissions per community	Not specified	Not specified		Not specified	Shall be allocated to products/services for 20 years after the land use change occurs using the IPCC default values table Indirect Land Use Change: shall not be included	Not specified	Consideration on dLUC or iLUC is rarely needed for EE products except for some special cases, e.g. bio polymers or bio fuels are used
Carbon storage	Consistent with Goal & Scope	Consistent with time boundary setting	Currently reported separately		Refer to ISO	Included: Describes calculation method	Not specified	Not specified		Not specified	temporary (carbon) storage shall not be considered	Not specified	Consideration on carbon storage of products is rarely needed for EE products except some special cases, e.g. a product uses wood and it will be landfilled
Delayed emissions (End-of-life phase)	Consistent with Goal & Scope	Consistent with time boundary setting	Delayed emissions associated with end-of-life should be included		Refer to ISO	Included: Provides calculation method	Not specified			Obligatory. Simplified rules when data not available	delayed emissions shall not be considered	Not specified	Not commented
Renewable electricity generation	Consistent with Goal & Scope	Rules to avoid double-counting	Plan to include rules, not decided yet	Considered	Not specifically mentioned	Rules to avoid double-counting	Plan to include rules, not decided yet	Considered in Korean electricity LCI DB	May report, at self-consuming case	considered in case of self-consuming	If excess renewable energy is produced within the organization, it may only be credited to the organization if the credit has not been taken in other related schemes		Rules to avoid double-counting

	ISO 14040/44 (Jul 2006)	ISO/DIS 14067	GHG Protocol Product Standard (WBCSD/ WRI)	ITU-T L.1410	ETSI EE TS 103 199	BSI PAS 2050 (UK)	JIS TS Q 0010 (Japan)	CFP (Korea, Republic of)	BP X30-323 (France)	PEP ecopassport: Product Category Rules for Electrical, Electronic and HVAC Equipments (in complia-nce with ISO 14025) (France]	EC Product Environmental Footprint Guide, 2nd draft	PAIA (U.S. and international)	IEC TR 62725
Assurance /verificat-ion	Peer review	3rd party verification or CFP disclosure report	Assurance required,- Self / internal audit /3rd party (preferred)	Critical review recommended in the case of comparative assertion	Consistent with ISO 14040/44	Assurance required, - Self or 3rd party	ISO-14025 (3rd party verification)	Verification required, - 3rd party verification	Verification required, - 3rd party verification	Independent verification required (ISO 14025: 2006)	shall be reviewed by an independent and qualified external reviewer	Statistical analysis of the uncertainties, and variance Model review by 3rd party	Basically, The result may be verified by an independ-ent 1st party in the organization
(Other issues)				ITU-T L.1410 covers positive effects of ICT goods, networks and services (second-order effects) with a dedicated Part II in the recommenda-tion	Provides detailed guidance for ICT sub-sector covers also positive effects of ICT goods, networks and services (second-order effects)	Provisions for development and use of supplemen-tary requir-ements							

Annex C
(informative)

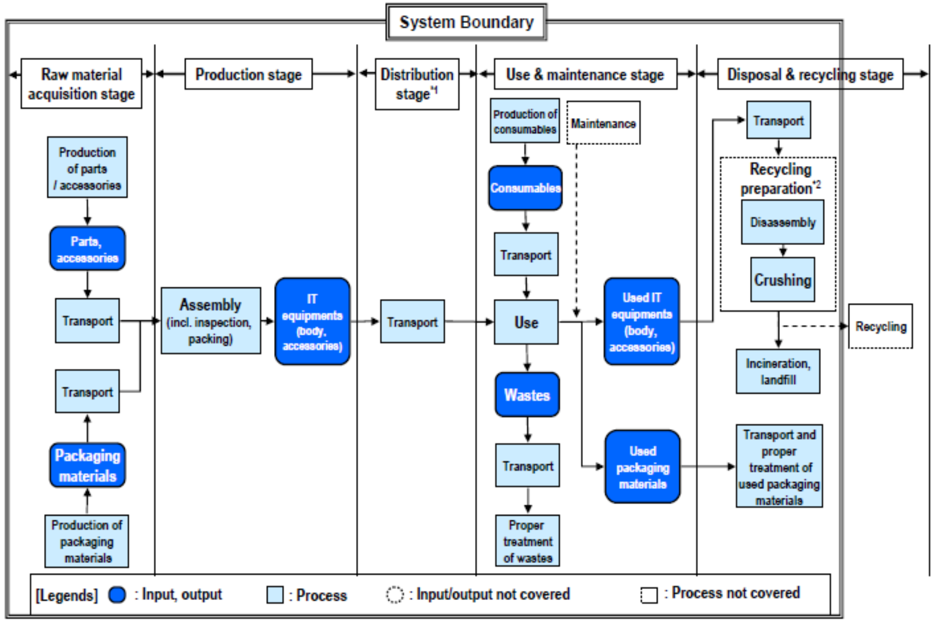
Examples of PCRs/Sector specific rules

C.1 General

This annex includes only extracted contents of main items of PCRs for illustrative purposes. If organizations intend to use these examples for actual purposes, they should refer to the sources.

C.2 Example – IT equipment (Japanese CFP programme)

Title	**Product Category Rules (PCR) – IT equipments**
URL	http://www.cms-cfp-japan.jp/english/pcr/pdf/61-I_PCR_PA-CI-01.pdf
Scope	This PCR prescribes rules, requirements and instructions for calculation and communication applicable to "IT equipments" under the JEMAI CFP Program
Definitions of products	"IT equipments" covered by this PCR are machinery and equipment categorized into "Electronic computers and related equipment" and "Communication and related equipment " as following; – Electronic computers (server computers excluding blade system), Magnetic disk units (subsystem), Switching equipment (L2 switch), PON equipment (ONU) Components of products - IT equipment itself, bundled accessories, packaging materials, and consumables.
Defining the unit of analysis **– Calculation unit**	Sales unit (per machinery or per equipment)

<table>
<tr><td colspan="2">Title</td><td colspan="4">Product Category Rules (PCR) – IT equipments</td></tr>
<tr><td>System boundary</td><td>life cycle stage</td><td>Raw material acquisition
Production
Distribution
Use and maintenance
Disposal and recycling</td><td>Process map (life cycle flow)</td><td>
</td><td>*1 the “sales process” in the distribution stage is provisionally excluded from the assessment until its proper calculation method is finally established.

*2 As for recycling, up to and including recycling processes shall be calculated. In this PCR, “disassembly” and “crushing” processes are applied.</td></tr>
</table>

Title		Product Category Rules (PCR) – IT equipments
	Data collect-ion and period	(i) General – Indirect department (e.g., clerical department, research department, etc.) and, capital goods such as facilities used for manufacturing/transporting products shall be excluded. – Primary data shall be collected over the most recent one year. The data is regarded as averaged value of those annual data. (ii) Data collection items

Stage	Subject of process	Input data (Primary data collection)	
Raw material acq isition	Production of parts/accessories Production of packaging materials Transport	Weight of parts/accessories by material Weight of packaging materials Amount of part/accessories and packaging materials to be transported	NOTE If there are so many suppliers and the collection of the data is difficult, however, primary data shall be collected for 50 % or more of the respective total procurement amount by part. To cover the rest of it, the averaged value of the primary data which could be collected may be used.
Production	Assembly (including inspection and packing) of IT equipments (body, accessories)	Amount of energy related to assembly (including inspection and packing) of IT equipments (body, accessories)	
Distribution	Transport from production site to user	Transported amount of IT equipments (body, accessories), packaging materials	NOTE As for transport, if primary data collection is difficult, the scenario in Annex (normative) may be used.
Use and maintenance	Electricity consumption when using IT equipments Production of consumables Proper treatment of consumables (wastes) to be disposed Transport	Electricity consumption when using IT equipments [unit: kW] Weight of consumables Mass of consumables (waste) to be disposed of Amount of consumables to be transported use stage, transported amount of consumables (waste) to be disposed of	NOTE 1 As for transport scenario of consumables, if primary data collection is difficult, the scenario in Annex (normative) may be used. NOTE 2 As for transport scenario of consumables (waste), if primary data collection is difficult, the scenario in Annex (normative) may be used.
Disposal and recycling	Recycling preparation (disassembly, crushing) of used IT equipments (body, accessories) Landfill of materials not to be recycled Incineration of materials not to be recycled Proper treatment of used packaging materials Transport	Weight of used IT equipments (body, accessories) Weight of used IT equipments to be disassembled and crushed Weight of landfilled materials not be recycled Weight of incineration materials not be recycled	NOTE As for transport of used IT equipments (body, accessories), if primary data collection is difficult, the scenario in Annex (normative) may be used.

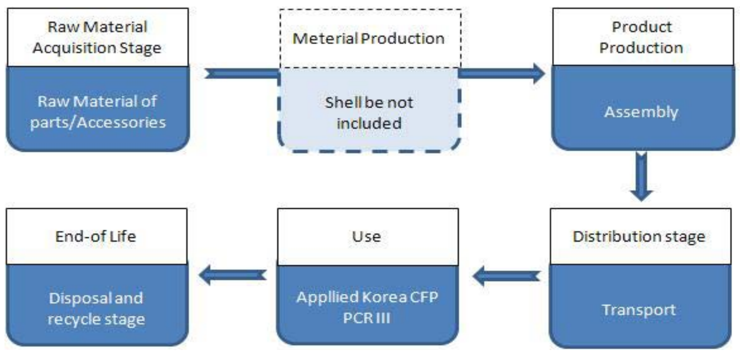
	Alloca-tion	Weight ratio shall be used. When another allocation method is used according to process characteristic, the allocation method and its validity shall be verified.
	Cut-off criteria	Cut-off shall be conducted provided that it is difficult to use any scenarios, similar data, and estimated data. When conducting cut-off, GHG emissions to be conducted cut-off shall be within 5 % of the total life cycle GHG emissions, and the range of the cut-off shall be clearly reported.

Title	Product Category Rules (PCR) – IT equipments
Items applied secondary data	The database prepared for this program is applied. Tentative Database of GHG Emission Factors for the CFP Pilot Project
Use and maintenance scenario	Process related to electricity consumption when using IT equipments. The following “operating time [h]” shall be used for each machinery/equipment. Electronic computers (server computers excluding blade system): Operating time [h] = 24 [h/day] 365 [day/year] Use period [year] Magnetic disk units (subsystem): Operating time [h] = 24 [h/day] 365 [day/year] Use period [year] Switching equipment (L2 switch): Operating time [h] = 24 [h/day] 365 [day/year] Use period [year] PON equipment (ONU): Operating time [h] = 24 [h/day] 365 [day/year] Use period [year] Use period of machinery/equipment shall be set based on statutory durable period of depreciation (hereinafter referred to as “statutory durable period”).
End-of-life scenario	Primary data shall be collected for respective processing amount of “recycling preparation (disassembly, crushing) of used IT equipments (body, accessories),” “landfill of materials not to be recycled,” and “incineration of materials not to be recycled”. If it is difficult to collect those primary data, however, the scenario in Annex (normative) may be used by assuming that the product itself is disposed of without any processing.
Communication	Unit to be displayed for CFP (approved by the CFP verification panel). Calculation unit shall be used. When displaying “GHG emissions per function”, for example, the following displays are considered for each category of equipment. e.g. Magnetic disk units (subsystem): Display numerical value calculated by dividing “life cycle GHG emissions in a sales unit” by storage capacity and the use period defined (operating time).
(Other issues)	Term of validity, scheduled until March 31, 2013. “Transport scenario” and “Disposal and recycling scenario” are specified to the Annex (normative).

NOTE 1 This example shows the outline of PCR.

NOTE 2 Validity dates included in the table above are only examples.

C.3 Example – Energy-using durable goods (Consumer goods) (Korea CFP labelling certification)

<table>
<tr><td>Title</td><td colspan="4">Korea carbon footprint labeling certification (Example: Application to a refrigerator)</td></tr>
<tr><td>PCR</td><td colspan="4">The refrigerator is followed by two kind of PCRs that are Korea CFP PCR II and III.
– Korea CFP PCR II: Energy-using durable goods (general PCR)
– Korea CFP PCR III: Energy using scenario
Energy-using durable goods: consumer goods that require energy for use, e.g. refrigerators and washing machines.
– “Energy-using durable goods” included EE products and other energy using products such as automobile, gas stove, industrial gas heating pump and etc.</td></tr>
<tr><td>URL</td><td colspan="4">http://www.edp.or.kr/carbon/english/main/main.asp and http://www.keiti.re.kr/eng/action.do</td></tr>
<tr><td>PCR Scope</td><td colspan="4">Korea CFP PCD is developed for certification of labeling.
– The PCR II prescribes rules, requirements and instructions for calculation and communication applicable to “Energy-using durable goods” under the Korea CFP labeling
– The PCR III prescribes how carbon emission of specific EE product using phase calculate.</td></tr>
<tr><td>Definition and Scope of products</td><td colspan="4">Scope of Application: this measurement/calculation method is applicable for all ranges of home and commercial electric freezer, refrigerator.
Function: refrigeration and freezing of food for prolonged storage of food.</td></tr>
<tr><td>Defining the unit of analysis
– Calculation unit</td><td colspan="4">Sales unit(per unit)
Two door refrigerator (weight of refrigerator: 146 kg, weight of packing material: 10 kg)</td></tr>
<tr><td>System boundary</td><td>life cycle stage</td><td>Raw material Acquisition
Production
Distribution
Using phase
Disposal and recycling</td><td>Process map (life cycle flow)</td><td>

Material production shell is not included Distribution
Distribution of product is considered distance from factory to region.(Distance that is from market to customer’s place is not included)
Ratio of recycle and disposal(landfill, incineration) is base on Korea national statistics(publish by Ministry of Environment)</td></tr>
</table>

Data collection and quality

(i) General

Primary data should be collected at relevant business sites for calculation of GHG emissions subject to assessment.

Data collected at business sites should be primary data in a stationary state. The cumulative average data of most recent one year out of the three years from the data of application for a carbon footprint label can be collected.

(ii) Data need not be collected

Data on capital goods such as facilities and buildings and expendables that are no directly related to product production(work uniform, gloves, lubricant, etc)

Data on energy use for transportation within a business site and employees' commuting by company-owned cars.

(iii) Data collection

Time boundary

- Product production period: (e.g. 2010.01.10 ~ 2010.03.31)
- Distribution period: (e.g. 2010.1.10 ~ 2010.04.08)

Geographical boundary

- Product production: On-site in Korea
- Distribution: Republic of Korea

Data collection of each stage.

Stage	Subject of process	Data
Raw material acquisition	Production of raw material of parts/accessories Production of packaging materials Transport	Raw material data was used Korea national LCI data base ※Korea LCI data base is developed as base on ISO 14040s
Production	Assembly (including inspection and packing) process Waste treatment process(all pollutants)	Amount of energy related to assembly (including inspection and packing) process to produce refrigerator Weight amount of input and output materials in the assembly process
Distribution	Transport from production site to each region markets	Transport method Transported amount of the refrigerator
Use and maintenance	Electricity consumption	The experiment result of electricity consumption that is verified by national certification institute
Disposal and recycling	Recycling preparation (disassembly, crushing) of used IT equipments (body, accessories) Landfill of materials not to be recycled Incineration of materials not to be recycled Proper treatment of used packaging materials Transport	Weight of waste material Weight of incinerated and landfilled materials Ratio of recycle, incineration and landfill material.

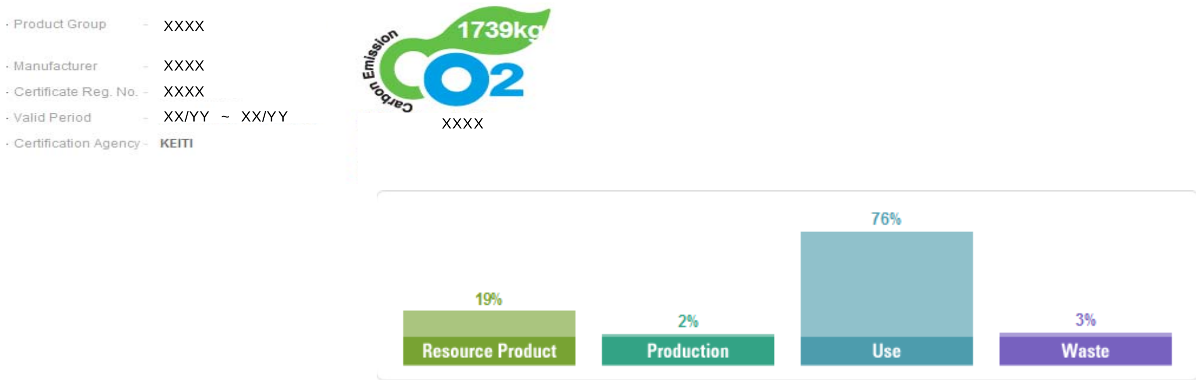
Cut-off criteria

First, collect data on the "consumption of raw materials and auxiliary materials that are accountable for cumulative mass contribution of up 95 % at each assembly stage or of total parts used" versus the "total raw materials and auxiliary materials used".

Second, in relation to the assemblies and parts that is included pursuant to the foregoing first step, collect data on the consumption of each material that are accountable for cumulative mass contribution of up to 95 % at each assembly stage or of parts used.

However, when calculating the cumulative mass contribution, process water, utilities (compressed air, compress nitrogen, steam, cooling water, etc), energy and packing materials should be exclude.

	Allocation	(i) General The following allocation standard based on weight ratios applies to the allocation of the environmental impact across the product and the byproducts during the product manufacturing process. Even if byproducts in the middle of the manufacturing process, it should be assumed that those byproducts are produced at the end of the process. For products and byproducts that meets certain condition, apply following allocation standards other than weight ratio-based allocation standards. – Price, boiling point, caloric value, etc. If matter and/or energy are circulated for reuse within a business site, the reused amounts should be excluded from the amount of input. Recycle is applied to open loop recycling. (ii) In case of a refrigerator Basically, carbon emission of the refrigerator was calculated by general allocation rule in PCR II. Allocation of energy and steam in the assembly process is based on number of products.
Items applied secondary Data		(i) General If there is no primary data, secondary data should be used. In case there are multiple sets of data, secondary date should be selected in order or geographical relevance, chronological relevance, and technical relevance. If there is no data available for certain phases or process, type of missing data and for their absence should be indicated in the report. – National life cycle inventory (LCI) data authorized by the government concerned – Industry average LCI data (APME, IISI, etc.) – Other LCI data (similar data, etc.) (ii) In case of a refrigerator Korea carbon emission factors were used for calculating GHG emission of refrigerator Korea carbon emission factors were developed as base on Korea National LCI DB
Use and maintenance scenario		(i) General GHG emission of EE products using phase should be calculated flowing the Korea CFP PCR III There are 36 specific using state scenarios (PCR III) that include EE products and other energy using products (ii) In case of a refrigerator Useful life is assumed to be 7 years. Total power consumption $(P)_{[kwh]}$ of refrigerator over useful life shall be calculated using the following method and relevant underlying data in form of report by certified testing agency, shall be presented. Total Power consumption$_{[kwh]}$ = monthly power consumption$_{[kwh/month]}$ $12_{[month]}$ useful life of product$_{[yr]}$ – Monthly power consumption shall be measured "Standard for Efficient Operation and Use of Equipment and Material(Ministry of Knowledge Economy Public Notice)" Refrigerant – Amount of refrigerant recharged during product use phase is assumed as zero.

End-of-life scenario	The end of life phase should take into different end of life scenarios of materials that compose the product. The end of life scenarios have to flow “Nationwide Waste Generation and Treatment(recycle, incineration, landfill) Status” that is published by Ministry of Environment. The “Nationwide waste generation and treatment (recycle, incineration, landfill) status” is consisted with three parts. a) Industry waste generation and treatment(recycle, incineration, landfill) status b) Normal waste generation and treatment(recycle, incineration, landfill) status c) Recycle waste materials in legal obligation generation and treatment (recycle, incineration, and landfill) status Ex) Iron waste: 100 kg Iron waste is recycle waste material in legal obligation – First, iron waste is applied by obligation recycle ratio (74 %) – GHG emission of 74 kg of iron waste is calculated by c) (landfill: 0.1 %, incineration: 0.2 %, recycle: 99.7 %) – GHG emission of 26 kg of iron waste is calculated by b) (landfill: 92.7 %, incineration: 2.6 %, recycle: 4.7 %)
Communication	Carbon footprint labeling is put on the refrigerator for communicating to costumer. <u>Example: Application to “product A” refrigerator</u> 
(Other issues)	Cut-off exception Some specific materials(such as PCB board) that have large amount of carbon emission should be included for calculating product carbon footprint although the materials are below to 95 % of cumulative mass contribution.

NOTE 1 This example shows the case in which PCR is applied to the "product A (refrigerator)".

NOTE 2 Validity dates included in the table above are only examples.

Annex D
(informative)

Additional information on trial estimation approach and uncertainty

D.1 Additional information on trial estimation approach

This Annex describes in more detail iterative trial estimation, an approach that can be used to reduce uncertainty and obviate the need to establish a cut-off boundary, as described in 6.5. This approach contains two parts; simulation-based on high level (or screening) analysis, followed by a targeted data collection to reduce the overall uncertainty.

- Simulation-based high level analysis
  - A high level analysis of the product/system is developed that includes rough estimates with high levels of uncertainty for all activities within the life cycle stages. Uncertainty ranges are determined by under-specifying data both on the materials quantity (amount within the bill of materials received a conservative, or high range of uncertainty) and the type of material (using a range emissions factors for metal rather than only aluminum, for example, where type information is not clear).
  - A statistical screening assessment is performed using simulation approaches to identify which of the product's life cycle activities have the most potential leverage to reduce overall uncertainty. The goal of the analysis is to determine the activities that are the highest contributors to impact as well as those that contribute to the uncertainty.
- Targeted data collection to reduce uncertainty
  - The second part of this approach is based on sensitivity analysis parameters, produced from the simulations quantifying each activity's contribution to the total impact and total variation. For example, the top 10 activities that contribute to a certain threshold of total impact with a particular statistical confidence can be identified, as well as the top 10 activities (some of which may be the same) that contribute greatest to the uncertainty in the analysis. Targeted data collection as described in 6.6 and 6.7 is conducted for these key activities until overall uncertainty is reduced to the point where the desired accuracy is reached.

The benefit of this approach is that data collection efforts are prioritized for improved quality.

D.2 Additional information on uncertainty

As identified in 6.8, the level of uncertainty for some electrical and electronic equipment is significant, and may result from a number of factors:

- Data (parameter) uncertainty, which is related to measured or observed input data uncertainty in both the inventory and translation to impact.
  - Consider the rough uncertainty associated with each item contributing to the final result, taking data quality (age, representativeness, number of sources) into account (often called data quality indicator approach – see next bullet). Then, identify the data which have a significant effect on the calculation result and quantify the uncertainty associated with these items more completely.
  - Data quality indicator-type approaches (DQI) can be used for single data point for a unit process or elementary flow of a unit process when other forms of uncertainty data are not available. Such DQI approaches have been discussed in the relevant LCA literature and can provide added guidance for CFP and LCA studies by the electrotechnical industry.
  - When multiple data points are available, it is recommended that they be used collectively to express the uncertainty in the underlying data. Where there are only two

data points and little information on likelihood a uniform distribution (or range) may be most appropriate.

- Methodological (scenario) uncertainty describes changes in the results based on choices within the analyses such as allocation approaches (particularly significant in manufacturing processes for multiple products or recycling at end-of-life), boundary definition and use phase assumptions such as the duty cycle of a product.
  - Conduct contribution analysis using results based on parametric analysis to identify key scenarios for further investigation.
  - This TR recommends considering the effect of uncertainty within the use stage profile on the final result, through sensitivity analysis as the use stage profile can have a significant effect on the final result of a CFP study for many EE products.
- Model uncertainty refers to uncertainty in the mathematical relationships used to develop LCIs and LCIAs as well as omissions of data or incorrect assumptions. Model uncertainty is typically difficult to measure.

Distinguishing precisely between these three aspects can be difficult as there is overlap among them. Given the prevalence of substantial uncertainty in these analyses it is often infeasible to determine the absolute performance of a product, system or service. Even if a study eliminates all parameter uncertainty, model and scenario uncertainty would still have impact. The limitations that uncertainty presents should be acknowledged; for example, if the overall uncertainty in the system is greater than the differences among a particular decision being considered, one cannot have confidence in the benefit of one alternative over another.

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