PD IEC/TR 62921:2016

BSI Standards Publication

Quantification methodology for greenhouse gas emissions for computers and monitors

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62921:2016

National foreword

This Published Document is the UK implementation of IEC/TR 62921:2016. It supersedes PD IEC/TR 62921:2015 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2016.
Published by BSI Standards Limited 2016

ISBN 978 0 580 92418 7
ICS 13.020.20; 35.160

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 Ocotber 2016.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62921:2016

IEC TR 62921

Edition 2.0 2016-10

TECHNICAL REPORT

colour inside

Quantification methodology for greenhouse gas emissions for computers and monitors

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.020.20; 35.160

ISBN 978-2-8322-3647-5

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62921:2016

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Terms and definitions 8
3 Symbols and abbreviations 11
4 Principles 12
4.1 Comparing streamlined CFP to comprehensive CFP 12
4.1.1 General 12
4.1.2 Level of streamlining 13
4.2 Viability of streamlined CFP 13
4.2.1 Streamlining in IEC TR 62725 13
4.2.2 Metrics for streamlining 14
4.2.3 Principles of CFP from IEC TR 62725 16
4.2.4 Uncertainty 16
5 Approaches to streamlined CFP 18
5.1 General 18
5.2 Streamlining of data collection 18
5.2.1 General 18
5.2.2 Approaches to streamlining data collection 18
5.3 Streamlining of data inputs 19
5.3.1 General 19
5.3.2 Approaches to streamlining data inputs (processing) 19
6 Comparative study on existing CFP methodologies 19
6.1 Examples of current worldwide streamlined CFP methodologies 19
6.1.1 General 19
6.1.2 Product attribute to impact algorithm (PAIA) 20
6.1.3 iNEMI eco-impact evaluator 20
6.1.4 Orange Telecom environmental methodology 20
6.1.5 Japan CFP method 20
6.1.6 China CFP method 20
7 CFP product category rules 20
7.1 General 20
7.2 Goal 21
7.3 Covered products 21
7.3.1 In scope 21
7.3.2 Out of scope 21
7.4 Use of primary, primary aggregated and secondary data 22
7.4.1 General 22
7.4.2 Allocation methods 22
7.5 Relevant emission factors and databases 22
7.6 Functional unit 22
7.6.1 General 22
7.6.2 Life cycle stages included 22
7.6.3 Life cycle stages excluded 22
7.7 Production 22

AVA Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

7.7.1 General 22
7.7.2 State-of-the-art calculation recommendations 23
7.8 Chassis 23
7.8.1 State-of-the-art calculation recommendations 23
7.8.2 Additional considerations for input data 23
7.9 Populated printed wiring board (PWB) (excluding integrated circuits) 24
7.9.1 State-of-the-art calculation recommendations 24
7.9.2 Additional considerations for input data 24
7.10 Integrated circuits (ICs) 25
7.10.1 State-of-the-art calculation recommendations 25
7.10.2 Additional considerations for input data 25
7.11 Display 26
7.11.1 State-of-the-art calculation recommendations 26
7.11.2 Additional considerations for input data 26
7.12 Data storage device 26
7.12.1 State-of-the-art calculation recommendations 26
7.12.2 Additional considerations for input data 27
7.13 Optical disk drive (ODD) 27
7.13.1 State-of-the-art calculation recommendations 27
7.13.2 Additional considerations for input data 27
7.14 Power supply unit (PSU, internal or external) 27
7.14.1 State-of-the-art calculation recommendations 27
7.14.2 Additional considerations for input data 28
7.15 Battery 28
7.15.1 State-of-the-art calculation recommendations 28
7.15.2 Additional considerations for input data 28
7.16 Final assembly 29
7.16.1 State-of-the-art calculation recommendations 29
7.16.2 Additional considerations for input data 29
7.17 Final product packaging 29
7.17.1 State-of-the-art calculation recommendations 29
7.17.2 Additional considerations for input data 29
7.18 Distribution 30
7.18.1 State-of-the-art calculation recommendations 30
7.18.2 Additional considerations for input data 30
7.19 Use 30
7.19.1 State-of-the-art calculation recommendations 30
7.19.2 Additional considerations for input data 31
7.20 End of life (EoL) 31
7.20.1 State-of-the-art calculation recommendations 31
7.20.2 Additional considerations for input data 31
8 Documentation 31
8.1 General 31
8.2 CFP database 32
9 Communication and verification 32
Annex A (informative) Results of a comparative study on existing relevant streamlined product carbon footprinting methodologies 33
Annex B (informative) Generic example of streamlined CFP process for ICT products 46
B.1 Initial analysis 46

AVA Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

B.2 Example calculation for a notebook computer 46
B.3 Data collection 47
Annex C (informative) Examples of relevant databases for the IT industry 48
C.1 Ecoinvent 48
C.2 US Life Cycle Inventory 48
C.3 GaBi 48
C.4 ELCD (European Reference Life Cycle Data System) 48
C.5 PAIA (Product Attribute to Impact Algorithm) Data 48
Annex D (informative) Recommended sources for product energy consumption 49
Bibliography 50

Figure 1 – Depiction of how streamlined CFP fits into comprehensive CFP 13

Table 1 – Depiction of how streamlined CFP fits into comprehensive CFP 15
Table A.1 – Comparison of "streamlined" product carbon footprinting methodologies 34

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

INTERNATIONAL ELECTROTECHNICAL COMMISSION

QUANTIFICATION METHODOLOGY FOR GREENHOUSE GAS EMISSIONS FOR COMPUTERS AND MONITORS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 62921, which is a Technical Report, has been prepared by technical area 13: Environment for AV and multimedia equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2015.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
100/2598/DTR	100/2717/RVC

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

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 website 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.

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62921:2016

INTRODUCTION

Many organizations are looking to adopt product greenhouse gas emissions reporting mechanisms, including:

- computer and monitor manufacturers, as well as their suppliers and downstream users;
- governmental agencies including France, China, Japan, Korea and the European Commission;
- retailers and non-regulatory agencies.

There have been several international and regional efforts to provide guidance for calculating product greenhouse gas emissions. Some of these efforts include IEC TR 62725, ITU-T L.1410, ETSI TS 103 199, and Greenhouse Gas Protocol ICT Sector Supplement.

Unfortunately, some lack of specificity within these documents allows for variability that can create a significant difference in product greenhouse gas emission results, depending on how a practitioner interprets the information. Throughout the process of developing IEC TR 62725, there was significant discussion regarding the need for further specificity, transparency and pragmatism in methodology guidance for products covered under IEC TC 100, including computers and monitors. There is an urgent need to enable methodologies that offer accurate and defensible estimates of impact in a rapid and effective manner. This Technical Report aims to fill in some of those gaps.

This Technical Report builds upon the structure laid out by IEC TR 62725. Its goal is to support universal streamlined product greenhouse gas methodologies for practitioners, with a further goal of harmonizing the various regional efforts currently in progress.

This Technical Report's quantification methodology aims to be compliant with, and therefore be used within, a number of these broader standards efforts. It will provide detailed guidance for estimating greenhouse gas emissions for computers and monitors, in order to obtain consistent, accurate results. The benefit of consistent results is that they can assist multiple efforts, including but not limited to:

- supporting customer enquiries;
- instituting sustainable design practices;
- initiating conversations around emissions reduction strategies with suppliers and downstream users;
- targeting data collection within the supply chain in order to address data quality issues.

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

QUANTIFICATION METHODOLOGY FOR GREENHOUSE GAS EMISSIONS FOR COMPUTERS AND MONITORS

1 Scope

This Technical Report outlines detailed guidance to streamline the quantification of greenhouse gas emissions for computers and monitors. Other audio, video and multimedia products, such as e-readers, phones, and storage equipment, can be included in future revisions of this Technical Report.

For this Technical Report, computers and monitors include notebooks, desktops, integrated desktop computers, tablets, thin clients, workstations and monitors.

This Technical Report provides specific guidance for the use of streamlining techniques that minimize cost and resources needed to complete greenhouse gas emissions quantifications. In addition, the product category rules (PCR) section of this Technical Report recommends "state-of-the-art" process and data assumptions in order to reduce uncertainty. Lastly, this Technical Report provides an example of how a calculation could be performed.

2 Terms and definitions

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

2.1
carbon footprint of a product
CFP
sum of greenhouse gas emissions and removals in a product system, expressed as CO_2 equivalents and based on a life cycle assessment using the single impact category of climate change

Note 1 to entry: The CO_2 equivalent of a specific amount of a greenhouse gas is calculated as the mass of a given greenhouse gas multiplied by its global warming potential.

Note 2 to entry: Results of the quantification of the CFP are documented in the CFP study report expressed in mass of CO_2e per functional unit.

[SOURCE: ISO/TS 14067:2013, 3.1.1.1, modified – Notes 2 and 3 have been removed and Note 4 has been renumbered as Note 2.]

2.2
comprehensive carbon footprint of a product
carbon footprint of a product (2.1) that is product-specific and includes the carbon impacts for every component and process in that product's life cycle

2.3
computer
device which performs logical operations and processes data

Note 1 to entry: Computers are composed of, at a minimum:

a) a central processing unit (CPU) to perform operations;

b) user input devices such as a keyboard, mouse, digitizer or game controller; and

c) a computer display screen to output information.

[SOURCE: ENERGY STAR® Program Requirements for Computers]

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

2.4
desktop
computer whose main unit is designed to be located in a permanent location, often on a desk or on the floor

Note 1 to entry: Desktops are not designed for portability and are designed for use with an external monitor, keyboard, and mouse. Desktops are intended for a broad range of home and office applications, including point of sale applications.

[SOURCE: ENERGY STAR® Program Requirements for Computers]

2.5
greenhouse gas emissions
GHG emissions
total mass of greenhouse gases released to the atmosphere over a specified period of time

[SOURCE: ISO 14064-1:2006, 2.5, modified – Use of the plural in the terms.]

2.6
integrated desktop computer
computer in which the computing hardware and monitor are integrated into a single housing, and which is connected to a.c. mains power through a single cable

Note 1 to entry: Integrated Desktop Computers come in one of two possible forms:

a) a system where the monitor and computer are physically combined into a single unit; or

b) a system packaged as a single system where the monitor is separate but is connected to the main chassis by a d.c. power cord and both the computer and monitor are powered from a single power supply.

As a subset of desktops, integrated desktop computers are typically designed to provide similar functionality as desktops.

[SOURCE: ENERGY STAR® Program Requirements for Computers]

2.7
monitor
product with a display screen and associated electronics, often encased in a single housing, that as its primary function produces visual information from a computer, workstation, or server

Note 1 to entry: Visual information input can be received via one or more inputs (e.g., VGA, DVI, HDMI, DisplayPort, IEEE 13994, USB), external storage (e.g. USSB flash drive, memory card), or a network connection.

[SOURCE: ENERGY STAR® Program Requirements for Displays]

2.8
notebook computer
computer designed specifically for portability and to be operated for extended periods of time both with and without a direct connection to AC mains power source

Note 1 to entry: Notebooks include an integrated monitor, a non-detachable, mechanical keyboard (using physical, moveable keys) and pointing devices.

[SOURCE: ENERGY STAR® Program Requirements for Computers]

2.9
primary data
data collected from specific processes in the studied product's life cycle

[SOURCE: GHG Protocol Product standard:2011]

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

2.10
primary aggregated data
data that are collected directly from suppliers or industry associations on a product type (not specific product) and aggregated

Note 1 to entry: This is an approach in which single components can be sourced from multiple suppliers each with multiple facilities and multiple downstream suppliers. Primary data for every item is impossible.

2.11
product category rules
PCR
set of specific rules, requirements and guidelines for quantification and communication on the carbon footprint of a product for a specific product category

[SOURCE: ISO TS 14067:2013, 3.1.4.12, modified — “for developing Type III environmental declarations for one or more product categories” has been replaced by "for quantification and communication on the carbon footprint of a product for a specific product category".]

2.12
secondary data
process data that are not from specific processes in the studied product’s life cycle

[SOURCE: GHG Protocol Product standard:2011]

2.13
state-of-the-art
<data and processes> developed stage of technical capability at a given time as regards products, processes and services, based on the relevant consolidated findings of science, technology and experience

[SOURCE: ISO/IEC Guide 2:2004, 1.4, modified — The domain “<data and processes>” has been added before the definition.]

2.14
streamlined carbon footprint of a product
carbon footprint of a product (2.1) that involves some level of simplification compared to a comprehensive carbon footprint

Note 1 to entry: Typical approaches to streamlining a product carbon footprint calculation consist of simplifying data collection and/or reducing the number of data inputs required.

2.15
slate
tablet
computer designed for portability that meets all of the following criteria:

a) includes an integrated display with a diagonal size greater than 1 650 mm (6,5 inches) and less than 4 420 mm (17,4 inches);
b) lacking an integrated, physical attached keyboard in its as-shipped configuration;
c) includes and primarily relies on touchscreen input (with optional keyboard);
d) includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and
e) is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device)

[SOURCE: ENERGY STAR® Program Requirements for Computers]

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

2.16
thin client
independently-powered computer that relies on a connection to remote computing resources (e.g., computer server, remote workstation) to obtain primary functionality

Note 1 to entry: Main computing functions (e.g. program execution, data storage, interaction with other Internet resources) are provided by the remote computing resources.

Note 2 to entry: Thin clients covered by this Technical Report are

a) limited to devices with no rotational storage media integral to the computer and

b) designed for use in a permanent location (e.g. on a desk) and not for portability.

[SOURCE: ENERGY STAR® Program Requirements for Computers]

2.17
uncertainty analysis
systematic procedure to quantify the uncertainty introduced in the results of a life cycle inventory analysis due to the cumulative effects of model imprecision, input uncertainty and data variability

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 14040:2006, 3.33, modified – The note has been changed.]

2.18
workstation
high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other compute intensive tasks

[SOURCE: ENERGY STAR® Program Requirements for Computers]

3 Symbols and abbreviations

AC	alternating current
CAD	computer-aided design
CFP	carbon footprint of a product
CPU	central processing unit
DQI	data quality inventory
DR	distinction rate
DVI	digital visual interface
EE product	electrical and electronic product
EoL	end-of-life
FS	false signal rate
HDD	hard disk drive
HDMI	high-definition multimedia interface
ICs	integrated circuits
ICT	information and communications technology
IEEE	institute of electrical and electronics engineers
kg CO_2e	kilograms of carbon dioxide equivalent
LCA	like cycle assessment
LCD	liquid crystal display

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

LCI	life cycle inventory
LCIA	life cycle impact assessment
LCT	life cycle thinking
ODD	optical disk drive
PAIA	product attribute to impact algorithm
PCR	product category rules
PSU	power supply unit
PWB	printed wiring board
SSD	solid state drive
TEC	typical energy consumption
USB	universal serial bus
VGA	video graphics array
VT	validation team

4 Principles

4.1 Comparing streamlined CFP to comprehensive CFP

4.1.1 General

The carbon footprint of a product estimates the total potential contribution of a product to global warming by quantifying all significant greenhouse gas emissions and removals over the product's life cycle. Comprehensive CFPs are product-specific and include the carbon impacts for every component and process in that product's life cycle. A comprehensive CFP takes a significant amount of resources, time, and data-demands to complete.

Given these challenges, streamlined CFP approaches are critical, particularly in industries such as the information and communications technology (ICT) industry, which have complex products and rapid product-development cycles. The streamlined approach reduces the amount of time and resources needed for data gathering and calculation in order to achieve the needed level of accuracy. Therefore, the streamlining approach follows the rule that only the materials, components and processes that are associated with the most significant product carbon impacts are included in the analysis.

While many different definitions of a streamlined CFP exist, the common characteristic is that they all involve some level of simplification, as compared to a comprehensive CFP. With comprehensive CFPs rarely being executed, it is this collection of streamlined CFP approaches that represent a common approach to CFP. These streamlined approaches, when executed according to recognized practices, reduce the burden of a CFP, while still allowing the necessary goals of the CFP to be achieved (see Figure 1).

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

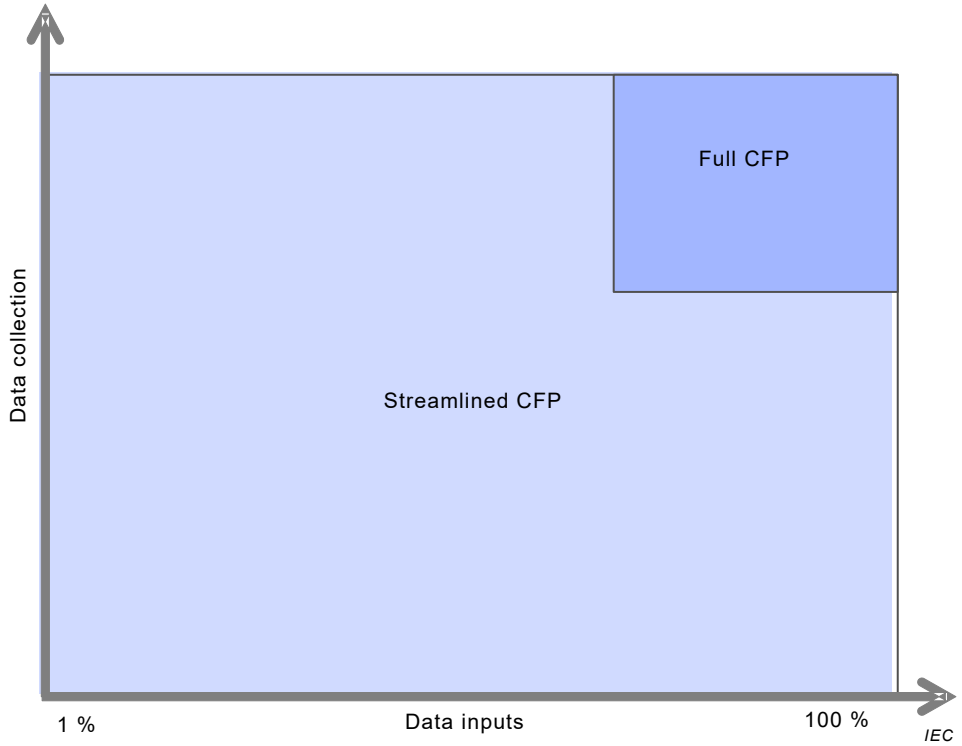

Figure 1 – Depiction of how streamlined CFP fits into comprehensive CFP

4.1.2 Level of streamlining

While streamlined CFPs are clearly less resource-intensive, the extent of streamlining that is possible is entirely dependent on the goal of the CFP and, more specifically, the questions that the CFP is attempting to answer. Typically, the more general the questions are that need to be answered, the more streamlined the CFP can be.

For example, high-level product CFPs, focused on understanding the overall impact of a product or which life cycle phases dominate product impact, can be completed using a streamlined CFP. For such cases, the additional resolution and specificity provided through a more comprehensive CFP are not needed.

However, if information is needed to assess specific materials or design choices around a product (i.e. evaluating materials used in packaging, or evaluating trade-offs in product design), then a more specific and detailed analysis is warranted. In this case, improved data collection and more primary data input can be required, leading to a more comprehensive CFP. In general, the more specificity that is required in the CFP results, the more comprehensive the CFP will need to be.

4.2 Viability of streamlined CFP

4.2.1 Streamlining in IEC TR 62725

Streamlined methodologies that apply a trial estimation approach are described in IEC TR 62725:2013, 6.4, 6.5, Annex B and Annex D. Rather than applying a quantitative cut-off threshold (e.g. less than 5 % of the total estimated emissions can be excluded from the CFP analysis) as described in IEC TR 62725, in the streamlined approach a high level statistical analysis using available data and Monte Carlo simulations is performed to determine the life cycle 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. Use of a streamlined approach informs the appropriate cut-off criteria in view of the workability and availability of the process data.

AVA Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016

4.2.2 Metrics for streamlining

In order to determine whether the result of a CFP analysis is sufficient given the degree of uncertainty present in all aspects of the calculation (see 4.2.4), measures of resolution are often calculated. This can be done as part of a sensitivity check in order to determine the ability of the CFP analysis to find significant differences between different studied alternatives, as described in ISO 14044.

One common way to assess whether a result is “good enough” to answer the question posed is to determine how much overlap there is between the sampled distribution corresponding to the product of interest and a variety of related alternatives. (For example, this could be a comparison of the product of interest with another product utilizing a different set of materials or architecture.) When the uncertain CFP of the product of interest overlaps considerably with the uncertain CFP of the alternative, then it would be inappropriate to declare that the two have different CFPs. If there is little overlap, then one could confidently identify a difference and therefore which of the two alternatives had the lower CFP.

There are several terms used to describe this degree of overlap (i.e. between the estimated CFP of the product of interest and the estimated CFP of an alternative) including the comparison indicator, distinction rate (DR), or false signal rate (defined below). For this discussion, distinction rate will be used to signify how distinct the product of interest is from a selected baseline. Distinction rate essentially quantifies the frequency at which one of the alternatives has a distinctly lower CFP than the other alternative or a prescribed benchmark (described subsequently).

To calculate the distinction rate between the product of interest (B) and the baseline or benchmark (A), the expected distribution for CFP_B as well as for CFP_A should be sampled via statistical simulation, such as through Monte Carlo sampling. The formulation for this distinction rate (DR) is then expressed as:

$$DR = P\,(CFP_B < CFP_A)$$

where

DR is the distinction rate;

P is the probability;

CFP_B is the CFP for the product of interest;

CFP_A is the CFP for some baseline comparison product.

The probability of $CFP_B < CFP_A$, can be estimated directly from the Monte Carlo simulation results by comparing scenario pairs CFP_A and CFP_B and calculating the relative frequency where $CFP_B < CFP_A$. The false signal rate (FS) is a specific version of the distinction rate defined as the frequency of observing a result where the CFPs of the products are comparatively different (higher than, or lower than the other) than would be expected based on the relative position of the mean CFP (μ, μ_A for product A and μ_B for product B). That is:

$$FS = \begin{cases} P(CFP_B < CFP_A), \text{ where } \mu_A < \mu_B \\ P(CFP_A < CFP_B), \text{ where } \mu_A > \mu_B \end{cases}$$

It is important to note that there is often correlation among life cycle activities across a product of interest and a baseline, particularly for downstream activities such as the grid mixes associated with use phase.

In assessing the difference between the uncertain impact of a product of interest and a baseline, therefore, consider correlation (i.e. the degree to which two or more variables are related in some fashion) to avoid statistical bias. To that end, the analysis should probably be conducted simultaneously for both the product and baseline such that for each Monte Carlo run the same sample sets are used for the correlated activities and parameters.

AVA Documents
Document Sharing Hub

Another form of resolution metric which is often reported is referred to as the comparison indicator (β), which is defined as the probability that the ratio between the product of interest and the baseline is less than one, that is

$$\beta = P\left(\frac{CFP_B}{CFP_A} < 1\right)$$

where

β is the comparison indicator;

P is the probability;

CFP_B is the CFP for the product of interest;

CFP_A is the CFP for some baseline comparison product.

This enables characterization of the likelihood that the baseline has lower impact than the product of interest.

A decision regarding the sufficiency of the analysis can then be made when β is greater than a prescribed threshold. This threshold is a decision parameter that controls the level of risk that a decision-maker is willing to take and should be set by the decision-maker for a given context. If the metric of interest does not indicate that there is high statistical confidence in the comparison result (i.e. there is high risk that a conclusion drawn on this result will be directionally incorrect), the analyst has the option either to declare the products not differentiable or to attempt to collect additional more precise data to improve the resolution of the analysis.

An example of a hypothetical benchmark could be the use of the same data distribution for a product of interest displaced by a difference threshold established in the goals of the study. This difference threshold distance could be defined as a percentage of the magnitude of the mean, i.e. shifting the mean of A (μA) by 10 %. The reason for this sort of a benchmark would be if data for another product were not available. Another example could be a product analysis for a larger or smaller screen size in the case of a laptop.

An example of the above calculations for a hypothetical comparison is shown in Table 1.

Table 1 – Depiction of how streamlined CFP fits into comprehensive CFP

Monte Carlo trial	Footprint of product of interest (CFP_B)	Footprint of alternative product (CFP_A)	Is $CFP_B < CFP_A$?	Is $CFP_A < CFP_B$?	Ratio CFP_B/CFP_A
1	73	71	–	Y	1,02
2	77	131	Y	–	0,59
3	90	92	Y	–	0,99
4	92	122	Y	–	0,76
5	98	74	–	Y	1,32
6	103	122	Y	–	0,85
7	81	90	Y	–	0,90
8	96	105	Y	–	0,91
9	104	87	–	Y	1,19
10	100	154	Y	–	0,65
	91 Average CFP_B (μ_B)	105 Average CFP_A (μ_A)	0,7 Distinction rate (DR)	0,3 False signal rate (FS)	0,70 Comparison indicator (β)

AVA Documents
Document Sharing Hub
Full document details: PD IEC/TR 62921:2016