IEC TR 62921

Edition 1.0 2015-02

TECHNICAL REPORT

Quantification methodology for greenhouse gas emissions for computers and monitors

IEC TR 62921:2015-02(en)

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colour inside

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.020.20; 35.1160

ISBN 978-2-8322-2272-0

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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QUANTIFICATION METHODOLOGY FOR GREENHOUSE GAS EMISSIONS FOR COMPUTERS AND MONITORS

FOREWORD

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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.

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

Enquiry draft	Report on voting
100/2381/DTR	100/2448/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 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- withdrawn,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.

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 computer and monitor products, 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.

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, tablets, thin clients, workstations and storage equipment, can be included in future revisions of IEC TR 62921.

For this Technical Report, computers and monitors include notebooks, desktops, and liquid crystal display (LCD) 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]

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: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer display screen to output information

[SOURCE: ENERGY STAR® Program Requirements for Computers]

2.4
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]

2.5
monitor
electronic device that displays a computer’s user interface and open programs

[SOURCE: ENERGY STAR® Program Requirements for Displays]

2.6
primary data
data collected from specific processes in the studied product’s life cycle

[SOURCE: GHG Protocol Product standard: 2011]

2.7
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.

2.8
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 — deleted “for developing Type III environmental declarations”]

2.9
secondary data
process data that are not from specific processes in the studied product’s life cycle

[SOURCE: GHG Protocol Product standard: 2011]

2.10
state-of-the-art
<data and processes> developed stage of technical capability at a given time as regards to products, processes and services, based on the relevant consolidated findings of science, technology and experience

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

2.11
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.

2.12
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]

3 Symbols and abbreviations

CFP	carbon footprint of a product
DQI	data quality inventory
DR	distinction rate
EE product	electrical and electronic product
EoL	end-of-life
FS	false signal rate
HDD	hard disk drive
ICs	integrated circuits
ICT	information and communications technology
kg CO_2e	kilograms of carbon dioxide equivalent
kWh	kilowatt per hour
LCD monitor	liquid crystal display monitor
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
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).

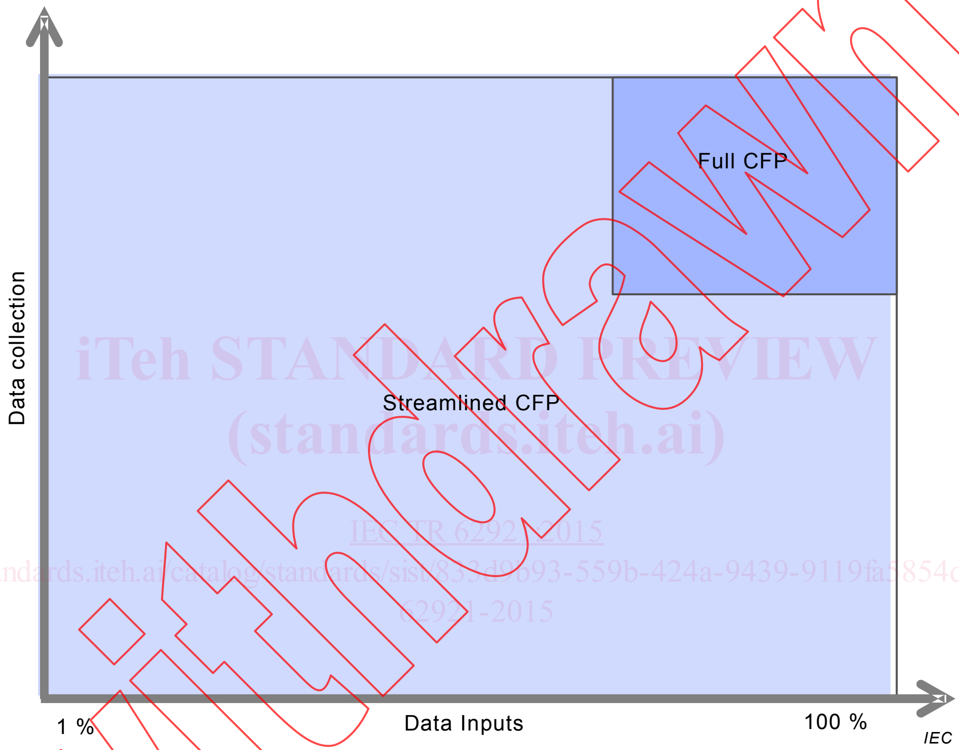

Figure 1 – Depiction of how streamlined CFP fits into comprehensive CFP

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 and 6.5, and Annexes B and 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.

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:

$$FS = \begin{cases} P\left(CFP_{\mathrm{B}} < CFP_{\mathrm{A}}\right), \text{ where } \mu_{\mathrm{A}} < \mu_{\mathrm{B}} \\ P\left(CFP_{\mathrm{A}} < CFP_{\mathrm{B}}\right), \text{ where } \mu_{\mathrm{A}} > \mu_{\mathrm{B}} \end{cases}$$

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 likely 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.

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

$$\beta = P\left(\frac{CFP_{\mathrm{B}}}{CFP_{\mathrm{A}}} < 1\right)$$

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 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.