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Environmental management — Life cycle assessment — Principles, requirements and guidelines for normalization, weighting and interpretation

Management Environnemental — Analyse du cycle de vie — Principes, exigences et lignes directrices pour la normalisation, la pondération et l'interprétation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 5, *Life cycle assessment.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The United Nations Sustainable Development Goals (SDGs)[3] identify the need for transition toward sustainable patterns of consumption and production. Life cycle assessment (LCA) can support this goal with a quantitative approach to evaluating the environmental impacts of products from raw material acquisition to end-of-life treatment (disposal, recycling, etc). It can help with the identification of improvement potentials of measures to achieving SDGs and can compare alternative approaches on product, company and country levels.

NOTE The term "environmental impact" is always used in the sense of potential environmental impact.

LCA studies can help to identify ways of improving resource and energy efficiency, avoiding releases to the environment, and developing a circular economy. LCA can also help identify and evaluate trade-offs between different environmental aspects and life cycle stages.

ISO 14040 and ISO 14044 are the generic environmental management standards for LCA. These standards provide principles, requirements and guidelines for the four phases of an LCA: goal and scope definition, life cycle inventory analysis, impact assessment and interpretation.

Normalization and weighting are optional elements of life cycle impact assessment (LCIA). These elements can support the interpretation of the assessed life cycle impact category indicator results, also known as the "LCIA profile".

Presently, LCA results are interpreted through a variety of different methods and approaches. A consistent approach to the interpretation of LCA results can be helpful, especially considering the growth in LCA applications, such as:

— LCA-based regulations, e.g. greenhouse gas reporting;

— national programmes for LCA-based environmental statements, e.g. environmental labelling;

— use of LCA to support public and private sector procurement, e.g. environmental product declarations (EPDs), footprint communication.

Through providing additional principles, requirements and guidelines applicable to normalization, weighting and interpretation of LCA results, this document:

— improves the credibility of LCA results;

— increases the use of LCA results in decision-making related to environmental management;

— increases the number of LCA studies and applications;

— improves the interpretation phase of LCA.

In this way, this document aims to increase the contribution of LCA to advancing sustainable consumption and production patterns.

In this document, the following verbal forms are used:

— "shall" indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

— "can" indicates a possibility or a capability.

Environmental management — Life cycle assessment — Principles, requirements and guidelines for normalization, weighting and interpretation

1 Scope

This document specifies principles, requirements and guidelines for normalization, weighting and life cycle interpretation, in addition to those given in ISO 14040 and ISO 14044.

The document is applicable to any life cycle assessment (LCA) and footprint quantification study.

In particular, this document addresses:

— the use of normalization and its limitations;

— the use of weighting and its limitations;

— the selection or development of weighting factors;

— the generation of single scores;

— requirements that relate to documentation and reporting.

For the interpretation phase, it provides, in addition to ISO 14044, procedures and guidance for:

— performing completeness, sensitivity and consistency checks;

— addressing uncertainties and limitations;

— documenting conclusions and recommendations.

This document does not specify the composition of panels for weighting nor does it specify multi-criteria decision analysis.

This document does not intend to recommend or require a specific weighting approach or method or any priority of one weighting approach or method over another as they are based on value choices. Organizations have the flexibility to implement LCA in accordance with the intended application and the requirements of the organization.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14044 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
weighting
converting and possibly aggregating life cycle inventory results or indicator results across impact categories using *weighting factors* (3.4) based on *value choices* (3.7)

Note 1 to entry: Weighting can result in an aggregated score or in multiple scores.

3.2
normalization
calculation of the magnitude of life cycle inventory results or indicator results relative to reference information

Note 1 to entry: The reference information typically has the same unit as the indicator result, e.g. CO2e, so the normalized indicator result is reported without a unit, e.g. in per cent.

3.3
reference information
quantitative data that serves as the basis for comparison

3.4
weighting factor
factor that expresses relative importance

Note 1 to entry: The determination of weighting factors is based on *value choice* (3.7).

3.5
normalization factor
number by which an impact category indicator result is multiplied to obtain a normalized impact category indicator result

Note 1 to entry: The normalization factor is the inverse of the *reference information* (3.3).

3.6
reference system
system that serves as the basis for *normalization* (3.2)

3.7
value choice
subjective decision based on a judgement of what is important

3.8
midpoint indicator
category indicator expressing an environmental impact occurring anywhere along the environmental mechanism before a category endpoint is affected

Note 1 to entry: Despite its name, “midpoint” is not intended to mean that the indicator is located in the (exact) middle of the environmental mechanism.

4 Principles

For the purposes of this document, the principles of ISO 14040 shall apply.

5 General requirements and guidance

Normalization, weighting and interpretation of the results of LCA studies and footprint quantification studies can support informed decision-making.

When LCA results are expressed relative to a reference information, it can help in understanding and communication LCA results.

EXAMPLE Some people find it easier to understand the magnitude of an indicator result related to human toxicity if it is expressed relative to the relevant annual indicator results of an average citizen rather than in units such as comparative toxic unit for human (CTUh).

Similarly, when comparing a range of options, it can be helpful to express results relative to a base case or to a best- or worst-case scenario.

Weighting can help in understanding the relative importance of LCA results covering different impact categories. It can also support the comparison of one LCIA profile with another. However, trade-offs can occur between impact categories, life cycle stages, the geographic regions where environmental impacts occur, and the different areas of concern. These trade-offs are not always evident in results obtained after normalization or weighting. Therefore, whenever normalization and weighting are used, the results shall be reported in sufficient detail to allow understanding of the complexities and trade-offs inherent in the LCA.

Environmental mechanisms have different spatial and temporal scales. In addition, governments and interested parties from different countries and population groups can have different views about environmental priorities. Reference system and information used in the normalization and data used in weighting shall be chosen based on their regional and temporal relevance and shall be documented.

Life cycle inventory results should be consulted iteratively when normalization, weighting and interpretation is performed. When undertaking normalization, weighting and life cycle interpretation, the requirements and guidelines of ISO 14044 shall apply, with a special attention to the validation of data, in accordance with ISO 14044:2006, 4.3.3.2.

Weighting shall not be used in LCA studies intended to be used in comparative assertions intended to be disclosed to the public. However, weighting is permitted for comparisons which are not intended to be used in comparative assertions intended to be disclosed to the public. When publishing a single score weighted result, full non-weighted indicator results shall be available to the public.

6 Normalization

6.1 General

Normalization transforms an indicator result by dividing it by the indicator result for a selected reference system.

Possible uses for normalization include:

— checking the plausibility of impact category indicator results;

— assessment of the relative magnitude of impact category indicator results;

— an intermediate step before weighting;

— assistance in the interpretation of results;

— assistance in communication of results.

Internal normalization describes the situation where the selected reference system is one of the options under study, such as a base case or best-case scenario.

External normalization describes the situation where the selected reference system is external to the product system under study. Examples can include indicator results for:

— a nation or region in a specified time period;

— an average citizen living in a nation or region in a specified time period;

— some other familiar reference, such as driving an average car a specified distance.

EXAMPLE A product is produced and consumed in Germany in 2017. The carbon footprint of the product system was 129 kg CO_2e. The total carbon footprint in Germany in 2017 was 8,7 t CO_2e per citizen. The carbon footprint of the product system can be normalized per citizen in Germany (129/8,700), resulting in a normalized indicator result of 0,014 8 or 1,48 %.

Normalization shall apply the same reference system to all impact categories considered and all the product systems under study. The choice of reference system shall be relevant to and consistent with the goal and scope of the study.

No reference system is unequivocally superior to another.

For a given impact category, the normalization factor and the impact category indicator result shall use the same characterization factors.

Reference systems used for normalization shall be documented and justified in the study report.

The uncertainty and completeness of the normalization factors should be documented when such information is available.

Potential bias introduced by inconsistent elementary flow coverage between the system under study and the reference system shall be documented.

Where the choice of reference system has implications for study results and conclusions, these shall be described in the study report.

When normalization is used as an intermediate step before weighting, the normalization factors shall be relevant for and consistent with the weighting factors applied (e.g. in terms of geographical region or people concerned or involved).

Normalization results without weighting shall not be used for comparisons across impact categories.

6.2 Limitations

Normalization results do not necessarily point to priority environmental concerns. A normalized indicator result of higher value does not necessarily represent an impact of higher environmental concern.

EXAMPLE A product system can make a large contribution to an impact category of smaller environmental concern, or a small contribution to an impact category of larger environmental concern. Similarly, a product system can make a small global contribution to an environmental concern but a large contribution locally. This later case draws attention to the role the choice of reference information can play on study conclusions.

A high normalized life cycle impact category indicator result can be the consequence of one or more of the following:

— high impact category indicator results of the product system under study;

— low impact category indicator results of the chosen reference system (i.e. a high normalization factor);

— a bias introduced by inconsistent elementary flow coverage between the product system under study and the normalization data.

The influence of the above aspects on the normalization results should be taken into consideration in the interpretation of the results.

A change in reference system can change conclusions of the study.

Reflecting globalization of supply chains and products of a long lifetime, different processes of a product system can occur in different regions and at different times. For such cases, the selection of

the reference information can depend on many assumptions, which influences the resulting set of normalized indicator results.

For some cases, reference information is difficult to determine and therefore not readily available in literature and in databases.

Normalization results without weighting cannot be used for interpretation of high or low environmental concerns across impact categories.

7 Weighting

7.1 General

According to ISO 14044, weighting is an additional optional element in LCIA which allows aggregation of category indicators obtained from the LCIA modelling, beyond what characterization models based on natural science can quantify.

The weighting method shall be consistent with goal and scope of the study. While LCA gives priority to natural science, the optional element "weighting" is based on value choices and reflects social values, preferences and attitudes towards environmental impacts. Values are inherently subjective and the values of one person cannot scientifically be given more weight than those of another person. Social science methods can be applied to survey these values from a population of interest.

Weighting supports the practitioner in aggregating results into a single score or into multiple scores by assigning a weighting factor to each impact category or inventory indicator. If weighting factors are developed as part of the study, the selected method and the procedure, including data sources, to determine the final weighting factors shall be documented. If the weighting factors are taken from existing literature, the source shall be referenced.

Weighting reflects a process of quantifying the relative importance of environmental impacts based upon a set of criteria. In weighting, the indicator results are multiplied by weighting factors which quantify the relative importance of the impact category. Weighting factors and their derivation shall be transparent. Weighting shall be justified and documented in a transparent manner.

The selection and derivation of weighting factors shall be consistent with the scope of the indicators and their characterization factors. The scope of each indicator and any limitations shall be presented transparently and considered as part of the process of developing weightings.

The selection and derivation of weighting factors shall be consistent with normalization used.

EXAMPLE If normalization is for a certain country, it is not consistent if the weighting factors are at the regional or global level or for a different country.

Weighting can help to aggregate the LCIA results into a reduced number of impact categories or a single score. The development of a set of weighting factors that is transparently presented and whose limitations are highlighted and discussed can help not only to lead to better decisions but also to make the decision process more transparent. Aggregation should not be applied to data with different dimensions or units.

Weighting is not intended to conceal indicator results in LCA reports. All indicator results prior to and after the weighting in the study shall be included in the LCA report. Life cycle inventory results shall be accessible to the practitioner who performs weighting. Different weighting methods use different criteria on which to convert and aggregate indicator results into one or more aggregated value(s).

The set of weighting factors shall be the same for all alternatives assessed in a study.