

Commentaries

The New International Standards for Life Cycle Assessment: ISO 14040 and ISO 14044

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Abstract

Background, Aims and Scope. The development of the international standards for life cycle assessment (ISO 14040:1997, ISO 14041:1999, ISO 14042:2000, ISO 14043:2000) was an important step to consolidate procedures and methods of LCA. Their contribution to the general acceptance of LCA by all stakeholders and by the international community was crucial. Currently, the process of the revision of this first generation of LCA standards is close to completion. The paper explains the outline as well as formal and technical changes of the coming new international standards of LCA, i.e. the new ISO 14040 and ISO 14044.

Methods. The paper refers to life cycle assessment based on the international standards for LCA (ISO 14040:1997, ISO 14041:1999, ISO 14042:2000, ISO 14043:2000). The content relates to the Final Draft International Standard (FDIS) versions of the new ISO 14040 and ISO 14044.

Results and Discussion. With the publication of the two new standards, ISO 14040 and ISO 14044, the existing four standards ISO 14040:1997, ISO 14041:1999, ISO 14042:2000 and ISO 14043:2000 are technically revised, cancelled and replaced. According to the scope of the revision, the core part of the technical contents remains unchanged. Improved readability and the removal of errors and inconsistencies was the focus of the revision. However, despite the fact that the main technical content was confirmed to be still valid, some relevant formal and technical changes were made. On the technical side these include e.g. the addition of principles for LCA, the addition of an annex about applications, the addition of several definitions (e.g. product, process, etc.), clarifications concerning LCA intended to be used in comparative assertions intended to be disclosed to the public, clarifications concerning the critical review panel, clarifications concerning system boundary, etc. On the formal side, changes include the reduced number of standards, a reduced number of annexes, a reduced number of pages that contain requirements, alignment of definitions and clarification of compliance with the standards.

Conclusion. The two new standards, ISO 14040 and ISO 14044, reconfirm the validity of the main technical content of the previous standards. Errors and inconsistencies were removed and the readability was improved. The added technical content is in line with the previous requirements and serves mainly as a clarification of the technical content. The unanimous vote on the Draft International Standard versions proved that this was achieved on the basis of the broadest possible international consensus.

Recommendation and Outlook. Currently the national member bodies undertake the final voting on the FDIS-versions of the standards. Based on the voting results at the previous stages of the documents, a positive result is expected. The publication of the new international standards for life cycle assessment (ISO 14040 and ISO 14044) is expected around mid-2006. For the sake of the international and stakeholder acceptance of LCA, it is recommended that the new standards serve as core reference documents for the users and practitioners of LCA.

Keywords: ISO; ISO-standards; ISO 14040; ISO 14041; ISO 14042; ISO 14043; ISO 14044; Life Cycle Assessment (LCA)

Introduction

The development of the international standards for life cycle assessment (ISO 14040:1997, ISO 14041:1999, ISO 14042:2000, ISO 14043:2000) was an important step to consolidate procedures and methods of LCA. Their contribution to the general acceptance of LCA by all stakeholders and by the international community was crucial.

The success, for instance, can be measured through the number of documents sold. Although a comparison with other standards is lacking, the sale of 1200 copies of ISO 14040 in Sweden, as well as of 909 copies in the Czech Republic, allows one to ascertain that this product has been useful as well as successful (Klüppel 2002).

As a result of discussions relating to the future strategy of the LCA standards, a task force of the responsible subcommittee 5 (Life Cycle Assessment) of the ISO Technical Committee 207 (Environmental Management) was formed in July 2001 to identify the areas for improvements.

A consensus was achieved on the following 4 key objectives:

- Increase readability by compiling only two documents / merging different documents / reorganising the current standards, but
 - Keep the technical content (only improvements are acceptable)
 - Keep the consensus / balance
 - Keep the requirements

- Address applications of LCA (life cycle thinking; relations to ecolabel, DfE, Life Cycle Management etc.)
 - Integrate the different application of life cycle in TC 207 into SC 5 documents
 - Include the identification of significant environmental aspects (regarding the products of an organisation) as additional application of LCA
- Inclusion of economic and social aspects are beyond the scope of TC207, but links should be addressed
- Give guidance / training for application in industry, government etc., especially in developing countries
 - Translate the LCA language for experts coming from other fields
 - Facilitate the use of the LCA standards
 - Collect case studies using ISO standards showing their applicability

Not all of these issues could be dealt within international standardization. However, most of the issues could be solved by a revision of the standards. To explore this possibility and with a focus to improve the readability of the ISO 14040 series a new ad-hoc group was created in June 2002 to review the ISO 14040/41/42/43 standards with the mandate to seek consensus on a possible way of revision of these standards (boundaries of the revision, structure, contents, etc.) and if there is a consensus, to develop the corresponding New Work Item Proposals (NWIP(s)) with accompanying working documents.

The ad-hoc group, consisting of 21 international experts and co-chaired by Inaba and Finkbeiner, achieved a consensus on a possible way of revision of the standards and developed the necessary elements for the corresponding NWIPs which were presented to SC5 in July 2003.

The scope of the proposed work items was to begin immediately with the revision of the standards ISO 14040, 14041, 14042 and 14043 with the objective of improving readability, while leaving the requirements and technical content unaffected, except for errors and inconsistencies. It was the intention to:

- 1) gather all requirements ('shalls') in one new standard, keeping the structure of 'goal and scope', 'inventory', 'impact assessment' and 'interpretation' as separate chapters,
- 2) maintain 14040 as a framework document, but transferring all requirements ('shalls') to the new standard, adding to 14040 a requirement ('shall') of compliance with the requirements ('shalls') of the new standard.

This proposal was justified with regard to applicability and readability as several member bodies requested an improvement, because the current documents are partly not consistent and not all parts are clear and unambiguous. In addition to language improvement, a merging of standards was requested by some member bodies to make them more readable. As indicated in the scope of the NWIP it was proposed to fulfil this need by two new standards: a revised ISO 14040 standard ('Environmental Management – Life Cycle Assessment – Principles and Framework') and a new standard 14044 containing all requirements ('Environmental management – Life cycle assessment – Requirements and Guidelines').

Therefore, the new ISO 14040 would become a framework and guidance standard, while the new standard 14044 would contain all technical requirements and guidelines on these.

The voting of the international member bodies on this proposal in the autumn of 2003 revealed an almost unanimous result (no negative vote, two abstentions). Therefore, a new working group WG6 (with more than 50 international experts, co-chaired by Finkbeiner, Inaba and Tan, secretariat provided by Christiansen) was created to accomplish the revision of the standards according to the scope of the NWIP.

1 General Outline of the New Standards

The general outline of the two new standards and the relation to the current standards is shown in Fig. 1.

As defined by the scope of the revision, the content of the current standards is transferred to the two new standards. Basically, all technical requirements were transferred to the new ISO 14044 making it the core reference document for the practitioners of LCA. The new ISO 14040 aims to provide a description of LCA principles and framework that is readable and accessible not only for LCA practitioners, but also a broader target audience. The revised 14040 will contain a single, formal requirement of compliance with the new ISO 14044 standard.

In order to arrive at the outlined structure in an effective and efficient way, the working group adopted a revision strategy of three steps:

1. Rearrange
2. Change
3. Enhance

This strategy basically meant, that, first, the technical content of the original 14040-43 standards is to be rearranged according to the NWIPs, and that potential changes are to be addressed as a second step. Editorial issues for improved language were the final step.

Based on this strategy, the roadmap for the revision was developed (Fig. 2). Starting point were the existing documents, i.e. the standards plus the so-called 'should'- and 'shall'-documents respectively. The latter were compiled by Denmark as an exercise to separate all the existing require-

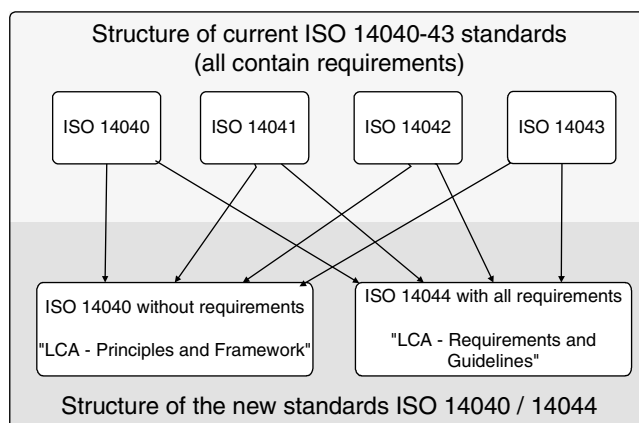


Fig. 1: General outline of the new standards

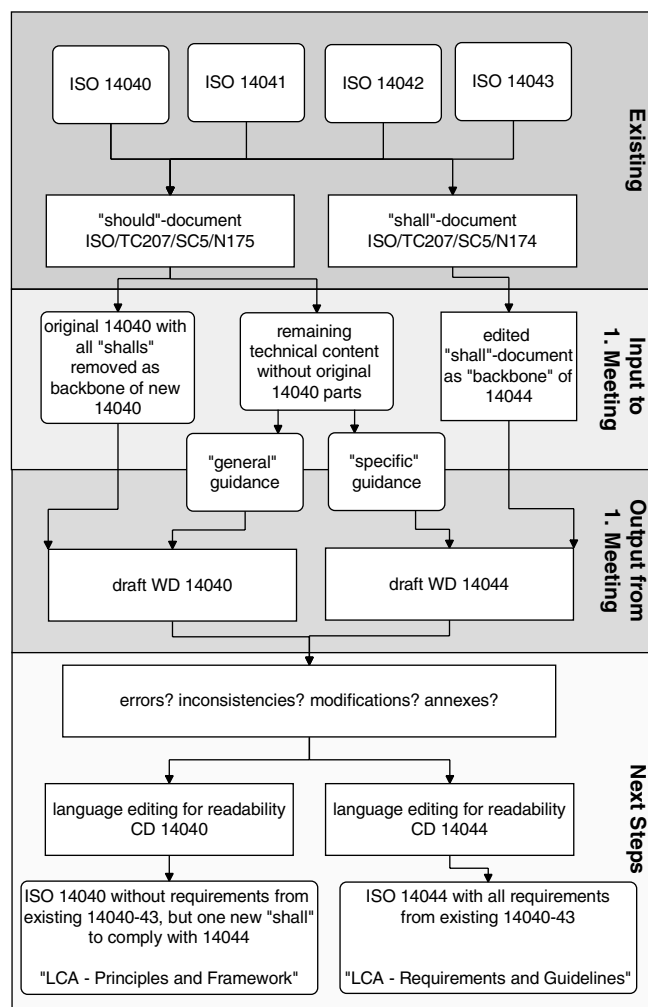


Fig. 2: Roadmap for the revision of the ISO 14040 series

ments ('shall'-document) and the guidance ('should'-document). The work was started with the main technical content (excl. scope, normative references, definitions, annexes). As indicated by Fig. 2, the so-called the 'backbone' documents of 14040 and 14044 were generated, followed by an allocation of the remaining guidance to general guidance (→ 14040) and specific guidance (→ 14044). As a next step, errors and inconsistencies were addressed and finally, the text was edited for readability incl. scope, references, definitions and annexes. The next two sections summarise the resulting formal changes (see section 2) and technical changes (see section 3) in the new standards.

2 Main Formal Changes of the New Standards

A first important formal change is the clarification concerning the compliance with the standards. Currently the missing reference between the standards leads to an ambiguity of compliance claims (today compliance with 14040 does not necessarily include compliance with 14041-3). Linking both standards with the only requirement in the new 14040 to comply with 14044 eliminates this situation. Therefore, a compliance claim to the new ISO 14040 does unambiguously include compliance with the new ISO 14044.

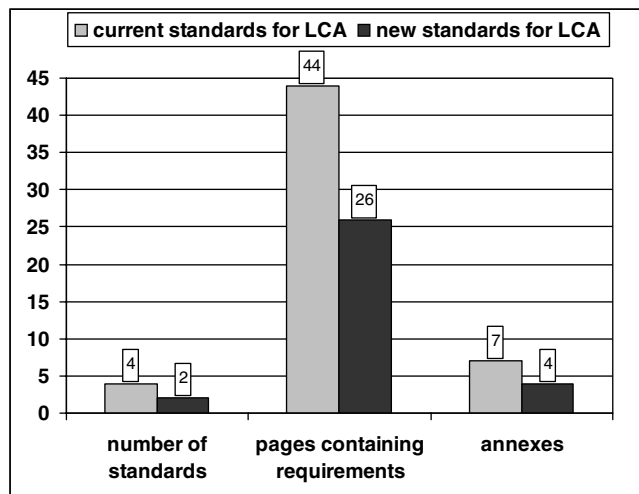


Fig. 3: Formal changes in the new standards of LCA

Another formal improvement is the alignment of the definitions in the two new documents. The two new standards contain both the same set of definitions. Formally, all definitions specific to LCA originate in the new ISO 14040, but they are repeated in ISO 14044. This ensures that the practitioners do not need to use another document (e.g. ISO 14040) just to get access to the relevant definitions (e.g. while working with ISO 14044).

Further obvious formal changes include the reduced number of standards, the reduced number of annexes and the reduced number of pages that contain requirements (Fig. 3). All these changes are intended to increase the readability and accessibility of the standards. For the practitioners of LCA, this means that the technical requirements can be found in one document (instead of previously four) and that they are condensed on 26 pages (instead of 44 previously).

3 Main Technical Changes of the New Standards

Generally, the main technical content of the current standards was reconfirmed to be still valid. Many important issues of fundamental importance, e.g. allocation, requirements for comparative assertions or the phases of LCA were not changed. Therefore, the new LCA standards will not generate a comprehensive need to adapt LCA practice, if it is based on the current standards. This was both not the intention of the revision and not found to be justified during the revision. However, still some technical changes were made. The modified technical content is in line with the previous requirements and serves mainly as a clarification of the technical content, and as a correction of errors and inconsistencies. It includes e.g. the addition of several definitions (e.g. product, process, etc.), the addition of principles for LCA, clarifications concerning LCA intended to be used in comparative assertions intended to be disclosed to the public, clarifications concerning system boundary, clarifications concerning the critical review panel and the addition of an annex about applications.

3.1 Definitions

In addition to the formal alignment of the definitions as described in section 3, several new definitions were added and several definitions revised. Among the new definitions there are fundamental terms like 'product' and 'process' based on the definitions in ISO 9000 (ISO 9000) and ISO 14021 (ISO 14021) respectively.

Among the relevant revisions of definitions are the terms 'waste' and 'system boundary'. The definition of waste was modified by relating to the 'Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal' (22. March 1989) including a clarification, that it is not limited to hazardous waste for the application within the standards.

In the current standards the term 'system boundaries' was used for both the interface between product systems and the interface between the product system and the environment. The new standards clarify here, that the term 'system boundary' only relates to the issue which unit processes are part of the product system, i.e. as part of the inventory analysis. Therefore, the term 'system boundary' is not used anymore in relation to LCIA. This revised definition also was reflected in changes in the text of the standards.

3.2 Principles of LCA

Both current and new ISO 14040 have the title 'principles and framework', but the current version does not include any principles. To remove this inconsistency the following principles were added to the new ISO 14040.

- **Life cycle perspective.** LCA considers the entire life cycle of a product, from raw material extraction and acquisition, through energy and material production and manufacturing, to use and end of life treatment and final disposal. Through such a systematic overview and perspective, the shifting of a potential environmental burden between life cycle stages or individual processes can be identified and possibly avoided.
- **Environmental focus.** LCA addresses the environmental aspects and impacts of a product system. Economic and social aspects and impacts are, typically, outside the scope of the LCA. Other tools may be combined with LCA for more extensive assessments.
- **Relative approach and functional unit.** LCA is a relative approach, which is structured around a functional unit. This functional unit defines what is being studied. All subsequent analyses are then relative to that functional unit as all inputs and outputs in the LCI and consequently the LCIA profile is related to the functional unit.
- **Iterative approach.** LCA is an iterative technique. The individual phases of an LCA use results of the other phases. The iterative approach within and between the phases contributes to the comprehensiveness and consistency of the study and the reported results.

- **Transparency.** Due to the inherent complexity in LCA, transparency is an important guiding principle in executing LCAs, in order to ensure a proper interpretation of the results.
- **Comprehensiveness.** LCA considers all attributes or aspects of natural environment, human health and resources. By considering all attributes and aspects within one study in a cross-media perspective, potential trade-offs can be identified and assessed.
- **Priority of scientific approach.** Decisions within an LCA are preferably based on natural science. If this is not possible, other scientific approaches (e.g. from social and economic sciences) can be used or international conventions can be referred to. If neither a scientific basis exists nor a justification based on other scientific approaches or international conventions is possible, then, as appropriate, decisions may be based on value choices.

It is explained that these principles are fundamental and should be used as guidance for decisions relating to both the planning and the conducting of an LCA.

As a general requirement in ISO 14044 it is stated that LCA is to be conducted in accordance with the principles and the framework described in ISO 14040.

3.3 LCA intended to be used for a comparative assertion intended to be disclosed to the public

The current standards of LCA have a specific set of requirements for LCA intended to be used for a comparative assertion intended to be disclosed to the public. This is a crucial part of the standards as it serves to protect third party interests and aims at restricting misuse of public application of LCA. All relevant requirements for this application of LCA are still part of the new standards. However, several inconsistencies were removed and clarifications were added. Among the inconsistencies of the current standards was the problem of many different formulations to address the same issue. In the new standards, the unambiguous formulation 'LCA intended to be used for a comparative assertion intended to be disclosed to the public' is used throughout the whole text. The working group realised that this is a rather lengthy and cumbersome formulation. However, the attempts to shorten it or to define an appropriate abbreviation failed. The main reason was that an exact and clear description of this application of LCA requires the two intentions: the intention for the use for a comparative assertion and the intention to disclose it to the public. Because of the importance of this issue for the overall credibility of LCA, unambiguousness, clarity and accuracy were seen as more crucial than conciseness in this case.

Another clarification for this topic was the introduction of a requirement for the goal definition of a study to unambiguously state whether the results are intended to be used in comparative assertions intended to be disclosed to the public.

3.4 Life cycle impact assessment

The general procedure and outline for LCIA were reconfirmed in the revision of the standards. Also, the limitations and restrictions were confirmed to be still valid, e.g. the statement that there is no scientific basis for reducing LCA results to a single overall score or number or the requirement that weighting is not allowed for LCA intended to be used for a comparative assertion intended to be disclosed to the public. For weighting, there was the clarification that weighting steps are based on value-choices and are not scientifically based, where the current text relates this statement to natural science.

A new section was added between the mandatory and optional elements of LCIA that addresses resulting data after characterization. It clarifies that after characterization and before further optional elements, the inputs and outputs of the product system are represented by e.g.:

- a set of impact category indicator results;
- a set of inventory results that are elementary flows but have not been assigned to impact categories;
- a set of data that do not represent elementary flows.

3.5 Life cycle interpretation

The final objective of this phase according to the current standards is to draw conclusions and to make recommendations reflecting the identification of significant issues and the evaluation element. A clarification added in the new standards is the requirement to identify limitations when drawing conclusions and making recommendations. Methodological and study limitations were also added to the list of items that need to be checked for consistency when assessing preliminary conclusions from the study. Therefore, the term 'limitations' is also added to the relevant section heading and to the figure describing the interpretation phase (Fig. 4 in the new ISO 14044 which was originally Fig. 1 in ISO 14043).

Another inconsistency that has been removed was the missing link between the requirements for conclusions and recommendations. The new standards clarify that conclusions shall be drawn from the study and that recommendations shall be based on the final conclusions of the study, and shall reflect a logical and reasonable consequence of the conclusions.

3.6 Critical review and reporting

For the critical review of LCA, several clarifications were added to the new standards. The section for internal critical review and external critical review were merged. In the scope definition phase, it was added that, not only whether and how a critical review is conducted and the type of critical review as well as who conducts the review needs to be defined, but also that the level of expertise of the reviewers needs to be justified.

Finally, it was clarified that review panels, especially for the review by interested parties, consist of at least three members.

For reporting, an important clarification was added to the section of third party reports. The new ISO 14040 contains a clause that a third party report can be based on study documentation that contains confidential information that may not be included in the third party report.

3.7 Informative annex on applications of LCA

The new ISO 14040 includes an entirely new informative annex on applications of LCA. In this annex applications of LCA in the field of other environmental management systems and tools are addressed, e.g.:

- environmental management systems and environmental performance evaluation (ISO 14001, ISO 14004, ISO 14031 and ISO 14032) e.g. identification of significant environmental aspects of the products and services of an organization;
- environmental labels and declarations (ISO 14020, ISO 14021 and ISO 14025);
- integration of environmental aspects into product design and development (Design for environment) (ISO 14062);
- inclusion of environmental aspects in product standards (ISO Guide 64);
- environmental communication (ISO 14063);
- quantification, monitoring and reporting of entity and project emissions and removals and validation, verification and certification of greenhouse gas emissions (ISO 14064);

The variety of potential further applications in private and public organizations is addressed as well. These techniques, methods and tools are not based on the LCA technique as such, but the life cycle approach, principles and framework can be beneficially applied to them.

There is no single solution as to how LCA can best be applied within the decision-making context. Each organization has to solve and decide on each case depending – among other things – on the size and culture of the organization, its products, the strategy, the internal systems, tools and procedures and the external drivers.

LCA can be used for a broad spectrum of applications. The individual use, adaptation and practice of LCA for all potential applications are based on ISO 14040 and ISO 14044.

In addition, the LCA technique with proper justification could be applied in studies, which are not LCA or LCI studies. Examples are:

- cradle-to-gate studies;
- gate-to-gate studies;
- specific parts of the life cycle (e.g. waste management, components of a product).

For those studies most requirements of ISO 14040 and ISO 14044 are applicable e.g. data quality, collection and calculation as well as allocation and critical review, but not all requirements for system boundary.

For specific applications, it can be appropriate, as part of the LCIA, to determine the indicator results of each unit process or of each stage of a life cycle individually and to calculate the indicator results of the whole product system by adding up the indicator results of the different unit processes or stages.

This procedure is within the framework of this International Standard, provided that

- it has been defined within the goal and scope definition phase;
- it is shown that the results of such an approach are identical with the results of an LCA which applies the sequence of steps according to the guidance of ISO 14040 and ISO 14044.

Finally, the annex addresses application approaches for the consideration of the decision-making context when defining the scope of an LCA.

4 Discussion, Conclusion and Outlook

The two new standards, ISO 14040 and ISO 14044, reconfirm the validity of the main technical content of the previous standards. **Errors and inconsistencies were removed and the readability was improved.** The added technical content is in line with the previous requirements and serves mainly as a clarification of the technical content. The unanimous vote on the Draft International Standard versions proved that this was achieved on the basis of the broadest possible international consensus. Currently the national member bodies undertake the final voting on the FDIS-versions of the standards. Based on the voting results at the previous stages of the documents, a positive result is expected. The publication of the new international standards for life cycle assessment (ISO 14040 and ISO 14044) is expected around mid-2006.

For the sake of the international and stakeholder acceptance of LCA, it is recommended that the new standards serve as core reference documents for the users and practitioners of LCA.

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