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Environmental management — Life cycle assessment — Life cycle interpretation

Management environnemental — Analyse du cycle de vie — Interprétation du cycle de vie

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14043 was prepared by Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 5, *Life cycle analysis*.

Annex A of this International Standard is for information only.

Introduction

This International Standard on life cycle interpretation describes the final phase of the life cycle assessment (LCA) procedure, in which the results of a life cycle inventory analysis (LCI) and — if conducted — of a life cycle impact assessment (LCIA), or both, are summarized and discussed as a basis for conclusions, recommendations and decision-making in accordance with the goal and scope definition.

An LCA study begins with the goal and scope definition phase and finishes with the interpretation phase.

Life cycle interpretation is a systematic procedure to identify, qualify, check and evaluate information from the results of the LCI and/or LCIA of a product system, and to present them in order to meet the requirements of the application as described in the goal and scope of the study. The practitioner undertaking the LCA study should be in close contact with the commissioner throughout the study in order to ensure that specific questions are addressed. This communication also has to be maintained through the life cycle interpretation phase. Therefore, transparency throughout the life cycle interpretation phase is essential. Where preferences, assumptions or value-choices are involved, these need to be clearly stated by the LCA practitioner in the final report.

LCA is but one of several tools to help in decision-making, irrespective of the application, for example for information purposes (documentation of existing product systems), for improvements (implementation of changes to existing product systems) or for establishment of a new product system.

Life cycle interpretation may also demonstrate links which exist between LCA and other environmental management techniques, by rationalizing and focusing on the results. It is therefore important not only to look backward from application to the life cycle interpretation phase (and the other phases) of the LCA but also forward, e.g. to the concurrent use of other techniques.

Life cycle interpretation includes communication, to give credibility to the results of other LCA phases (namely the LCI and LCIA), in a form that is both comprehensible and useful to the decision-maker.

Whereas decisions based on technical performance, economic or social aspects are outside the LCA study, environmental issues chosen for inclusion as part of the goal and scope definition may reflect such issues.

Environmental management — Life cycle assessment — Life cycle interpretation

1 Scope

This International Standard provides requirements and recommendations for conducting the life cycle interpretation in LCA or LCI studies.

This International Standard does not describe specific methodologies for the life cycle interpretation phase of LCA and LCI studies.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 14040:1997, *Environmental management — Life cycle assessment — Principles and framework.*

ISO 14041:1998, *Environmental management — Life cycle assessment — Goal and scope definition and inventory analysis.*

ISO 14042:2000, *Environmental management — Life cycle assessment — Life cycle impact assessment.*

ISO 14050:1998, *Environmental management — Vocabulary*.

3 Terms and abbreviated terms

3.1 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 14040, ISO 14041, ISO 14042 and ISO 14050 and the following apply.

3.1.1
completeness check
process of verifying whether information from the preceding phases of an LCA or an LCI study is sufficient for reaching conclusions in accordance with the goal and scope definition

3.1.2
consistency check
process of verifying that the assumptions, methods and data are consistently applied throughout the study and in accordance with the goal and scope definition

NOTE The consistency check should be performed before conclusions are reached.

3.1.3
evaluation
⟨life cycle interpretation⟩ second step within the life cycle interpretation phase to establish confidence in the results of the LCA or LCI study

NOTE Evaluation includes the completeness check, sensitivity check, consistency check, and any other validation that may be required in accordance with the goal and scope definition of the study.

3.1.4
sensitivity check
process of verifying that the information obtained from a sensitivity analysis is relevant for reaching the conclusions and giving recommendations

3.2 Abbreviated terms

LCA life cycle assessment

LCI life cycle inventory analysis

LCIA life cycle impact assessment

4 General description of life cycle interpretation

4.1 Objectives of life cycle interpretation

The objectives of life cycle interpretation are to analyse results, reach conclusions, explain limitations and provide recommendations based on the findings of the preceding phases of the LCA or LCI study and to report the results of the life cycle interpretation in a transparent manner.

Life cycle interpretation is also intended to provide a readily understandable, complete and consistent presentation of the results of an LCA or an LCI study, in accordance with the goal and scope definition of the study.

4.2 Key features of life cycle interpretation

The key features of life cycle interpretation are:

— the use of a systematic procedure to identify, qualify, check, evaluate and present the conclusions based on the findings of an LCA or LCI study, in order to meet the requirements of the application as described in the goal and scope of the study;

— the use of an iterative procedure both within the interpretation phase and with the other phases of an LCA or an LCI study;

— the provision of links between LCA and other techniques for environmental management by emphasizing the strengths and limits of an LCA or an LCI study in relation to its goal and scope definition.

4.3 Elements of life cycle interpretation

The life cycle interpretation phase of an LCA or an LCI study comprises three elements as depicted in Figure 1, as follows:

— identification of the significant issues based on the results of the LCI and LCIA phases of LCA;

— evaluation which considers completeness, sensitivity and consistency checks;

— conclusions, recommendations and reporting.

4.4 Relationship

The relationship of the interpretation phase to other phases of LCA is shown in Figure 1.

The goal and scope definition and interpretation phases of life cycle assessment frame the study, whereas the other phases of LCA (LCI and LCIA) produce information on the product system.

5 Identification of significant issues

5.1 Objective

NOTE See clause A.2 in annex A for examples.

The objective of this element is to structure the results from the LCI or LCIA phases in order to determine the significant issues, in accordance with the goal and scope definition and interactively with the evaluation element. The purpose of this interaction is to include the implications of the methods used, assumptions made, etc. in the preceding phases, such as allocation rules, cut-off decisions, selection of impact categories, category indicators and models, etc.

5.2 Identification and structuring of information

There are four types of information required from the findings of the preceding phases of the LCA or the LCI study:

a) the findings from the preceding phases (LCI and LCIA), which shall be assembled and structured together with information on data quality. These results should be structured in an appropriate manner, e.g. in accordance with the stages in the life cycle, the different processes or unit operations in the product system, transportation, energy supply and waste management. This may be in the form of data lists, tables, bar diagrams or other appropriate representation of the inputs and outputs and/or category indicators results. Therefore, all relevant results available at the time will be gathered and consolidated for further analysis;

b) methodological choices, such as allocation rules and product system boundaries from the LCI and category indicators and models used in LCIA;

c) the value-choices used in the study as found in the goal and scope definition;

d) the role and responsibilities of the different interested parties as found in the goal and scope definition in relation to the application, and also the results from a concurrent critical review process, if conducted.

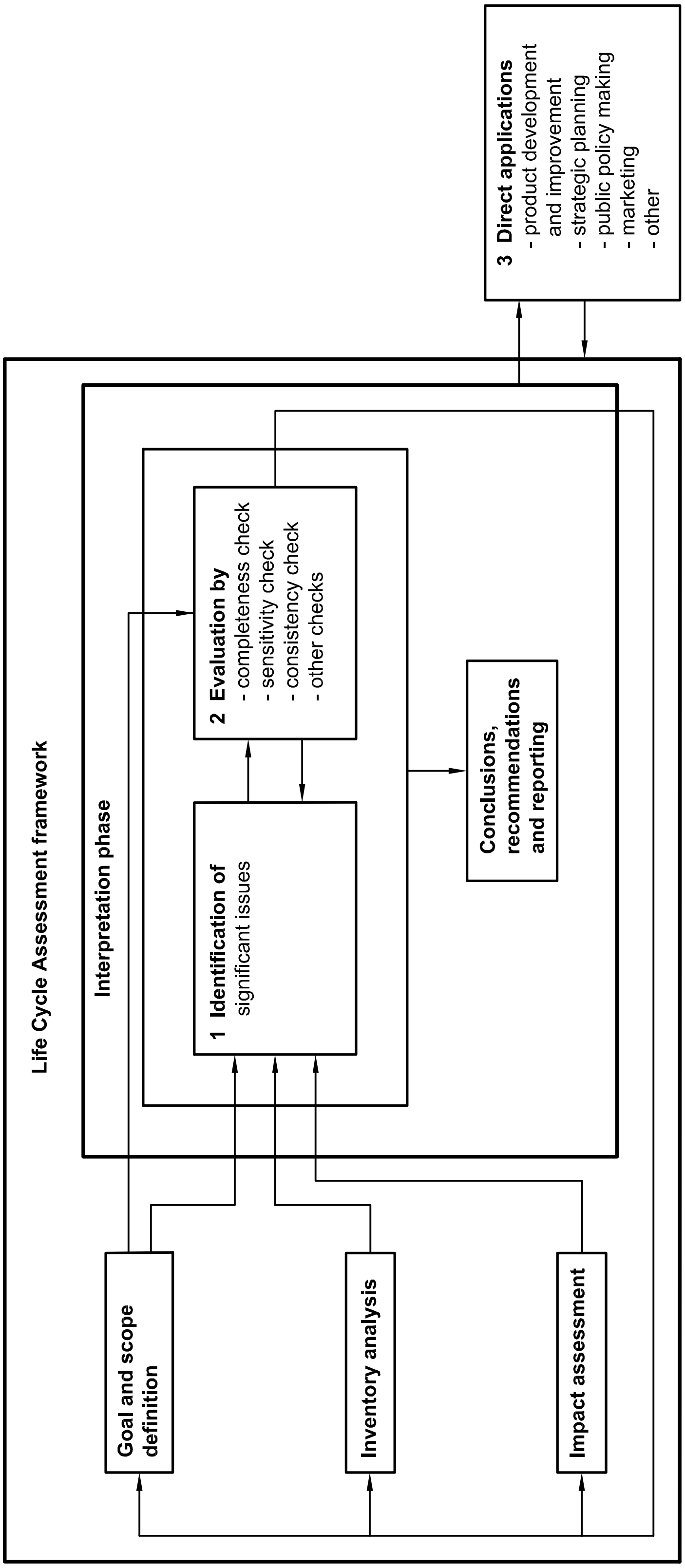

Figure 1 — Relationships of the elements within the interpretation phase with the other phases of LCA

5.3 Determining the significant issues

When the results from the preceding phases (LCI, LCIA) have been found to meet the demands of the goal and scope of the study, the significance of these results shall then be determined. The results from both the LCI phase and/or LCIA phase are used for this purpose. This should be done as an iterative process with the evaluation element.

Significant issues can be:

— inventory data categories, such as energy , emissions, waste, etc.;

— impact categories, such as resource use, Global Warming Potential, etc.;

— essential contributions from life cycle stages to LCI or LCIA results, such as individual unit processes or groups of processes like transportation and energy production.

Determining significant issues of a product system can be simple or complex. This International Standard does not provide guidance on why an issue may or may not be relevant in a study, or why an issue may or may not be significant for a product system.

A variety of specific approaches, methods and tools are available to identify environmental issues and to determine their significance.

6 Evaluation

6.1 Objectives and requirements

NOTE See clause A.3 in annex A for examples.

The objectives of the evaluation element are to establish and enhance the confidence in and the reliability of the results of the LCA or the LCI study, including the significant issues identified in the first element of the interpretation. The results should be presented in a manner which gives the commissioner or any other interested party a clear and understandable view of the outcome of the study.

The evaluation shall be undertaken in accordance with the goal and scope of the study, and should take into account the final intended use of the study results.

During the evaluation, the use of the following three techniques shall be considered:

a) completeness check (see 6.2);

b) sensitivity check (see 6.3);

c) consistency check (see 6.4).

The results of uncertainty analysis and assessment of data quality should supplement these checks.

6.2 Completeness check

6.2.1 Objective

The objective of the completeness check is to ensure that all relevant information and data needed for the interpretation are available and complete.

6.2.2 Missing or incomplete information

If any relevant information is missing or incomplete, the necessity of such information for satisfying the goal and scope of the LCA or LCI study shall be considered.

If this information is considered unnecessary, the reason for this should be recorded, after which it is possible to proceed with the evaluation.

If any missing information is considered necessary for determining the significant issues, the preceding phases (LCI, LCIA) should be revisited, or alternatively the goal and scope definition should be adjusted.

This finding and its justification shall be recorded.

6.3 Sensitivity check

6.3.1 Objective

The objective of the sensitivity check is to assess the reliability of the final results and conclusions by determining whether they are affected by uncertainties in the data, allocation methods or calculation of category indicator results, etc.

This assessment shall include the results of the sensitivity analysis and uncertainty analysis, if performed in the preceding phases (LCI, LCIA), and may indicate the need for further sensitivity analysis.

6.3.2 Recommendations for conducting a sensitivity check

The level of detail required in the sensitivity check depends mainly upon the findings of the inventory analysis and, if conducted, the impact assessment.

In a sensitivity check, consideration shall be given to:

a) the issues predetermined by the goal and scope of the LCA or LCI study;

b) the results from all other phases of LCA or LCI study and;

c) expert judgements and previous experiences.

The output of the above sensitivity check determines the need for more extensive and/or precise sensitivity analysis as well as apparent effects on the study results.

The inability of a sensitivity check to find significant differences between different study alternatives does not automatically lead to the conclusion that such differences do not exist. The differences may exist but cannot be identified or quantified due to uncertainties related to the data and methods used.

The lack of any significant differences may be the end result of the study.

When an LCA is used to support a comparative assertion that is disclosed to the public, the evaluation element shall include interpretative statements based on detailed sensitivity analysis.

6.4 Consistency check

6.4.1 Objective

The objective of the consistency check is to determine whether the assumptions, methods and data are consistent with the goal and scope.

6.4.2 Checklist

If relevant to the LCA or LCI study, or required as part of the goal and scope definition, the following questions shall be addressed.

— Are differences in data quality along a product system life cycle and between different product systems consistent with the goal and scope of the study?

— Have the regional and/or temporal differences, if any, been consistently applied?

— Have allocation rules and system boundaries been consistently applied to all product systems?

— Have the elements of impact assessment been consistently applied?

7 Conclusions and recommendations

7.1 Objective

The objective of this third element of the life cycle interpretation is to draw conclusions and make recommendations for the intended audience of the LCA or LCI study.

7.2 Conclusions

Drawing conclusions from a study should be done interactively with the other elements in the life cycle interpretation phase. A logical sequence for the process is as follows:

a) identify the significant issues;

b) evaluate the methodology and results for completeness, sensitivity and consistency;

c) draw preliminary conclusions and check that these are consistent with the requirements of the goal and scope of the study, including, in particular, data quality requirements, predefined assumptions and values, and application-oriented requirements;

d) if the conclusions are consistent, report as full conclusions. Otherwise return to previous steps a), b) or c) as appropriate.

7.3 Recommendations

Whenever appropriate to the goal and scope of the study, specific recommendations to decision-makers should be justified.

Recommendations shall be based on the final conclusions of the study, and shall reflect a logical and reasonable consequence of the conclusions.

Recommendations should relate to the intended application as mentioned in ISO 14040.

8 Reporting

The report shall give a complete and unbiased account of the study, as detailed in ISO 14040. In reporting the interpretation phase, full transparency in terms of value-choices, rationales and expert judgements made shall be strictly observed.

9 Other investigations

9.1 Critical review

The decision on the type of critical review shall be recorded.

NOTE The types of critical review are presented in 7.3 of ISO 14040:1997.

Where the study is used to support a comparative assertion that is disclosed to the public, a critical review shall be conducted as presented in 7.3.3 of ISO 14040:1997.

Annex A
(informative)

Examples of Life Cycle Interpretation

A.1 General

This informative annex is intended to provide constructed examples of the elements within the interpretation phase of an LCA or an LCI study, in order to help users understand how Life Cycle Interpretation can be processed.

A.2 Examples for the identification of significant issues

The identification element (see clause 5) is performed in iteration with the evaluation element (see clause 6). It consists of the identification and structuring of information and the subsequent determination of any significant issues. The structuring of the available data and information is an iterative process undertaken in conjunction with the LCI and, if performed, LCIA phases, as well as with the goal and scope definition. This structuring of information may have been completed previously in either the LCI or LCIA, and is intended to provide an overview of the results of these earlier phases. This facilitates the determination of important and environmentally relevant issues, as well as the drawing of conclusions and recommendations. On the basis of this structuring process, any subsequent determination is performed using analytical techniques.

Depending on the goal and scope of the study, different structuring approaches can be useful. Amongst others, the following possible structuring approaches can be recommended for use:

— differentiation of individual *life cycle stages*; e.g. production of materials, manufacturing of the studied product, use, recycling and waste treatment (see Table A.1);

— differentiation between *groups of processes*, e.g. transportation, energy supply (see Table A.4);

— differentiation between processes under different degrees of *management influence*, e.g. own processes, where changes and improvements can be controlled, and processes which are determined by external responsibility, such as national energy policy, supplier specific boundary conditions etc. (see Table A.5);

— differentiation between the individual *unit processes*. This is the highest resolution possible.

The output of this structuring process may be presented as a two-dimensional matrix in which, for example, the above-mentioned differentiation criteria form the columns and the inventory inputs and outputs or individual category indicators results form the rows. It may also be possible to undertake this structuring procedure for individual impact categories for a more detailed examination.

The determination of significant issues is based on structured information.

Data on the relevance of individual inventory data categories can be predetermined in the goal and scope definition, or be available from the inventory analysis or from other sources, such as the environmental management system or the environmental policy of the company. Several possible methods exist. Depending on the goal and scope of the study and the level of detail required, the following methods can be recommended for use:

— *contribution analysis*, in which the contribution of life cycle stages (see Tables A.2 and A.8) or groups of processes (see Table A.4) to the total result are examined, by, for example, expressing the contribution as a percent of the total;

— *dominance analysis*, in which, by means of statistical tools or other techniques such as quantitative or qualitative ranking (e.g. ABC Analysis), remarkable or significant contributions are examined (see Table A.3);

— *influence analysis*, in which the possibility of influencing the environmental issues is examined (see Table A.5);

— *anomaly assessment*, in which, based on previous experience, unusual or surprising deviations from expected or normal results are observed. This allows a later check and guides improvement assessments (see Table A.6).

The result of this determination process may also be presented as a matrix, in which the above-mentioned differentiation criteria form the columns, and the inventory inputs and outputs or the category indicator results form the rows.

It is also possible to undertake this procedure for any specific inventory inputs and outputs selected from the goal and scope definition, or for any single impact category, as a possibility for a more detailed examination. Within this process of identification no data is changed or recalculated. The only modification made is the conversion into percentages, etc.

In the following tables, examples are given as to how a structuring process can be performed. The proposed structuring methods are suitable for both LCI and possible LCIA results.

The structuring criteria are based either on the specific requirements of the goal and scope definition or on the findings of the LCI or LCIA.

Table A.1 gives an example of structuring LCI inputs and outputs by groups of unit processes representing various life cycle stages, expressed as percentages in Table A.2.

Table A.1 — Structuring of LCI inputs and outputs to life cycle stages

LCI input/output	Materials production kg	Manufacturing processes kg	Use phases kg	Others kg	Total kg
Hard coal	1 200	25	500	—	1 725
CO_2	4 500	100	2 000	150	6 750
NO_x	40	10	20	20	90
Phosphate	2,5	25	0,5	—	28
AOX[a]	0,05	0,5	0,01	0,05	0,61
Municipal waste	15	150	2	5	172
Tailings	1 500	—	—	250	1 750

[a] AOX = Absorbable Organic Halides.

Analysis of the contributions of the LCI results from Table A.1 identifies the processes or life cycle stages which contribute the most to different inputs and outputs. On this basis, later evaluation can reveal and state the meaning and stability of those findings, which then are the bases for conclusions and recommendations. This evaluation can either be qualitative or quantitative.

Table A.2 — Percentage contribution of LCI inputs and outputs to life cycle stage

LCI input/output	Materials production %	Manufacturing processes %	Use phases %	Others %	Total %
Hard coal	69,6	1,5	28,9	—	100
CO_2	66,7	1,5	29,6	2,2	100
NO_x	44,5	11,1	22,2	22,2	100
Phosphate	8,9	89,3	1,8	—	100
AOX	8,2	82,0	1,6	8,22	100
Municipal waste	8,7	87,2	1,2	2,9	100
Tailings	85,7	—	—	14,3	100

In addition, these results can be ranked and prioritized, either by individual ranking procedures or by predefined rules from the goal and scope definition. Table A.3 shows the results of such a ranking procedure, using the following ranking criteria:

A: most important, significant influence, i.e. contribution > 50 %

B: very important, relevant influence, i.e. 25 % < contribution ⩽ 50 %

C: fairly important, some influence, i.e. 10 % < contribution ⩽ 25 %

D: little important, minor influence, i.e. 2,5 % < contribution ⩽ 10 %

E: not important, negligible influence, i.e. contribution < 2,5 %

Table A.3 — Ranking of LCI inputs and outputs to life cycle stages

LCI input/output	Materials production	Manufacturing processes	Use phases	Others	Total kg
Hard coal	A	E	B	—	1 725
CO_2	A	E	B	D	6 750
NO_x	B	C	C	C	90
Phosphate	D	A	E	—	28
AOX	D	A	E	D	0,61
Municipal waste	D	A	E	D	172
Tailings	A	—	—	C	1 750

In Table A.4, the same LCI example is used to demonstrate another possible structuring option. This table shows the example of structuring LCI inputs and outputs into different process groups .

Table A.4 — Structuring matrix sorted into process groups

LCI input/output	Energy supply kg	Transport kg	Others kg	Total kg
Hard coal	1 500	75	150	1 725
CO_2	5 500	1 000	250	6 750
NO_x	65	20	5	90
Phosphate	5	10	13	28
AOX	0,01	—	0,6	0,61
Municipal waste	10	120	42	172
Tailings	1 000	250	500	1 750

The other techniques, such as determining the relative contribution and ranking to selected criteria, follow the same procedure as shown in Tables A.2 and A.3.

Table A.5 shows an example of LCI inputs and outputs ranked as to the degree of influence and structured in groups of unit processes, representing process groups for different LCI inputs and outputs. The degree of influence is indicated here by:

A: significant control, large improvement possible

B: small control, some improvement possible

C: no control

Table A.5 — Ranking of the degree of influence on the LCI inputs and outputs sorted into process groups

LCI input/output	Power grid mix	Site energy supply	Transport	Others	Total kg
Hard coal	C	A	B	B	1 725
CO_2	C	A	B	A	6 750
NO_x	C	A	B	C	90
Phosphate	C	B	C	A	28
AOX	C	B	—	A	0,61
Municipal waste	C	A	C	A	172
Tailings	C	C	C	C	1 750

Table A.6 shows the example of an LCI result, assessed with respect to anomalies and unexpected results and structured in groups of unit processes, representing process groups for different LCI inputs and outputs. The anomalies and unexpected results are marked by:

●: Unexpected result, i.e. contribution too high or too low

#: Anomaly, i.e. certain emissions where no emissions are supposed to occur

○: No comment

Anomalies can represent errors in calculations or data transfer. Therefore, they should be considered carefully. Checking of LCI or LCIA results is recommended before making conclusions.

Unexpected results also should be re-examined and checked.

Table A.6 — Marking of anomalies and unexpected results of the LCI inputs and outputs of process groups

LCI input/output	Power grid mix	Site energy supply	Transport	Others	Total kg
Hard coal	○	○	●	○	1 725
CO_2	○	○	●	○	6 750
NO_x	○	○	○	○	90
Phosphate	○	○	#	○	28
AOX	○	○	○	○	0,61
Municipal waste	○	●	○	●	172
Tailings	○	○	○	○	1 750

The example in Table A.7 demonstrates a possible structuring process on the basis of LCIA results. It shows a category indicator result, Global Warming Potential (GWP), structured in groups of unit processes, representing life cycle stages for different category indicators.

The analysis of the contributions of specific substances to the category indicator result from Table A.7 identifies the processes or life cycle stages with the highest contributions.

Table A.7 — Structuring of a category indicator result (GWP) against life cycle stages

Global Warming Potential (GWP) from	**Materials production** CO_2-equiv.	**Manufacturing processes** CO_2-equiv.	**Use phases** CO_2-equiv.	**Others** CO_2-equiv.	**Total GWP** CO_2-equiv.
CO_2	500	250	1 800	200	2 750
CO	25	100	150	25	300
CH_4	750	50	100	150	1 050
N_2O	1 500	100	150	50	1 800
CF_4	1 900	250	—	—	2 150
Others	200	150	120	80	550
Total	4 875	900	2 320	505	8 600

Table A.8 — Structuring of a category indicator result (GWP) against life cycle stages, expressed as a percentage

GWP from	**Materials production** %	**Manufacturing processes** %	**Use phases** %	**Others** %	**Total GWP** %
CO_2	5,8	2	20,9	2,3	31,9
CO	0,3	1,1	1,7	0,3	3,4
CH_4	8,7	0,6	1,2	1,8	12,3
N_2O	17,4	1,2	1,8	0,6	21
CF_4	22,1	2,9	—	—	25,0
Others	2,4	1,7	1,4	0,9	6,4
Total	56,7	10,4	27	5,9	100

In addition, methodological issues can be considered, by e.g. running different options as scenarios. The influence of e.g. allocations rules and cut-off choices can easily be examined by either showing the results in parallel with those for other assumptions, or determining which emissions really occur.

In the same way, the influence of characterization factors for the LCIA (e.g. GWP 100 vs. GWP 500) or data set choices for normalization and weighting, if applied, can be illustrated by demonstrating the differences in effect of the various assumptions on the result.

In summarizing, the identification is aiming at providing a structured approach for the later evaluation of the study's data, information and findings. Subjects recommended for consideration are, amongst others:

— individual *inventory* data categories: emissions, energy and material resources, waste, etc.;

— individual *processes*, unit processes or groups thereof;

— individual *life cycle stages*;

— individual *category indicators*.

A.3 Examples of the evaluation element

A.3.1 General

The evaluation element and the identification element are procedures which are carried out simultaneously. In an iterative procedure, several issues and tasks are discussed in more detail, in order to determine the reliability and stability of the results from the identification element.

A.3.2 Completeness check

The completeness check attempts to ensure that the full required information and data from all phases have been used and are available for interpretation. In addition, data gaps are identified and the need to complete the data acquisition is evaluated. The identification element is a valuable basis for these considerations. Table A.9 shows an example of the completeness check. Nevertheless completeness can only be an empirical value, ensuring that no major known aspects have been forgotten.

Table A.9 — Summary of a completeness check

Unit process	Option A	Complete?	Action required	Option B	Complete?	Action required
Material production	X	Yes		X	Yes	
Energy supply	X	Yes		X	No	Recalculate
Transport	X	?	Check inventory	X	Yes	
Processing	X	No	Check inventory	X	Yes	
Packaging	X	Yes		—	No	Compare A
Use	X	?	Compare B	X	Yes	
End of life	X	?	Compare B	X	?	Compare A
X: data entry available. —: no data entry present.						

Results from Table A.9 reveal that several tasks need to be done. In case of recalculation or rechecking of the original inventory, a feedback loop is required.

For example, in the case concerning a product for which the waste management is not known, a comparison between two possible options may be performed. This comparison may lead to an in-depth study of the waste management phase, or to the conclusion that the difference between the two alternatives is not significant or not relevant for the given goal and scope.

The basis for this survey is to use a checklist which includes the required inventory parameters (such as emissions, energy and material resources, waste, etc.), required life cycle stages and processes, as well as the required category indicators, etc.

A.3.3 Sensitivity check

Sensitivity analysis (sensitivity check) tries to determine the influence of variations in assumptions, methods and data on the results. Mainly, the sensitivity of the most significant issues identified is checked. The procedure of sensitivity analysis is a comparison of the results obtained using certain given assumptions, methods or data with the results obtained using altered assumptions, methods or data.

In sensitivity analysis, typically the influence on the results of varying the assumptions and data by some range, e.g. ± 25 %, is checked. Both results are then compared. Sensitivity can be expressed as the percentage of change or as the absolute deviation of the results. On this basis, significant changes in the results (e.g. larger than 10 %) can be identified.

The performance of sensitivity analysis can also either be required in the goal and scope definition, or be determined during the study based on experience or on assumptions. For the following examples of assumptions, methods or data, sensitivity analysis may be considered valuable:

— rules for allocation;

— cut-off criteria;

— boundary setting and system definition;

— judgements and assumptions concerning data;

— selection of impact category;

— assignment of inventory results (classification);

— calculation of category indicator results (characterization);

— normalized data;

— weighted data;

— weighting method;

— data quality.

Tables A.10, A.11 and A.12 demonstrate how the sensitivity check can be performed on basis of the existing sensitivity analysis results from LCI and LCIA.

Table A.10 — Sensitivity check on allocation rule

Hard coal demand	Option A	Option B	Difference
Allocation by mass, MJ	1 200	800	400
Allocation by economic value, MJ	900	900	0
Deviation, MJ	– 300	+ 100	400
Deviation, %	– 25	+ 12,5	Significant
Sensitivity, %	25	12,5	

The conclusions which can be drawn from Table A.10 are that allocation has a significant influence, and that under the circumstances no real difference exists between Options A and B.

Table A.11 — Sensitivity check on data uncertainty

Hard coal demand	Material production	Manufacturing process	Use phases	Total
Base case, MJ	200	250	350	800
Altered assumption, MJ	200	150	350	700
Deviation, MJ	0	– 100	0	– 100
Deviation, %	0	– 40		– 12,5
Sensitivity, %	0	40	0	12,5

The conclusions which can be drawn from Table A.11 are that significant changes occur, and that variations alter the result. If the uncertainty here has significant influence, a renewed data collection is indicated.

Table A.12 — Sensitivity check on characterization data

GWP data input/effect	Option A	Option B	Difference
Score for GWP = 100 CO_2-equiv.	2 800	3 200	400
Score for GWP = 500 CO_2-equiv.	3 600	3 400	– 200
Deviation	+ 800	+ 200	600
Deviation, %	+ 28,6	+ 6,25	Significant
Sensitivity, %	28,6	6,25	

The conclusions which can be drawn from Table A.12 are that significant changes occur, that altered assumptions can change or even invert conclusions, and that the difference between Options A and B is smaller than originally expected.

A.3.4 Consistency check

The consistency check attempts to determine whether the assumptions, methods, models and data are consistent either along a product's life cycle or between several options. Inconsistencies are, for example:

- differences in *data sources*, e.g. Option A is based on literature, whereas Option B is based on primary data;
- differences in *data accuracy*, e.g. for Option A a very detailed process tree and process description is available, whereas Option B is described as a cumulated black-box system;
- differences in *technology coverage*, e.g. data for Option A are based on experimental process (e.g. new catalyst with higher process efficiency on a pilot plant level), whereas data for Option B are based on existing large-scale technology;
- differences with *time-related coverage*, e.g. data for Option A describe a recently developed technology, whereas Option B is described by a technology mix, including both recently built and old plants;
- differences in *data age*, e.g. data for Option A are 5-year-old primary data, whereas data for Option B are recently collected;
- differences in *geographical coverage*, e.g. data for Option A describe a representative European technology mix, whereas Option B describes one European Union member country with a high-level environmental protection policy, or one single plant.

Some of these inconsistencies may be accommodated in line with the goal and scope definition. In all other cases, significant differences exist and their validity and influence need to be considered before drawing conclusions and making recommendations.

Table A.13 provides an example of the results of a consistency check for an LCI study.

Table A.13 — Result of a consistency check

Check	Option A		Option B		Compare A and B ?	Action
Data source	Literature	OK	Primary	OK	Consistent	No action
Data accuracy	Good	OK	Weak	Goal and scope not met	Not consistent	Revisit B
Data age	2 years	OK	3 years	OK	Consistent	No action
Technology coverage	State-of-the-art	OK	Pilot plant	OK	Not consistent	Study target = no action
Time-related coverage	Recent	OK	Actual	OK	Consistent	No action
Geographical coverage	Europe	OK	USA	OK	Consistent	No action

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