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Plastics — Carbon and environmental footprint of biobased plastics —

Part 4: Environmental (total) footprint (Life cycle assessment)

Plastiques — Empreinte carbone et environnementale des plastiques biosourcés —

Partie 4: Empreinte environnementale (totale) (Analyse de cycle de vie)

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Foreword

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 14, *Environmental aspects*.

A list of all parts in the ISO 22526 series can be found on the ISO website.

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

Increased use of biomass resources for manufacturing plastic products can be effective in reducing global warming and the depletion of fossil resources.

Current plastic products are composed of biobased synthetic polymers, fossil-based synthetic polymers, natural polymers and additives that can include biobased materials.

Biobased plastics refer to plastics that contain materials wholly or partly of biogenic origin.

Plastics — Carbon and environmental footprint of biobased plastics —

Part 4:
Environmental (total) footprint (Life cycle assessment)

1 Scope

This document provides life cycle assessment (LCA) requirements and guidance to assess impacts over the life cycle of biobased plastic products, materials and polymer resins, which are partly or wholly based on biobased constituents.

The applications of LCA as such are outside the scope of this document. Clarifications, considerations, practices, simplifications and options for the different applications, are also beyond the scope of this document.

In addition, this document can be applied in studies that do not cover the whole life cycle, with justification, for example in the case of business-to-business information, such as cradle-to-gate studies, gate-to-gate studies, and specific parts of the life cycle (e.g. waste management, components of a product). For these studies, most requirements of this document are applicable (e.g. data quality, collection and calculation as well as allocation and critical review), but not all the requirements for the system boundary.

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 472, *Plastics — Vocabulary*

ISO 14025, *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*

ISO 14040:2006, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044:2006, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO/TR 21960, *Plastics — Environmental aspects — State of knowledge and methodologies*

EN 16575, *Bio-based products — Vocabulary*

EN 16760, *Bio-based products — Life cycle assessment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, ISO 14040, ISO 14044, EN 16575, EN 16760 and ISO/TR 21960 apply.

ISO and IEC maintain terminological 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/

4 Methodology for LCA of biobased products

4.1 General description of an LCA

The general description of life cycle assessment is defined in ISO 14040:2006, Clause 4.

4.2 General aspects of LCA for biobased plastic products

The LCA of a biobased plastic product shall cover the whole product, not only the biobased part; see Figure 1. However, the focus of this document is on how to handle the specificities of the biobased part of the product.

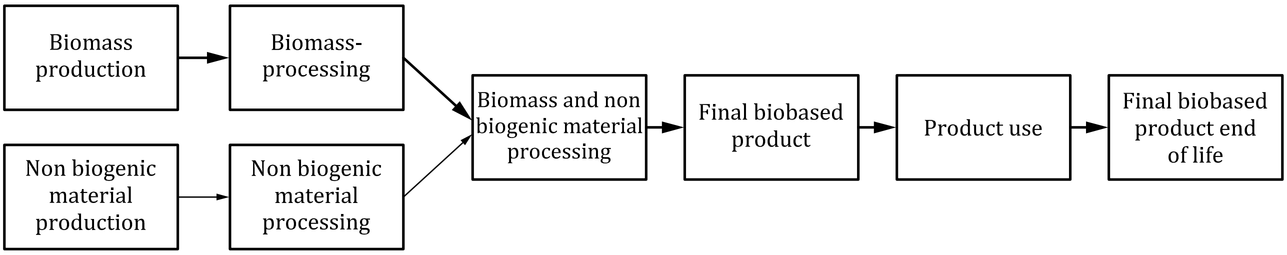

Figure 1 — Example of a product system of a biobased plastic product which includes biomass as well as non-biogenic material feedstocks

NOTE 1 The boxes linked with bold arrows in Figure 1 represent the flows of biobased products (partly or fully derived from biomass) that can be raw materials, intermediary products and final product.

NOTE 2 For simplification purposes, transportation steps have not been reported in Figure 1, but transportation can occur within or between any of the unit processes.

This document provides requirements and guidelines for biobased products: see 4.3, Clause 5, Clause 6 and Clause 7.

An LCA for a biobased product shall include the four phases of LCA. LCA requirements and guidelines are provided in ISO 14044:2006, 4.2, 4.3, 4.4 and 4.5.

This document provides further guidance on the following, which can be important for biobased plastic products, due to their biomass origin:

— geographical (see 5.2.2) and temporal scope (see 5.2.3) to be representative for the biomass acquisition phase considering agricultural, forest and aquaculture specificities;

— allocation procedures (see 5.3) as the production stages typically generates co-products;

— consideration for resource elementary flows (see 5.4.1);

— data collection and modelling for land use (see 5.4.2), water use (see 5.4.3), and fossil and biogenic carbon flows (see 5.5);

— modelling of agriculture and aquaculture systems (see 5.6) and

— inventory and modelling requirements for biobased plastic products end-of-life (see 5.6.4).

The ISO 22526 series focuses on biobased products for industrial application; food, feed and energy are excluded from the scope. However, the guidelines and requirements for LCA provided in this document can be applied to any product derived from biomass, irrespective of the application.

4.3 Goal and scope of the LCA study

4.3.1 Goal of the LCA study

When defining the goal of the LCA study, the requirements of ISO 14040:2006, 5.2.1 and ISO 14044:2006, 4.2.2 and 4.2.3 shall apply.

There is no single solution as to how LCA can be best applied, it depends on the goal of the LCA and on each organization size and culture, its products, the strategy, the internal systems, tools and procedures and the external drivers.

In defining the goal of an LCA, the following items shall be clearly stated:

— the intended application of the study;

— the reasons for carrying out the study;

— the intended audience, i.e. to whom the results of the study are intended to be communicated; and

— whether the results are intended to be used in comparative assertions intended to be disclosed to the public.

4.3.2 Scope of the LCA study

4.3.2.1 General

The scope should be sufficiently well-defined to ensure that the breadth, depth and detail of the study are compatible and sufficient to address the stated goal.

In addition to the definition of the scope of the LCA study in ISO 14044:2006, 4.2.3, the limitations, assumptions and methods to assess issues specific to biobased products should be explained (e.g. assumptions for use stage, for end-of-life stage, carbon storage).

In some cases, the goal and scope of the study may be revised due to unforeseen limitations, constraints or as a result of additional information. Such modifications, together with their justification, should be documented.

It shall be determined which impact categories, category indicators and characterization models are included within the LCA study. The selection of impact categories, category indicators and characterization models used in the LCIA methodology shall be consistent with the goal of the study and considered as described in ISO 14044:2006, 4.4.2.2.

4.3.2.2 Function and functional unit

In defining the functional unit, the requirements of ISO 14040:2006, 5.2.2 and ISO 14044:2006, 4.2.3.2 shall apply.

The scope of an LCA shall clearly specify the function (performance characteristics) of the product system being studied. The functional unit shall be consistent with the goal and scope of the study. One of the primary purposes of a functional unit is to provide a reference to which the input and output data are related. This reference is necessary to ensure comparability of LCA results, in particular when different systems are being assessed to enable comparison on a common basis. Therefore, the functional unit shall be clearly defined and measurable.

An appropriate reference flow shall be determined in relation to the functional unit. The quantitative input and output data collected in support of the analysis shall be calculated in relation to this flow. For biobased products which are intermediates or which can serve several functions or services, it is recommended to use a reference flow such as weight or volume (e.g. 1 kg of product), and to provide information whether it refers to dry matter weight, gross weight, etc.

EXAMPLE In the function of drying hands, both a paper towel and an air-dryer system are studied. The selected functional unit can be expressed in terms of the identical number of pairs of hands dried for both systems. For each system, it is possible to determine the reference flow, e.g. the average mass of paper or the average volume of hot air required for one pair of hand-dry, respectively. For both systems, it is possible to compile an inventory of inputs and outputs on the basis of the reference flows. At its simplest level, in the case of paper towel, this is related to the paper consumed. In the case of the air-dryer, this is related to the mass of hot air needed to dry the hands (copied from ISO 14040:2006, 5.2.2).

4.3.2.3 System boundary

In defining the system boundary, the requirements of ISO 14040:2006, 5.2.3 and ISO 14044:2006, 4.2.3.3 shall apply.

The system boundary shall be explained clearly and in an unambiguous way, preferably in a flow chart figure. The exclusion of any life cycle stage shall be documented and explained.

LCA technique with proper justification may be applied in studies that are not LCA or LCI studies. Examples are:

— cradle-to-gate studies;

— gate-to-gate studies; and

— specific parts of the life cycle (e.g. waste management, components of a product).

4.3.2.4 Cut-off criteria

When using cut-off criteria to decide on inclusion of inputs and outputs, the requirements of ISO 14044:2006, 4.2.3.3.3 shall apply.

The choice of elements of the physical system to be modelled depends on the goal and scope definition of the study, its intended application and audience, the assumptions made, data and cost constraints, and cut-off criteria. The models used should be described and the assumptions underlying those choices should be identified. The cut-off criteria used within a study should be clearly understood and defined within the goal and scope definition phase.

In principle, all elementary and technosphere flows should be accounted for. If not, mass, energy and environmental significance should be used to determine cut-off criteria. The final report shall include an estimation of completeness, based on:

— Mass cut-off (in % of total product mass): best estimation of the mass of all non-accounted components of the product.

— Energy cut-off (in % of total energy consumption): best estimation of all energy consumption of non-accounted mass inputs.

— Environmental significance: decisions on cut-off criteria should be based on best knowledge of environmental significance. Such information may, for example, be sought on safety data sheets for toxicological and ecotoxicological effects of a product where substance classification can guide on possible cut-offs regarding such categories. For assessment of other relevant environmental impacts also other sources of information should be looked for, such as emission declaration, approval documentation, etc. Inputs such as transport of staff, or consumer transport may be excluded as where it is established that they are insignificant.

Such simplifications shall be explicitly stated in the study report along with any supporting documentation showing these calculations, specifying the names of any flows which have not been taken into consideration.

4.3.2.5 LCIA methodology and types of impacts

The choices of which impact categories, category indicators and characterization models are selected within the LCA study shall be explained.

4.3.2.6 Data quality

Data quality requirements shall be specified to enable the goal and scope of the LCA to be met and should address what is listed in ISO 14044:2006, 4.2.3.6.2 and 4.2.3.6.3.

Site-specific and primary data should be used when appropriate and in line with the goal and scope of the study.

The selection of level of geographical detail should be consistent with the goal and intended use of the LCA and be justified in view of the availability and quality of data.

4.3.2.7 Comparisons between systems

As this document provides additional guidance and requirements for biobased products, the equivalence of the systems being compared shall be evaluated before interpreting the results. Consequently, the scope of the study shall be defined in such a way that the systems can be compared. Systems shall be compared using the same functional unit and equivalent methodological considerations, such as system boundary, data quality, allocation procedures, decision rules on evaluating inputs, and outputs and impact assessment. Any differences between systems regarding these parameters shall be identified and reported. Based on this information a well-reasoned assessment shall be included why the study is valid and can be performed or why a comparison is very problematic or even scientifically not allowed. In the latter case, such a study should not be terminated, but still should be published to educate about the limits of LCA. If the study is intended to be used for a comparative assertion intended to be disclosed to the public, interested parties shall conduct this evaluation as a critical review.

A life cycle impact assessment is an integral part of any LCA study, but especially for studies intended to be used in comparative assertions and be disclosed to the public, this impact assessment part shall be performed with utmost care.

If comparative assertions are intended to be disclosed to the public, additional requirements as set in ISO 14044 apply.

5 Life cycle inventory (LCI)

5.1 General

Inventory analysis involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system.

The process of conducting an inventory analysis is iterative. As data are collected and more is learned about the system, new data requirements or limitations may be identified that require a change in the data collection procedures so that the goals of the study will still be met. Sometimes, issues can be identified that require revisions to the goal or scope of the study.

The qualitative and quantitative data for inclusion in the inventory shall be collected for each unit process that is included within the system boundary. The collected data, whether measured, calculated or estimated, are utilized to quantify the inputs and outputs of a unit process. All individual unit processes should be taken up in a process flow diagram representing the studied system and so also identifying the system boundary.

When data have been collected from public sources, the source shall be referenced. For those data that can be significant for the conclusions of the study, details about the relevant data collection process, the time when data have been collected, and further information about data quality indicators shall be referenced.

If life cycle inventory data do not meet the data quality requirements, as given in 4.3.2.6, this shall be reported.

To decrease the risk of misunderstandings (e.g. resulting in double counting when validating or reusing the data collected), a description of each unit process shall be recorded.

Since data collection may span several reporting locations and published references, measures should be taken to reach uniform and consistent understanding of the product systems to be modelled.

5.2 Sources of data

5.2.1 General

Sources of inventory data should be specified and transparent.

Responsible sourcing and sustainable management practices can be found in the production of biobased raw materials. Certification schemes usually address a broad array of management and performance aspects that can be used directly in determining elementary flows and in informing impact assessment and interpretation.

EXAMPLE Managing conformity with standards covering fertiliser application can be linked directly to levels of fertiliser run-off and therefore elementary flow determination.

If biomass has been produced in conformance with a relevant standard this shall be taken into account in determining elementary flows and in impact assessment and interpretation.

The most representative data should be used and the quality of data shall always be examined in order to guarantee that they are adequate for the purpose of the study, and that they conform with the data quality requirements of the study.

5.2.2 Geographical data

Average data should be collected and assessed across a representative geographical area where the specific biomass has been produced. The data and scales used should be clearly specified in the study in order to ensure optimal transparency. Mean values by region can be used only for part of agricultural data (contributions from fertilisers, yields, etc.), since other variables cannot yet be regionalised due to the lack of a recognized model (e.g. N_2O emissions).

5.2.3 Temporal data

Time period is an important issue in LCA, as emissions to air, water and soil are subject to variation over the management cycle of the system. The LCI should cover the relevant period in the life cycle of the product.

For industrials processes and systems, the inventory may cover the cycle of productions, e.g. seasonal production, start-up, maintenance, and temporary process shutdown.

For biomass production the collection of data and modelling should consider the management regime and cropping or harvesting and crop rotation [including the positioning of the crop in the rotation], e.g. the effect of inter- and intra-annual variation and when possible use values representing the selected period.

Ideally, average biomass production data should be collected over a period of at least three recent consecutive years.

5.3 Allocation procedure

The inputs and outputs shall be allocated to the different products according to clearly stated procedures that shall be documented and explained together with the allocation procedure.

