भारतीयमानक
Indian Standard

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पर्यावरण के प्रति जागरूक डिज़ाइन (ईसीडी) — सिद्धांत, आवश्यकताएं और मार्गदर्शन

(पहला पुनरीक्षण)

Environmentally Conscious Design ECD — Principles Requirements and Guidance

(First Revision)

ICS 13.020.01

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NATIONAL FOREWORD

This Indian Standard which is identical with IEC 62430 : 2019 ‘Environmentally conscious design (ECD)-Principles, requirementsand guidance’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian standard on there commendation of the Standardization of environmental aspects for electrical and electronic product sectional committee and approval of the Electrotechnical division council.

This standard was first published in 2017 identical to IEC 62430 : 2009. This revision has been under taken to align this standard with the latest version of IEC 62430.

This document does not provide requirements for assessing the conformity of individual products.

This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

a) Scope is extended from electrotechnical product and systems to all products including services.

b) As a consequence of the scope expansion, non-electrotechnical products, services in particular, are taken into account to modify requirements.

c) Clause **6** is added as a guidance.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations .Certain conventions are ,however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be readas ‘Indian Standard’.

b) Comma(,) has been used as adecimal 9marker,while in Indian Standards the current practice is to use apoint (.) as the decimal marker.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

INTRODUCTION

The main purpose of this document is to set requirements and give guidance on how an organization can integrate environmentally conscious design (ECD) into their design and development. It is not a product standard and so does not describe requirements that apply to individual products, or a series of products.

This document uses the term ECD but other terminology used worldwide with the same meaning includes ecodesign, design for environment (DFE), green design and environmentally sustainable design.

This document covers physical goods, services, and a combination of the two, all of which are referred to as ‘products’.

ECD is not a separate activity; it is rather an integral part of an organization’s existing design and development. While this is not a management system standard, its requirements regarding ECD can be incorporated into an organization’s existing management system, such as created to support conformance with ISO 14001 and ISO 9001.

NOTE ISO 14001 links management of an organization's processes with environmental impacts, but it does not specify requirements for the management processes associated with design and development. Therefore, this ECD standard can be an addition for organizations which have ISO 14001 in place, as ISO 14001 does not specify how to incorporate ECD into products. ISO 14006 provides guidance on how to incorporate ECD into an environmental management system, however, it does not specify how to apply ECD.

Every product has environmental impacts, and these can occur during all stages of its life cycle. These impacts can range from slight to significant; they may be short-term or long-term; and they may occur at the local, national, regional or global level (or a combination thereof).

In order to minimize these impacts, it is essential to implement ECD within design and development. ECD is a systematic approach to achieve reduction of these adverse impacts of a product throughout its entire life cycle.

Multiple benefits can be achieved for the organization, its customers, and other stakeholders by applying ECD, such as an overall environmental improvement, a cost reduction, and better marketability.

This document is intended for those, directly and indirectly, involved in the implementation of ECD into the design and development.

This document does not preclude sectors from generating their own ECD specific standards or guidance. However, where such documents are produced, the authors are encouraged to use this document as a reference to ensure consistency across areas of various products and supply chains.

Indian Standard

ENVIRONMENTALLY CONSCIOUS DESIGN ECD — PRINCIPLES, REQUIREMENTS AND GUIDANCE

1 Scope

This document describes principles, specifies requirements and provides guidance for organizations intending to integrate environmental aspects into the design and development in order to minimize the adverse environmental impacts of their products.

This document applies to processes on how ECD (environmentally conscious design) are integrated into the design and development. This document applies to any organization, regardless of its size, type or sector.

This document does not provide requirements for assessing the conformity of individual products.

This horizontal standard is primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 108.

One of the responsibilities of a technical committee is, wherever applicable, to make use of horizontal standards in the preparation of its publications. The contents of this horizontal standard will not apply unless specifically referred to or included in the relevant publications.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- ISO Online browsing platform: available at http://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms related to design and development

3.1.1
environmentally conscious design
ECD
systematic approach which considers environmental aspects in the design and development with the aim to reduce adverse environmental impacts throughout the life cycle of a product

Note 1 to entry: Other terminology used worldwide with the same meaning includes ecodesign, design for environment (DFE), green design and environmentally sustainable design.

Note 2 to entry: This note applies to the French language only.

3.1.2
product
any goods or service

Note 1 to entry: This includes interconnected, interrelated goods or services.

[SOURCE: ISO 14050:2009, 6.2, modified – Note 1 and 2 deleted and new Note 1 added.]

3.1.3
product group
group of technologically or functionally similar products where the environmental aspects can reasonably be expected to be similar

3.1.4
design and development
process that transforms requirements into a product

Note 1 to entry: Design and development usually follow a series of steps e.g. starting with an initial idea, transforming the idea into a formal specification, through to the creation of a product, its possible redesign and consideration of end of life.

Note 2 to entry: Design and development can include taking a product idea from planning to product provision and review of the product. It can include considerations on business strategies, marketing, research methods and design aspects that are used. It includes improvements or modifications of existing products.

3.1.5
process
set of interrelated or interacting activities which transforms inputs into outputs

[SOURCE: ISO 14001:2015, 3.3.5, modified – Note1 deleted.]

3.1.6
requirement
need or expectation that is stated, generally implied or obligatory

[SOURCE: ISO/IEC Directives, Part 1, Consolidated ISO Supplement, Annex L, Appendix 2:2019, 3.3, modified – Notes have been deleted.]

3.2 Terms related to product life cycle

3.2.1
life cycle
consecutive and interlinked stages of a product

Note 1 to entry: Examples of interlinked stages for goods include value proposition creation, design and development, manufacture of goods, delivery/installation of goods, use of goods, maintenance, repair, upgrade, re-use, remanufacture, end of life treatment and final disposal.

Note 2 to entry: Examples of interlinked stages of service include value proposition creation, design and development, preparation of enablers/capabilities to deliver the service, launch/delivery of the service, and service provision.

Note 3 to entry: The term “entire life cycle” refers to all life cycle stages that a product goes through, e.g. from raw material acquisition or generation from natural resources to the final disposal.

3.2.2
life cycle stage
life cycle phase
element of a life cycle

3.2.3
life cycle thinking
LCT
life cycle perspective
LCP
consideration of all relevant environmental aspects of a product during its entire life cycle

Note 1 to entry: LCT does not imply undertaking a life cycle assessment.

Note 2 to entry: This note applies to the French language only.

Note 3 to entry: This note applies to the French language only.

3.3 Terms relating to those who control or influence ECD requirements

3.3.1
organization
person or group of people who have their own functions with responsibilities, authorities and relationships to achieve their objectives

[SOURCE: ISO/IEC Directives, Part 1, Consolidated ISO Supplement, Annex L, Appendix 2:2019, 3.1, modified – “that has” replaced with “who have” and “its” replaced with “their”.]

3.3.2
stakeholder
interested party
person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity

[SOURCE: ISO/IEC Directives, Part 1, Consolidated ISO Supplement, Annex L, Appendix 2:2019, 3.2]

3.3.3
value chain
entire sequence of activities or parties that create or receive value through the provision of a product

[SOURCE: ISO 26000:2010, 2.25, modified – “that provide” replaced with “that create”, “in the form of products or services” replaced with “through the provision of a product”, and notes deleted.]

3.4 Terms related to the environment

3.4.1
environment
surroundings which a product can affect, by its existence, including air, water, land, natural resources, flora, fauna, humans and their interrelations

Note 1 to entry: Surroundings can be described in terms of biodiversity, ecosystems, climate or other characteristics.

3.4.2
environmental aspect
element of an organization’s activities or products that interacts with, or can interact with, the environment

Note 1 to entry: An environmental aspect can cause (an) environmental impact(s). A significant environmental aspect is one that has or can have one or more significant environmental impact(s).

Note 2 to entry: Significant environmental aspects are determined by the organization applying one or more criteria.

Note 3 to entry: Activities of the organization are those related to design and development.

[SOURCE: ISO 14001: 2015, 3.2.2, modified – "or services" deleted and Note 3 added.]

3.4.3
environmental impact
change to the environment, whether adverse or beneficial, wholly or partially resulting from environmental aspects

[SOURCE: ISO 14001:2015, 3.2.4, modified – “an organization’s” deleted.]

3.4.4
environmental parameter
quantifiable attribute of an environmental aspect

EXAMPLE Environmental parameters include the type and quantity of materials used (weight, volume), power consumption, emissions, rate of recyclability.

3.4.5
objective
result to be achieved

Note 1 to entry: An objective can be strategic, tactical, or operational.

Note 2 to entry: An objective can be expressed in other ways, e.g. as an intended outcome, a purpose, an operational criterion, as an environmental objective, or by the use of other words with similar meaning (e.g. aim, goal, or target).

[SOURCE: ISO/IEC Directives, Part 1, Consolidated ISO Supplement, Annex L, Appendix 2:2019, 3.8, modified – Notes 2 and 4 deleted.]

3.4.6
environmental objective
objective set by the organization consistent with its environmental policy

[SOURCE: ISO 14001: 2015, 3.2.6.]

3.4.7
documented information
information required to be controlled and maintained by an organization and the medium on which it is contained

Note 1 to entry: Documented information can be in any format and media, and from any source.

Note 2 to entry: Documented information can refer to:

- the management system, including related processes;
- information created in order for the organization to operate (documentation);
- evidence of results achieved (records).

[SOURCE: ISO/IEC Directives, Part 1, Consolidated ISO Supplement, Annex L, Appendix 2:2019, 3.11]

4 Principles of environmentally conscious design (ECD)

4.1 General

The application of the following principles is fundamental to implement ECD:

- life cycle thinking;
- ECD as a policy of the organization.

4.2 Life cycle thinking

Life cycle thinking includes, but is not limited to, the following elements:

a) having an objective to reduce the overall adverse environmental impacts of the product while still taking into account other aspects such as safety, quality;
b) identifying the significant environmental aspects of the product;

c) considering the trade-offs between different environmental aspects throughout all life cycle stages;

EXAMPLE 1: The trade-off between energy and material use when replacing an old product with a new one.

d) considering the trade-offs of a specific environmental aspect between life cycle stages.

EXAMPLE 2: Consider an automobile; selecting lightweight materials (e.g. high-alloy steel or aluminum) could require more energy to be expended in the manufacturing stage, but the trade-off would be lower fuel consumption during the use stage (due to the lower mass).

NOTE When a product is part of a system, the environmental performance of that product, during one or more life cycle stages, can be altered by other products in that system.

In order to include life cycle thinking within ECD, the above elements are considered as early as possible in the design and development, since that is when the greatest opportunities exist to make improvements to the product and to reduce any consequential adverse environmental impact.

4.3 ECD as a policy of the organization

The objective of integrating ECD into the policy of an organization and its implementing strategy is to ensure:

a) management understanding of and commitment to ECD;
b) early contribution and commitment of all relevant business functions to the environmental objectives for the product throughout its entire life cycle.

5 Requirements of ECD

5.1 General

5.1.1 Integrating ECD into the management system of the organization

The organization shall establish, implement, and maintain ECD as an integral part of design and development by integrating corresponding requirements into the related procedures and instructions.

ECD shall be reflected in the policy and strategy of the organization.

If an organization has a management system which includes design and development, the ECD shall be a part of that management system.

NOTE Management systems are described, for example, in ISO 9001 and ISO 14001. ISO 14006 provides guidelines for incorporating ECD into a management system.

5.1.2 Determining the scope of ECD

The organization shall determine the scope of ECD for a particular product or product group. This scope shall consider the relevant stakeholder requirements, and environmental aspects relevant to the product (or product group, as applicable) and the environmental sphere of influence of the organization.

NOTE 1 Depending on the nature of the organization’s product, the scope can include manufacturing, remanufacturing, and service provision.

NOTE 2 The sphere of influence is the ability of an organization to affect other organizations through contractual, economic or other relationships to affect the decisions, activities or requirements of these other organizations.

5.1.3 Elements of ECD

Elements of ECD incorporated into the design and development are:

a) identification and analysis of relevant stakeholder requirements (see 5.2);
b) identification and evaluation of environmental aspects and corresponding impacts (see 5.3);
c) incorporation of ECD into design and development (see 5.4);
d) review and continual improvement (see 5.5);
e) information exchange (see 5.6).

NOTE The above items from a) to d) correspond to a PDCA (plan, do, check and act) cycle as follows:

- steps a) and b) correspond to Plan;
- step c) corresponds to Do;
- step d) corresponds to Check and Act.

5.1.4 Documented information

The scope determined in 5.1.2 shall be maintained as documented information and be available to relevant stakeholders.

The results obtained from the elements listed in 5.1.3 shall be documented, including subsequent conclusions and responsibilities assigned.

5.2 Analysis of stakeholder environmental requirements

The organization shall establish, implement, and maintain a process to identify the following items regarding the product being designed and developed:

- the relevant stakeholders;
- the generic, sector specific, product group specific, and product specific environmental requirements of the stakeholders.

NOTE 1 Generic requirements are those requirements that are applicable to any product, e.g. energy saving requirements.

NOTE 2 Sector specific requirements are those requirements that are applicable to a specific sector, e.g. automotive sectors.

NOTE 3 Product (group) specific requirements are those requirements that are applicable to a specific product (group), e.g. vacuum cleaners.

In implementing the above, the organization shall ensure that:

a) requirements from relevant stakeholders are identified, for example, covering:
   – the different life cycle stages where the requirements are applicable;
   – environmental aspects of the product;
   – the intended geographic market of the product;
   – activities of the organization related to the design and development of the product.
b) current and emerging relevant stakeholder requirements are identified, reviewed and updated as needed;
c) an analysis of the requirements in a) and b) is performed, to identify the affected potential functions and life cycle stages of the product;
d) steps from a) to c) are periodically repeated to address new or changed requirements which occur during design and development.

NOTE 4 It is for the organization to determine what life cycle stages are included.

5.3 Identification and evaluation of environmental aspects

The organization shall establish, implement and maintain a process to identify and evaluate product-related environmental aspects. The process shall take into account environmental

impacts corresponding to those environmental aspects of the product throughout the life cycle, and the scope of ECD determined in 5.1.2.

When assessing the environmental aspects of a product the steps below shall be followed:

a) identification of environmental aspects relevant to a product or product group;
b) evaluation of environmental impacts related to the identified environmental aspects;
c) determination of significant environmental aspects.

It is permitted to use qualitative or quantitative evaluation and prioritization of the environmental aspects. Where feasible, the quantitative approach is encouraged.

5.4 Incorporation of ECD into design and development

The organization shall establish, implement and maintain a process to ensure that the following tasks are carried out during design and development:

a) specify the functions to be provided by a product;
b) determine the relevant environmental parameters, taking into account legal and other relevant stakeholder requirements, and significant environmental aspects;
c) determine improvement strategies for the environmental parameters;
d) set environmental objectives for the environmental parameters based on the improvement strategies;
e) create a product specification addressing the environmental objectives;
f) create solutions to realize the specification while taking into account other design considerations.

NOTE 1 ECD is a multi-disciplinary set of activities and functions involved in design and development within an organization or value chain (e.g. design engineers, logistics, procurement, sales and suppliers).

The product solution resulting from design and development should achieve a balance between the various environmental aspects including relevant stakeholder requirements (see 5.2) and other requirements such as function, technical requirements, quality, performance, safety, economic aspects, ethical and social value, and technical and business risks.

NOTE 2 Further guidance on and definition of ethical and social value is provided in ISO 26000.

When compliance with regulations (e.g. health and safety) is required, these shall be met while considering the environmental objectives.

5.5 ECD review

5.5.1 Process review

The organization shall establish, implement and maintain a process to conduct reviews to ensure that the resulting system implements the requirements of this document correctly and fully.

Such reviews shall be conducted at planned intervals and additionally when necessary, to ensure that ECD is implemented and maintained in a suitable and effective manner.

Each review shall include assessing opportunities for improving how ECD is implemented resulting in a decision whether or not relevant policies and strategies of the organization need to be updated.

5.5.2 Design review

The organization shall establish, implement and maintain a process to review the ability to further reduce significant environmental impacts of products.

These reviews shall be conducted at planned intervals or when necessary, to ensure that each life cycle stage is considered, taking into account changes in both internal and external factors (such as revised relevant stakeholder requirements).

Improvement actions shall be determined and implemented based on knowledge gained through the review if:

- the environmental objectives have not been met; or
- the environmental objectives are no longer appropriate or valid.

5.5.3 Documented information of reviews

Documented information obtained from the reviews specified in 5.5.1 and 5.5.2, including the assigned actions arising from the review, shall be created, retained and serve as a reference for the future development of the product and continual improvement activities.

5.6 Information exchange

As part of the ECD, the organization shall exchange information with relevant stakeholders in the value chain to achieve its environmental objective. If the information from the value chain is not available the organization shall take other measures to obtain the required information.

The information to be exchanged in the value chain should facilitate the reduction of adverse environmental impacts throughout the entire life cycle of the product.

6 Guidance on implementing ECD

6.1 General

6.1.1 Overview

Subclause 6.1 provides guidance on implementing 5.1. Annex A provides examples of how to apply ECD. Annex B provides information on how to select methods and tools for ECD. This document also applies to design and development in multiple organizations, and activities occurring in different locations, providing one organization has overall responsibility for design and development.

6.1.2 Integrating ECD into the management system of the organization

ECD should not be a separate activity, rather it should be an integral part of the design and development within an organization. Hence, the organization’s policies and strategy determine the framework and objectives of the ECD, including the resource allocation (e.g. financial and human resources and time allocation for completing the tasks). The strategy also needs to cover engagement with relevant internal and external stakeholders to improve the organization’s ECD.

As an example, an organization could establish policies or strategies to improve the environmental performance of specific areas of its products. It could then have a mechanism to determine if these policies or strategies have been met. It is for the organization to determine the appropriate timescales, for example in short-term, medium-term and long-term action plans.

ISO 14006 provides guidance on how an organization can integrate ECD into their existing management system.

Continual improvement refers to a recurring process to improve performance over time, according to a plan set by the organization. Using the plan-do-check-act (PDCA) cycle can facilitate continual improvement.

6.1.3 Determining the scope of ECD

The scope of ECD will usually have an impact on other parts of the value chain within an organization. Moreover, choices and decisions made during the design and development will modify the environmental impacts caused by a product throughout its life cycle.

The scope of ECD can vary depending on the organization, its relevant stakeholder requirements and environmental sphere of influence.

The scope of ECD is set by the organization carrying out the design and development. It will be dependent on the range of activities that the organization can influence through design and development. Decisions made in the design and development influence activities such as choice of raw materials, manufacturing methods, logistics, sale, use and maintenance arrangements for the product, and end of life. Some of these influences could be internal to the organization while others could be external to it.

Guidance concerning relevant stakeholder requirements are given in 6.2 and environmental aspects relevant to a product are given in 6.3.

The sphere of influence is also determined on a case by case basis. The organization can have influence over suppliers in the value chain. If this is the case, it can determine the scope of ECD including those suppliers. If this is not the case, it could be feasible for an organization to increase its influence over time as part of their continual improvement plan, working together with their suppliers. In many cases, an organization can influence downstream users (e.g. customers) through various kinds of communication (e.g. user manuals, call centres), which suggests the organization may include downstream users in the value chain into its scope of ECD. In particular, in the field of service provisioning, the business activities are carried out in the interactions with customers and they can naturally be covered in the scope of ECD.

6.1.4 Elements of ECD

No guidance is needed regarding this subclause.

6.1.5 Documented information

No guidance is needed regarding this subclause.

6.2 Analysis of stakeholder requirements

This subclause provides guidance on implementing 5.2.

The requirements of relevant stakeholders regarding a product can be appropriate for any life cycle stage.

There are many stakeholders and their associated requirements, which can be external or internal to the organization undertaking the ECD. Examples include:

- local, national, regional and international legal requirements;
- local, national, regional and international technical standards and voluntary agreements;
- customer requirements and specifications;
- requirements from internal functions of the organization (e.g. logistics, production/service/maintenance personnel, sales/marketing and procurement);
- benchmark and market analysis reports;

- eco-label and sustainable procurement schemes;
- technical documentations from suppliers;
- societal, investor and media expectations.

When choosing which requirements are relevant, it is suggested to consider factors such as those that have to be met in all cases (e.g. those stemming from legal provisions which apply to the products under design or development) and those that are optional. The optional requirements can be then ranked by the organization into those which are, and are not, included in the specification for the design and development.

As stakeholder requirements change with time it is important to have a process to periodically check for changes that could affect the organization's products.

6.3 Identification and evaluation of environmental aspects

This subclause provides guidance on implementing 5.3.

A product has a range of environmental aspects that result in environmental impacts as described below.

The environmental impacts of goods are largely caused by the material and energy inputs and outputs that are generated at all life cycle stages. A service can cause environmental impacts through the use of goods associated with that service. Environmental impacts of a service can be caused by both the direct use of resources and also by managing and accessing infrastructures, which are needed to deliver the service. Furthermore, these environmental impacts can be influenced by the actions of the organization and individuals using the product.

For example, for every life cycle stage, a product has a range of environmental aspects that are related to:

- inputs (e.g. virgin or recycled material, substances, new/reused/remanufactured parts, subassemblies, spare parts, consumables, and energy);
- outputs (e.g. products, substances, parts, subassemblies, spare parts, consumables, semi-finished products, rejects, emissions to air, soil and water, wastes).

These aspects result in various environmental impacts (e.g. acidification, air/water/soil pollution, alteration of habitats, climate change, depletion of resources, eutrophication, ozone depletion, reduction of biological diversity, and smog formation).

Environmental aspects can result in risks and opportunities associated with either adverse impacts (threats) or beneficial ones (opportunities). Significant environmental aspects are those that have or can have significant environmental impacts.

As explained in 3.4.2, the significance is determined in accordance with criteria defined by an organization. It is important that the organization should develop relevant objective criteria and consistently use it throughout ECD.

The process of identifying and evaluating environmental aspects of a product should explicitly include its life cycle to be designed or redesigned. The purpose is to determine which aspects have or could have a significant impact on the environment. This generally follows the steps as follows:

a) Understanding the life cycle of the product.
b) Identification of the environmental aspects associated with all the life cycle stages of the product within the scope of ECD determined by the organization (see 5.1):

   For each life cycle stage of the product being designed or developed, the organization should identify environmental aspects, both inputs and outputs (see Clause A.1) that result

in environmental impacts. An arbitrary emphasis on a single environmental aspect or a single life cycle stage should be avoided.

c) Evaluation of environmental aspects to determine their significance:

In order to determine what aspects are significant, the organization should establish a method, based mainly on environmental criteria, which should take into account as many types of environmental impacts as possible. The result of the evaluation should be reproducible and repeatable.

When designing or redesigning a product, the evaluation of the significance of its environmental aspects can be performed on the basis of a previous model of the product, a similar product on its market, or a prototype.

A quantitative approach can be judged by a numerical value and so should be capable of being determined in a repeatable and reproducible manner. A qualitative approach involves distinctions based on qualities and so it is important that it is based on objective criteria.

6.4 Incorporation of ECD into design and development

This subclause provides guidance on implementing 5.4.

When considering both environmental and other requirements, as identified in 5.2 and 5.4, it is for the organization to decide which of these, possibly contradictory, requirements are incorporated into the product specification.

The organization evaluates various design and development approaches with the aim of reducing the adverse environmental impacts caused by the product over its entire life cycle. The following provides examples of possible design and development considerations:

a) determine product function considering opportunities for multiple functions and modularity, and consider dematerialization comparing the environmental performance to that of product's tailored for a specific use;

b) define significant environmental parameters based on stakeholder requirements determined in accordance with 6.2 and environmental aspects determined in accordance with 6.3;

c) consider the significant environmental parameters determined in b) and decide what design and development strategies will deliver an improvement in them (these can be long-term or short-term);

d) set environmental objectives based on the environmental parameters determined in c);

e) develop a design specification of the product addressing the environmental objectives determined in d);

f) any guidance on the applicability of technical solutions and concepts would be product-specific and so is outside the scope of this document.

6.5 Review

6.5.1 Process review

This subclause provides guidance on implementing 5.5.1.

In comparison with a design review, the process review addresses the overall appropriateness of ECD and does not focus on specific products.

6.5.2 Design review

This subclause provides guidance on implementing 5.5.2.

As part of the ECD, an appropriate procedure for reviewing the significant environmental aspects and resulting impacts of products throughout their life cycle should be defined including the timing of these reviews. For example, these could be initiated:

- at the completion of a major design stage;
- when new information on major aspects or uses of the product are emerging;
- when a significant environmental aspect is affected by emerging relevant stakeholders requirements;
- when new information concerning the interaction of the product with the environment arises;
- when the strategy of the organization changes; including the changes in the environmental objectives set by the organization.

Information concerning the product's environmental aspects or inputs can change after the product launch. Consequently, design reviews should, as part of continual improvement, include checking the appropriateness and validity of environmental objectives.

The organization should establish a process in the case where the environmental objectives for a product have not been met. The organization could choose to launch the product together with an improvement action plan. In such cases, a product review should confirm that the planned improvement actions have been implemented.

6.5.3 Documented information of reviews

This subclause provides guidance on implementing 5.5.3.

The documented information from reviews can be in any form or format. Determining an appropriate retention period is the responsibility of the organization undertaking the ECD.

6.6 Information exchange

This subclause provides guidance on implementing 5.6.

Information exchange between relevant stakeholders within the value chain supports collaboration which can support the analysis and improvement of environmental aspects and associated impacts covering the whole life cycle of a product.

Communication and information exchange across the value chain can be facilitated by standardized formats.

NOTE 1 IEC 62474 describes the exchange of information on material declarations.

Information exchange for cooperation among the relevant stakeholders involved should start as early as possible in the ECD.

Information to be exchanged can include:

a) resources used and recovered during the entire life cycle of the product;
b) emissions and waste generated by the product during its entire life cycle;
c) end of life treatment instructions to recyclers;
d) guidance to achieve or improve environmental performance of the product;
e) environmental labels and declarations relevant to the product.

NOTE 2 ISO 14020 provides information on environmental labels and declarations.

Annex A
(informative)

Examples of how to apply ECD

A.1 Environmental aspects and impacts

A.1.1 Application of ECD to goods and services

This document can be used when designing and developing all types of products whether goods (e.g. physical objects) or services, or a combination of both. It can be applied to the design and development of a large system (such as a building) or mass-produced goods (such as mobile phones). It can also be used when designing and developing a small-scale localized service (like shining shoes) or the provision of a mass-marketed service (such as internet banking).

Figure A.1 shows the inputs and outputs, and the indicative examples of life cycle stages of both goods and services. Life cycle stages are interconnected as shown in the figure. All activities related to life cycle stages through their inputs and outputs will result in environmental impacts as described in A.1.10.

Although goods or services are often recognized as separate entities, in practice a combination of the two is what will be delivered to the customers. Therefore, when assessing the environmental aspects associated with a product, both goods and services elements should be carefully reviewed as they can be interconnected and cause associated environmental impacts. For products comprising both goods and service elements, these elements are likely to require different types of optimization in order to reduce their adverse environmental impacts.

Inputs can include the materials, energy needed to make goods, and infrastructures needed to deliver a service. The environmental impacts for the service are related to the choice of the goods, infrastructures and the service capabilities and how the user or the service provider will interact with them.

Material and goods will need to be transported between the product life cycle stages, and people will need to travel to either deliver or receive a service. Transport or travel will consume energy and will result in emissions.

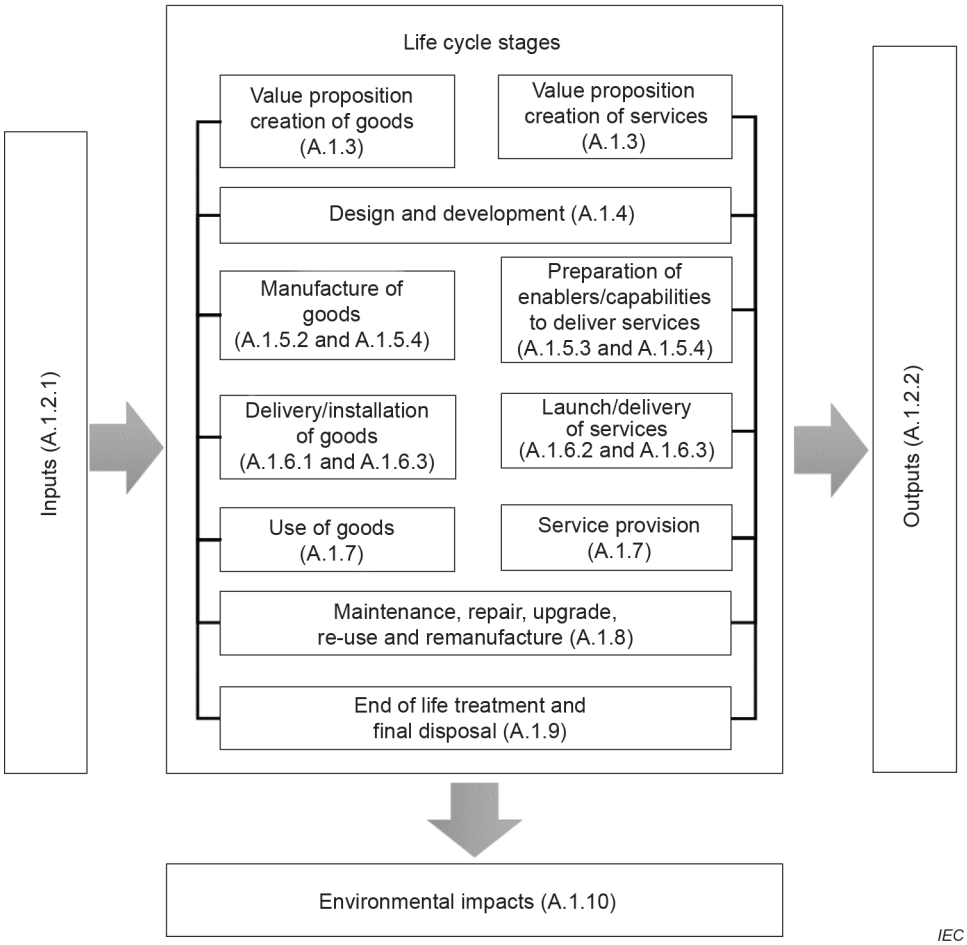

Figure A.1 – Inputs and outputs and indicative examples of life cycle stages for goods and services

A.1.2 Inputs and outputs

A.1.2.1 Inputs

Inputs that relate to the activities of an organization include:

- primary or recycled materials used in the manufacturing of the product, by the product itself during use, delivery, and installation;
- energy used in the manufacturing or remanufacturing of the product, in the use stage of the product itself and delivery and installation;
- water and other natural resources used in the manufacturing or remanufacturing of the product, in the product itself and used in delivery and installation of the product;
- parts and (sub)assemblies used in the product;
- spare-parts used to repair and extend the life of a product;
- consumables used during the use stage of the product;
- goods, systems and infrastructures (telecommunication, IT, etc.) needed to deliver a service;

There can be multiple inputs that affect the different activities throughout the life cycle of a product.

A.1.2.2 Outputs

Typical outputs from an organization’s activities include:

- finished goods (including systems and infrastructures);
- semi-finished goods;
- recycled materials;
- recovered materials;
- recovered energy.

Along with the product itself, unwanted outputs such as waste, and by-products will be generated in each of the activities carried out by the organization or outside the organization. Examples of these outputs are:

- product and material rejects;
- emissions to air (GHG, ozone depleting substances, etc.);
- emissions to water and soil;
- physical waste;
- noise and vibration;
- other releases.

The above outputs could result directly from the organization's activities, or indirectly as a result of the choices made by the organization. For example, many life cycle stages may result in emissions that are a consequence of the activities of the organization, but occur at sources owned or controlled by another organization.

A.1.3 Value proposition creation

A value proposition is a statement of the benefit expressed as a financial or environmental quantity to be delivered by an organization. A value proposition can apply to the entire or part of the organization, to customers, or to goods or services.

During the creation of a value proposition, an organization should determine which aspects of the product could be optimized so as to minimize adverse environmental impacts. Such aspects should then be set as improvement strategies (see 5.4 d) so as to ultimately create specific requirements to address the associated environmental objectives (see 5.4 e).

A.1.4 Design and development

As required by 5.2 and 5.4, it is necessary to transform the concept regarding the product into requirements. For services, this means identifying ways to provide the desired experience for the customer, for example, it could be an experience or a series of interactions (e.g. flying from point A to point B). In this stage, the service offering will be further defined so that the interactions between a service provider and receiver, the experiences, the required enablers (see A.1.5) and capabilities will be designed and developed.

Information of environmental impacts of a product can be obtained based on experience gained from feedback from users on, for example, earlier versions of the product.

Although requirements for the stages described in A.1.4 through A.1.9 could change with time, it is important from the very beginning to consider and plan for eventualities.

A.1.5 Manufacture of goods and preparation of enablers/capabilities to deliver services

A.1.5.1 General

This stage primarily relates to 5.3.

A.1.5.2 Considerations specific to the manufacture of goods

The manufacturing stage of goods includes the processing of materials or parts into goods and, where needed, spare parts. Environmental impacts in this stage are typically associated with the use of resources and energy, the creation of rejects and waste, and associated emissions to air, water and soil. New manufacturing technologies can become available which make more efficient use of materials, reduce energy consumption or create less waste. In line with 5.5.2, the different environmental aspects presented by these technologies should be considered to determine if it is feasible to reduce adverse environmental impacts.

A.1.5.3 Considerations specific to the preparation of enablers/capabilities to deliver services

This stage represents the integration of enablers and the needed capabilities to deliver the service. Examples of enablers and capabilities are:

- shampoo in a hair salon (enablers);
- telephones for a call centre (enablers);
- training people who will deliver the service (capabilities);
- the location where the service will be delivered (capabilities);
- preparation for the launch of the service (capabilities).

Customer experience and interactions in providing the service will have a strong impact on the required enablers and capabilities. Early clarity on concepts associated with the experience and interactions is therefore essential to build an environmentally conscious service.

A.1.5.4 Considerations common to both the manufacturing of goods and the preparation of enablers/capabilities to deliver services

Design and development will continue in an organization for as long as the manufacture of mass-produced goods continues, which could extend over many years. During such a time period it is likely that there will be multiple changes in relevant stakeholder requirements (see 5.2) and the availability of components and materials required for manufacturing. Likewise, a service can be provided over an extended period and their capabilities and enablers can also need to be revised in accordance with changing circumstances over time. It is for this reason that ECD should be a continuous process which is periodically reviewed (see 5.5).

In addition to the above reasons, it can also be necessary to revise the components or other design attributes for practical reasons such as non-availability of certain components. All these change requests will need to be evaluated as part of the design and development activity for, not only their functional aspects but also for their environmental aspects.

A.1.6 Delivery/installation of goods and launch/delivery of services

A.1.6.1 Considerations specific to the delivery/installation of goods

Packaging and transport needed for the distribution of the goods from the manufacturer to the customer and the materials and energy needed for its installation are likely the most important aspects to consider when evaluating the environmental impacts for this stage.

Just as it could be necessary to change the products themselves, so it may be necessary to change their packaging or presentation. For example, stakeholder requirements could affect what, if any, information is provided on the packaging itself, information provided with the product, or the way they are advertised (i.e. its presentation). There could be changes in the technology of transportation that can affect the environmental impacts. Such considerations need to be taken into account as part of design and development, together with consequential changes to environmental aspects.

A.1.6.2 Considerations specific to the launch/delivery of services

Before introducing a full service in the market for the first time, a small scale launch is often offered, allowing for fast optimization and better preparation for the scaling-up of the service. Learnings obtained in this stage allow faster iteration within the design and development, in case the service needs to be adapted or improved.

A.1.6.3 Considerations common to both the delivery/installation of goods, and launch/delivery of services

As examples, the market introduction of products including marketing advertisements, user instructions, and the logistics around the delivery of each product and its installation need to be considered.

A.1.7 Use stage of goods and provisioning of services

For both goods and services, when considering the entire life cycle, this stage is likely to have the greatest environmental impacts.

For goods, this stage involves inputs such as energy, consumables, and outputs such as emissions during the use of the product. The use stage of goods will include considerations such as serviceability and upgradeability.

NOTE 1 Extending the use phase by techniques such as reuse and remanufacturing is covered in A.1.8.

For a service, this stage starts when the full service is delivered to the end customer(s). Consequently, all components (including associated goods, systems and infrastructures) required to deliver the service have to be in place. Aside from inputs and outputs similar to those associated with the goods, every time the service is delivered provides an opportunity to collect feedback, analyse the outcome and enhance the service offering.

NOTE 2 Prompt reaction to feedback from the customers on the service can allow the design and development to swiftly implement adjustments of the service and provide improvements for the customer with a reduction in environmental impacts.

During the use stage, there can be a number of changes in the design brought about by activities such as changes in stakeholder requirements. All changes will require consideration for their potential to affect the environmental impact caused by the product.

A.1.8 Maintenance, repair, upgrade, reuse and remanufacture

This stage is simply a continuation of the use phase. The extent to which a product can be repaired and maintained will form an important consideration of the product specification. Likewise, whether it is possible to upgrade a product via hardware or software, and the time period over which the product possibility exists is also likely to be an important part of the product’s specification. All these considerations should be taken into account when undertaking 5.2 and 5.3 in particular.

The above activities of maintenance and upgrading are typically undertaken by the first owner of the product. Conversely, reuse and remanufacturing generally involve a change in ownership.

NOTE Within this document, the terms are used with meanings as follows:

- maintenance: the combination of all technical and management actions intended to retain an item in, or restore it to, a state in which it can perform as required;
- repair: returning a product that no longer functions back to a functioning state;
- upgrade: providing a product with some new or improved functionality.

While maintenance, repair and upgrading are usually performed at the customer’s location, reuse is not. Remanufacturing typically involves some kind of industrial process.

All the above processes have the possibility to reduce adverse environmental impacts. Nevertheless, changes in stakeholder requirements may make some of these processes impossible, at least within certain geographic regions.

A.1.9 End of life treatment and final disposal

Once goods reach their end of life, it should, consistent with stakeholders' requirements, be ensured that the used materials can be recycled and parts reused. When this is not technically or financially feasible, it may be possible to recover energy from certain materials. For the waste fractions where such treatments are not possible, they are then landfilled. The impacts associated with this stage are related to the loss of value in materials and the amount of energy recovered.

For a service, the end of life will entail the discontinuation of whole or parts and features of the service, often involving dismantling of capabilities and enablers. Appropriate treatment of the goods which are no longer required and for which a second life can be given is important. Where reuse is not possible, final treatment and disposal will be followed.

This stage can result in significant negative environmental impacts, for both goods and services. Therefore optimization during design and development, in particular in its earlier phase, is important to reduce such impacts.

Depending on the length of the use stage, treatment technologies could become available which have an environmental impact, whether favourable or otherwise. Stakeholder requirements may also change. Consequently, the environmental aspects associated with this stage need to be considered throughout the entire life time of the product, as well as appropriate decisions in design and development to minimize adverse environmental impacts.

A.1.10 Environmental impacts

All the activities described in Figure A.1, including design and development, influence and cause environmental impacts such as:

- depletion of resources;
- ozone depletion and smog formation;
- eutrophication;
- climate change/global warming;
- alteration of habitats;
- acidification;
- reduction of biological diversity;
- air, water and soil pollution;
- health impacts.

A.2 Examples of ECD strategies

Table A.1 provides examples of strategies for improving a product's environmental performance throughout the life cycle as part of ECD. As such, they facilitate incorporation of ECD into design and development (see 5.4)

When selecting those strategies, trade-offs between environmental aspects and impacts or between environmental stages can often be identified. Overall adverse environmental impacts throughout entire life cycle stages are intended to be minimized.

Each stage should be analysed, with a view to minimize the overall adverse environmental impact of the entire life cycle. It should be remembered that this should not be a one-time

activity, but something that is repeated throughout design and development (see 5.5.2) taking into account information exchanged with relevant stakeholders in the value chain (see 5.6).

The actual strategy used will vary, dependent on the type of product (e.g. goods, or services, or combination of goods and services) and the relevant environmental aspects of that product.

Table A.1 – Examples of product-related environmental improvement strategies

Design focus area	Options for design improvement
Design for material sourcing	Consider reducing weight and volume of product
	Increase reuse of products via remanufacturing
	Increase use of recycled materials to replace virgin materials
	Increase the reuse of components and sub-assemblies
	Reduce the use of scarce materials
	Minimize/eliminate the use of substances hazardous to health or the environment
	Decrease the need for consumables
	Decrease the quantity of energy (e.g. electricity, oil) used throughout the product's life cycle
	Specify materials that emit low or zero volatile organic compounds (VOCs) throughout the product's life cycle
	Use materials with a low environmental footprint
Design for manufacture	Reduce energy consumption
	Reduce consumption of natural resources, e.g. water
	Reduce process waste
	Use internally recovered or recycled materials from process waste
	Reduce emissions to air, water and soil during manufacture
	Consider reducing number of parts
	Reduce use of hazardous process chemicals (e.g. volatile solvents)
Design for transport and distribution	Minimize product size and weight
	Optimize shape and volume for maximum packing density
	Optimize transport/distribution in relation to energy efficiency and emissions
	In concert with choice of transportation used, maximize reuse of packaging where possible
	Reduce embodied energy in packaging
	Use packaging that emits low or zero VOCs
	Increase use of recycled materials in packaging
	Increase the sharing rate (ride share options) of commuting cars
Design for use (including installation and maintenance)	Reduce energy consumption in use
	Reduce consumption of natural resources, including water, in use
	Optimize quantity and nature of consumables
	Maximize product lifetime by designing for durability and reliability
	Maximize product lifetime by designing for ease of maintenance
	Maximize product lifetime by designing for reparability
	Maximize product lifetime by designing for refurbishment/remanufacturing
	Reduce emissions to air, water and soil
	Minimize/eliminate hazardous substances during use

Design focus area	Options for design improvement
Design for end of life	Restrict use of substances classified as hazardous
	Maximize the ability to reuse and recycle components and materials, e.g. by design for disassembly
	Minimize design aspects detrimental to reuse and recycling e.g. mixtures of materials
	Reduce amount of residual waste generated
	Reduce energy required for disassembly and recycling
	Reduce water required for disassembly and recycling

From the product-related environmental improvement strategies shown in Table A.1, the environmental objectives are developed (see 5.4 e). Examples of these objectives can include:

- reduce emissions by x %; improve energy efficiency by z %; reduce weight by y kg, etc.;
- increase the sharing rate of commuting cars in a city by x %;
- reduce the amount of transportation needed by providing a service by z %.

An integrated perspective can be achieved by including environmental aspects into design and development when considering trade-offs (see 4.2 c).

NOTE Examples of trade-offs which might be encountered are:

1) Between different environmental aspects: for example, optimizing a product for weight reduction might negatively affect its recyclability. The comparison of potential environmental impacts associated with each option can help decision-makers find the best solution.
2) Between environmental, economic and social benefits: These can be tangible (for example, lower cost, waste reduction), intangible (for example, convenience) and emotional (for example, image). As an example, making a product more robust is likely to lengthen its use stage and, as a result, could benefit the environment by reducing long-term resources use and waste generated, however, it could also increase the initial product cost. This can have social as well as economic effects.
3) Between environmental, technical or quality aspects: for example, design decisions related to the use of a particular material might negatively affect the reliability and durability of a product, even though this produces environmental benefits.

A.3 Information exchange

Information exchange is a requirement of 5.6. This is because information exchange facilitates the creation of solutions when multiple stakeholders come together with a common goal to reduce the overall adverse environmental impact through the value chain (see Figure A.2)

Information exchange has become easier due to the increasing introduction of “smart manufacturing”, “connected industries”, and “product life cycle management” in a standardized format. Technologies such as the internet of things and big data allow worldwide online communications between stakeholders in the value chain in real-time. These new technologies can be used not only improving manufacturing efficiency, but also for reducing adverse environmental impacts on a continual basis throughout the entire life cycle of a product.

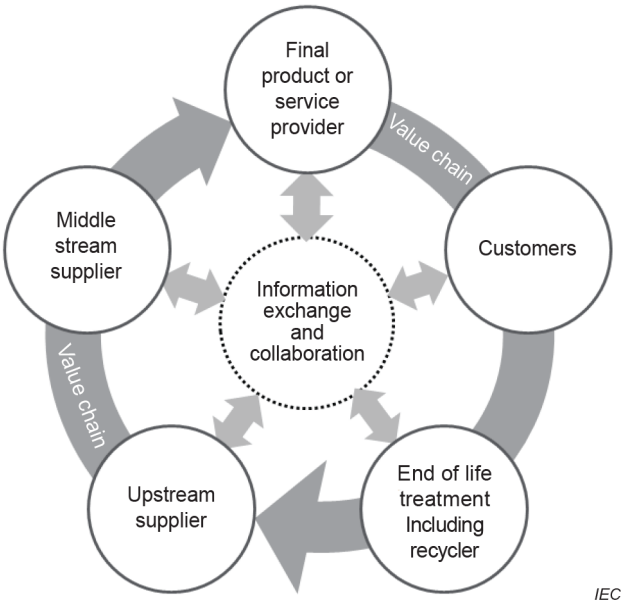

Figure A.2 – Conceptual diagram showing information exchange and collaboration across the value chain

Annex B
(informative)

ECD methods and tools selection

B.1 Overview

“ECD methods and tools” in this document refers to any specific procedure with a specified desired outcome that could be performed in a product design and development to support the work towards an environmental objective.

A structured procedure for ECD methods and tools selection is described as follows in order to ensure that the appropriate ones are selected.

Step 1: Identify, clarify and analyse the basic needs for the use of an ECD method or tool. For example, what kind of ECD answer is sought, and where in the design process is the method or tool supposed to be used, i.e. in the early or later phases of the product development process?

Step 2: Identify criteria depending on the needs and described objectives. The more detailed and specific the better the description of criteria since such a description facilitates the assessment of the method or tool. Potential criteria for an ECD method or tool are as follows:

1) be easy to adopt and implement;
2) facilitate the work of its user to fulfil the product requirements (see 5.4);
3) reduce the risk that important elements in design and development are overlooked;
4) ensure that the use of the method or tool improves the efficiency of the user’s tasks.

NOTE Points 2) and 3) above relate to the degree of appropriateness of a method or tool.

Step 3: Determine, sort and rank these criteria based on the specific needs, objectives and their relative importance.

Step 4: Identify and assess methods or tools according to the specific criteria. This can be done with traditional screening and scoring methods.

Step 5: Determine which method(s) or tool(s) should be used.

B.2 Examples of methods and tools

B.2.1 General

There are many different types of methods and tools, and this document does not recommend any specific ECD method. The methods and tools listed herein have been selected taking into account the following aspects:

- widely available and commonly recognized;
- intended to be used by organizations performing design and development;
- understood and accepted globally (not just regionally);
- neither too narrow nor too general in terms of their applicability to the consideration of environmental aspects.

B.2.2 ECD benchmarking

ECD benchmarking is a method often used to compare the environmental properties of one product against a similar product from a competitor or an industrial average. It can be used in various stages in the ECD. Common formats for presenting ECD benchmark results are tables, graphs and spider web diagrams.

B.2.3 ECD checklists and guidelines

The ECD checklist and guidelines are simple tools to evaluate and record the environmental performance requirements (see 5.2) or environmental impacts of a product (see 5.3). Different checklists and guidelines can be used, for example, to focus on the minimization of materials used, to reduce energy use, and to better apply reused/refurbished components or assemblies. Although they can be used at any phase of the ECD, they generally have the greatest effect in the earliest ones, since this is when the various trade-offs can most readily be accommodated. They can also be used to verify that ECD has been implemented for a project.

B.2.4 Environmental quality function deployment

Environmental quality function deployment (E-QFD) is used to systematically link relevant stakeholder requirements (see 5.2) to environmental parameters of the product (see 5.4 b). It can be used in various phases in ECD such as to transform customer environmental requirements into design parameters, to set target values for product environmental improvement over extended periods of time (see 5.4 d), and to help in the identification and evaluation of environmental aspects and corresponding impacts throughout the life cycle (see 5.3).

B.2.5 LCT based assessment

The environmental impacts of a product can be estimated by using various types of assessment methods and tools based on LCT such as environmental effect analysis (EEA) and life cycle assessment (LCA). A full assessment of the environmental impacts caused by a product is performed following the principles described in ISO 14040. The results can be applied in the identification and evaluation of environmental aspects and corresponding impacts (see 5.3), in review and continual improvement (see 5.5), and in information sharing along the value chain (see 5.6). The results of performing a LCT based assessment are, in practice, likely to be very different as they vary greatly based on the assumptions made and method of assessment employed. Therefore, if products are assessed by different people or organizations, the comparison of findings should include consideration on the assumptions made and the method used for the assessment or analysis.

B.2.6 Design and development methods and tools

B.2.6.1 General

Design and development methods and tools include those which facilitate the selection of materials and production processes, as well as those for the analysis of environmental impacts of different options.

For services, design and development methods and tools exist that can support ECD. Examples are a blueprint, process flows, customer journey mapping.

B.2.6.2 Material selection method and tools

Materials selection can be a key step in applying ECD. The objective of selecting environmentally compatible materials without either increasing costs or degrading the product functionality can be supported by the use of methods and tools that evaluate the environmental impacts of materials as well as costs, resource efficiency and functional performance.

B.2.6.3 Reuse, disassembly and recyclability assessment methods and tools

Reuse, disassembly and recyclability assessment methods and tools are useful when developing products in order to make them easier to reuse, disassemble and recycle. It is helpful to utilize this type of method or tool when designing new products.

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