PRIVATE CIRCULATION
GEL/111_18_0039
For vote - Action Due Date: 2018/08/31

111/484/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 62959 ED1**	
DATE OF CIRCULATION: **2018-07-06**	CLOSING DATE FOR VOTING: **2018-09-28**
SUPERSEDES DOCUMENTS: **111/463/CD, 111/482/CC**	

IEC TC 111 : ENVIRONMENTAL STANDARDIZATION FOR ELECTRICAL AND ELECTRONIC PRODUCTS AND SYSTEMS

SECRETARIAT: Italy	SECRETARY: Mr Andrea Legnani
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☒ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Environmentally Conscious Design (ECD) – Principles, requirements and guidance

PROPOSED STABILITY DATE: 2022

NOTE FROM TC/SC OFFICERS:

Joint project with ISO, under IEC lead

INTERNATIONAL ELECTROTECHNICAL COMMISSION TC111

IEC/ISO Joint Working Group ECD – 62959

CDV (DIS)

Environmentally Conscious Design (ECD) – Principles, requirements and guidance

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ENVIRONMENTALLY CONSCIOUS DESIGN – PRINCIPLES, REQUIREMENTS AND GUIDANCE

FOREWORD

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International Standard IEC 62959 has been prepared by a Joint Working Group of IEC technical committee 111: Environmental standardization for electrical and electronic products and systems, and ISO technical committee 207: Environmental management. This standard will replace IEC 62430:2009.

The text of this standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,

- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Every product has an impact on the environment, which may occur at any or all stages of its life cycle. These impacts may 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 minimise the environmental impacts of any product it is essential to have a systematic approach to design and development which governs, within an organisation, those lifecycle stages.

This International Standard addresses the systematic approach in the process of design and development within an organisation. It is not a product standard and so does not describe requirements that apply to individual products, or a series of products, etc.

There are various terms that are used to describe the process associated with the environmental aspects in order to reduce the adverse environmental impacts of a product throughout its life cycle. These include, but are not limited to, environmentally conscious design (ECD), design for environment (DfE), green design and eco-design. This standard uses the term ECD as a synonym for these other terms.

The goal of ECD is the reduction of adverse environmental impacts of a product throughout its entire life cycle. This can involve balancing the environmental aspects of the product with other factors, such as its intended use, performance, durability cost, marketability, and quality; and choosing methods to meet legal and other stakeholder requirements in an environmentally conscious way. In striving for this goal, multiple benefits can be achieved for the organization, its customers and other stakeholders. The consideration of environmental aspects, particularly in very early phases of the product design and development, can contribute in many ways, such as an overall environmental improvement, a cost reduction and better marketability.

This International standard recognises that there has been a move from providing only physical (or tangible) goods or services, to the integrated provision of both services and goods as a single product offering. Consequently this standard covers physical goods, services, and a combination of the two, all of which are referred to as ‘products’.

ECD is not a separate design activity; it is rather an integral part of the existing activities within an organisation which have an environmental impact of a product throughout its life cycle, from inception to end of life. Consequently, while this standard is not a management system standard, its requirements can be incorporated into an existing management system within an organization (ISO 14006 can provide further guidance).

The main purpose of the standard is to set requirements and give guidance on how to integrate ECD into design and development.

This International standard is intended for use by those involved in the design and development of a product whether new or modified, specifically in order to reduce adverse environmental impacts. It is written for those directly and indirectly involved in the design and development processes.

ISO 14001 the international standard for environmental management systems, links management of an organization's processes with environmental impacts, but does not specify aspect of design management processes. ISO/TR 14062 assists incorporation of environmental aspects into product design and development but does not provide requirements. IEC 62430:2009 (which is replaced by this International Standard) provides requirements, but its scope is limited to electrical and electronic products.

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

ENVIRONMENTALLY CONSCIOUS DESIGN - PRINCIPLES, REQUIREMENTS AND GUIDANCE

1 Scope

This International Standard describes principles, specifies requirements and provides guidance for organizations intending to integrate environmental aspects into the design and development of a product in order to minimise the adverse environmental impacts of that product.

This International Standard applies to processes associated with the integration of environmental aspects into the design and development of a product regardless of the organization's size, type and sector.

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

2 Normative references

No normative references are cited. Informative references are noted in the bibliography.

NOTE This clause is included in order to retain typical clause numbering.

3 Terms and definitions

3.1 General

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/

3.2 Terms related to product development

3.2.1 environmentally conscious design

ECD

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

Note 1 to entry: Other terminology used worldwide includes Ecodesign, Design for Environment (DFE), green design and environmentally sustainable design.

3.2.2 product

any goods or service

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

[SOURCE: ISO 14040:2006, definition 3.9. Note1, 2 and 3 are deleted and a new note is added.]

3.2.3 product group

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

3.2.4 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 that 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.

3.2.5 process

set of interrelated or interacting activities which transforms inputs into outputs

[SOURCE: 14001:2015, definition 3.3.5. Note1 is deleted.]

3.2.6 requirement

provision that conveys criteria to be fulfilled

[SOURCE: ISO/IEC Guide 2:2004, definition 7.5.]

3.3 Terms related to product lifecycle

3.3.1 life cycle

consecutive and interlinked stages for a product

Note 1 to entry: Examples of interlinked stages for goods include: raw material acquisition, design, manufacturing, delivery, use, maintenance, repair, remanufacturing, refurbishing, upgrading, end of life treatment, and disposal.

Note 2 to entry: Examples of interlinked stages of service include: design, commissioning of capabilities, provisioning and ends with decommissioning of capabilities.

3.3.2 life cycle stage

element of a life cycle

Note 1 to entry: The phrase ‘life cycle phase’ is sometimes used interchangeably with ‘life cycle stage’.

3.3.3 life cycle thinking

LCT

consideration of all environmental aspects relevant to a product during its entire life cycle

Note 1 to entry: LCT is used interchangeably with LCP (life cycle perspective).

[SOURCE: ISO Guide 64:2008, definition 2.6. "relevant environmental aspects (of a product) during the entire (product)" is changed to "environmental aspects relevant to a product during its entire".]

3.4 Terms relating to those who influence ECD requirements

3.4.1 organization

person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

[SOURCE: Annex SL of the Consolidated ISO Supplement to the ISO/IEC Directives, Part 1, 3.01.]

3.4.2 stakeholder

person or organization that can affect or be affected by a decision or activity

Note1 to entry: interested party and stakeholder are used interchangeably.

[SOURCE: ISO/IEC Directives, Part 1, Annex SL, 3.02. "or perceive itself to be affected by" is deleted.]

3.4.3 value chain

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

[SOURCE: Adapted from ISO 26000:2010, 2.25]

3.5 Terms related to the environment

3.5.1 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.

3.5.2 environmental aspect

element of an organization’s activities or products that interacts 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 the design and development.

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

3.5.3 environmental impact

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

[SOURCE: ISO 14001:2015, definition 3.2.4. “organization’s” is deleted.]

3.5.4 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, etc.

3.5.5 environmental target

detailed performance requirement, applicable to the products of an organization that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives

4 Principles of environmentally conscious design (ECD)

4.1 General

The application of principles is fundamental to implement ECD. The principles are basis for, and will guide the application of, requirements for ECD.

4.2 Life cycle thinking

Life cycle thinking is the consideration of all environmental aspects relevant to a product during its entire life cycle. It includes but is not limited to the following elements:

a) having an objective to reduce the overall adverse environmental impacts of that product taking into account other aspects like safety, quality, etc.;

b) identifying the significant environmental aspects of the product;

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

EXAMPLE 1: The trade-off between energy use and resource consumption when replacing an old by a new product.

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

EXAMPLE 2: The trade-off between energy use in the manufacturing and in the use stage.

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 Integration of ECD into the management strategy of an organization

A fundamental principle of ECD is that has to be an integral part of the policy and management strategy of an organization

The aim of an organization implementing ECD is to ensure that all relevant business functions communicate, contribute and commit to environmental improvement of their products through the management strategy. Relevant business function should be involved as early as possible in the design and development and remain involved throughout the life cycle of a product.

5 Requirements of environmentally conscious design (ECD)

5.1 General

5.1.1 Integrating ECD into management systems

The organization shall establish, implement and maintain ECD as an integral part of design and development activities.

ECD shall be reflected in the policies and strategies of the organization.

If an organization has a management system which includes a 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. The 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 may 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 Incorporating ECD into design and development

ECD shall be incorporated into the design and development and includes the following elements:

a) identification and analysis of 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).

The organization shall, demonstrate how the above elements are implemented in the design and development.

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

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

5.1.4 Documented information

The scope determined in 5.1.1 shall be maintained as documented information and be available to stakeholders.

The results obtained on a product or product group basis resulting from the elements listed in 5.1.3 shall be documented, including subsequent conclusions and responsibilities assigned.

5.2 Analysis of stakeholder requirements

The organization shall identify the relevant stakeholders and their environmental requirements for the product being designed and developed, at a generic, a sector specific, a product specific, and product group specific level.

NOTE 1 Generic level 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 cleaner.

In implementing the above, the organization shall ensure that:

a) requirements from relevant stakeholders are identified, for example, covering;

- life cycle stages,

- environmental aspects of the product,
- geographical scope of the intended market, and
- activities of the organization related to the design and development of the product;

b) current and emerging stakeholder requirements are regularly identified, reviewed and updated as needed;

c) an analysis of the requirements in a) and b) is performed, to identify the affected potential function(s) and life cycle stage(s) of the product;

d) steps from a) to c) are periodically repeated to address new or changed requirements which appear during design and development.

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 throughout the lifecycle of the product, and the scope of ECD determined in 5.1.

The environmental aspects can be expressed in either qualitative or quantitative terms, although wherever possible a quantitative approach should be adopted. When assessing the environmental aspects of a product the following steps shall be followed:

a) identification of environmental aspects relevant to a product or product group;

[For each life cycle stage of a product or product group, identify environmental aspects. An arbitrary emphasis on a single environmental aspect or a single life cycle stage should be avoided.]

NOTE 1 The boundary of life cycle stages are determined by the organization based on its criteria.

b) evaluation of environmental impacts related to the identified environmental aspects; and

c) determination of significant environmental aspects.

Significant environmental aspects are determined based on the organization’s criteria.

5.4 Incorporation of ECD into design and development

Design and development will require a balance between the various environmental aspects including stakeholder requirements (see 5.2) and other requirements such as function, technical requirements, quality, performance, economic aspects, ethical and social value, and technical and business risks.

NOTE 1 Further guidance on ethical and social value is provided in ISO 26000.

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

The following tasks shall be carried out during design and development:

a) specify the functions of the product;

b) determine the relevant environmental parameters, taking into account legal and other stakeholders’ requirements, and significant environmental aspects;

c) determine improvement objectives for the environmental parameters;

d) set environmental targets for the environmental parameters based on the improvement objectives;

e) create a specification of the product addressing the environmental targets; and

f) create solutions to realize the specification of the product while taking into account other design considerations.

NOTE 2 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).

NOTE 3 The use of ECD methods and tools (described in Annex C) can be helpful.

5.5 ECD Review

5.5.1 Process review

The organization, having established ECD as part of their design and development and reflected this within their policies and strategies, shall conduct reviews to ensure that the resulting system implements the requirements of this International Standard correctly and fully.

Such reviews shall occur, at planned intervals or when necessary, to ensure that the process of implementing ECD is being implemented and maintained in a suitable and effective manner.

Each review shall include assessing opportunities for improving the process of implementing ECD and a determination of whether related policies and strategies of the organization need to be revised.

5.5.2 Design review

In support of 5.5.1, a process for reviewing the ability to further reduce significant environmental aspects of products shall be established, implemented and maintained.

These reviews shall be conducted, at a planned interval 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 stakeholder requirements).

If the environmental targets have not been met, or if the environmental targets are no longer appropriate or valid, based on knowledge gained through the review, improvement actions shall be analysed and implemented as decided.

5.5.3 Documented information of reviews

Documented information of the reviews 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 future development of the product and continual improvement activities.

5.6 Information exchange

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

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

Information to be exchanged may include:

a) resources used;

b) emissions and waste generated by the product;

c) guidance to achieve or improve environmental performance;

d) end of life considerations (e.g. recyclability); and

e) environmental labels and declarations.

6 Guidance on implementing environmentally conscious design (ECD)

6.1 General

This subclause provides guidance to 5.1.

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

The scope of ECD can vary depending on the organization, such as stakeholder requirements or an environmental sphere of influence.

As an example, an organization could establish policies and/or strategies for improving certain environmental performance of its products. It could then have a mechanism to determine if these policies and/or strategies have been met. It is for the organization to determine the appropriate timescales, e.g. 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.

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. These influences could be internal to, or external to, the organization.

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

The sphere of influence is also determined on a case by case basis. The organization can possess an influence over suppliers in the value chain; if this is the case, it can determine the scope 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, together with their suppliers. In many cases an organization can influence downstream users (e.g. customers) through various kind 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.

6.2 Analysis of stakeholder requirements

This subclause provides guidance to 5.2.

The stakeholder's requirements can be relevant to any part of a product's life cycle.

There are many sources of stakeholders and 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 green 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 must 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 are then ranked by the organization into those which are, and are not, included into the specification for the design and development of the product.

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 to 5.3.

Products have a range of environmental aspects (e.g. emissions generated, resources used) that result in environmental impacts (e.g. air, water and soil pollution, climate change).

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

For example, throughout its life cycle, a product has a range of environmental aspects that are related to:

- input of resources (e.g. material (virgin or recycled), substances, parts (new and/or reused or remanufactured), subassemblies, spare parts, consumables) and energy;
- output (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 environmental risks and opportunities associated with either adverse environmental impacts (threats) or beneficial environmental impacts (opportunities). Significant environmental aspects are those that have or can have significant environmental impacts.

NOTE Significance is determined in accordance with criteria defined by an organization.

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 be based on objective criteria.

The process of identifying and evaluating environmental aspects should explicitly include the life cycle of the product(s) to be designed, or redesigned. The purpose is to determine which aspects have or could have significant impact on the environment. This generally follows the stages defined below.

a) Understanding the life cycle of the product(s).

b) Identification of the environmental aspects related to the life cycle of the product(s) 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 B.3) that result in environmental impacts.

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 previous model of the product, a similar product on the market, a prototype, or a hypothetical reference.

6.4 Incorporation of ECD into design and development

This subclause provides guidance to 5.4.

When developing requirements for a product, the organization needs to consider 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) product function: considering opportunities for multiple functions, modularity, and dematerialization; comparing the environmental performance to that of products tailored for specific use;

b) define significant environmental parameters based on the of 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 targets based on the environmental parameters determined in c);

e) develop a design specification of the product addressing the environmental targets 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 standard.

6.5 Review

6.5.1 Process review

This subclause provides guidance to 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 to 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 stakeholders requirements;
- when new information concerning the interaction of the product with the environment arises;
- when the strategy of the organisation changes – this includes changes in the environmental targets set by the organisation.

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 targets.

If the environmental targets 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 to 5.5.3.

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

6.6 Information exchange

This subclause provides guidance to 5.6

Information exchange between actors 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. For example, the resources used could include substances that can be hazardous or critical.

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

Annex A
(informative)

Examples on implementing environmentally conscious design (ECD)

A.1 Identification and evaluation of environmental aspects and impacts

A.1.1 General

The principles of incorporating ECD into design and development are contained in clause 4, requirements are given in clause 5 (in particular 5.4) and guidance specifically corresponding to 5.4 is given in 6.4. This part of Annex A provides further guidance which focuses in particular in the design and development of products, whether they are goods or services.

This standard can be applied to all types of products, whether goods (e.g. physical objects) or services (e.g. activities undertaken by one party for the benefit of another party), or a combination of both. It can also be applied for the creation of single, bespoke, goods (e.g. a luxury yacht) to mass-produced goods (such as mobile phones); from a small-scale localised service (e.g. shining shoes) to the provision of a mass-marketed service (such as international banking) or multi-availability services (such as a national health service).

Figure A.1 shows the inputs and outputs and the distinct life cycle stages for goods and services. The grey box indicates a particular organization with the various major activities indicated within it (e.g. design and development, manufacturing, etc.). Communication flows between the various activities is also shown and is represented as the lines connecting the boxes. The organization also receives external inputs (material, energy) and generates outputs (products and waste) (both considered in detail in A.1.2). All activities described in the grey box, their inputs and outputs will result in environmental impacts, described in A.1.9.

Although goods or services are often recognised as separate entities, in practice a combination of the two is what will be delivered to the customers (often referred to as product-service system). Therefore, when assessing the environmental aspects associated with a product, both goods and services aspects must be carefully reviewed as they can be interconnected and contribute to the environmental impacts of a product. Furthermore, the goods and service aspects of the product are likely to require different types of optimisation as to reduce their impacts into the environment.

Inputs are the materials, parts or energy needed to make goods and infrastructures needed to deliver a service. As such, goods are also inputs for services. Material, energy and goods will need to be transported along the product life cycle stages, and people will need to travel to either deliver or receive a service. In order to process the materials and parts into goods and their transport or travel, energy will be used.

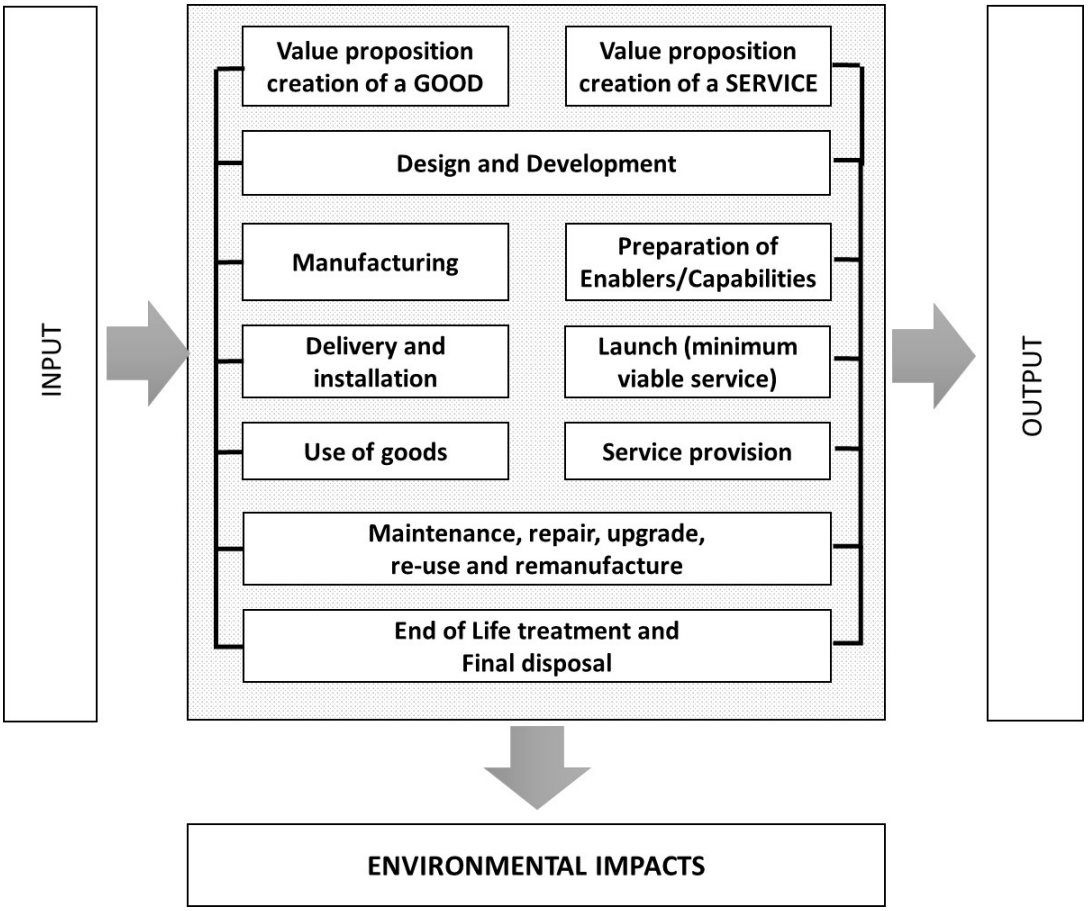

Figure A.1 – Inputs and outputs and distinctive life cycle stages for goods and services that will result in environmental impacts.

A.1.2 Inputs and outputs

A.1.2.1 Inputs

Inputs (both tangible and intangible~~)~~ to the activities of an organization include (for example):

- materials used in the fabrication of the product (including remanufacturing etc.), in the product itself (including whether they are virgin or recycled) and used in delivery and installation;
- energy used in the fabrication of the product (including remanufacturing etc.), in the use-phase of the product itself and in delivery and installation;
- water and other natural resources used in the fabrication of the product (including remanufacturing etc.), in the product itself and used in delivery and installation of the product
- parts and (sub)assembly used in the product;
- spare-parts used to repair and extend the life of a product;
- consumables used during the use phase of the product;
- goods, systems and infrastructure (telecommunication, IT, etc.) needed to deliver a service
- Activities like transport of goods and travel of people (to deliver or consume a service or goods)

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

A.1.2.2 Outputs

Important outputs from an organization's activities include:

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

Along with the products itself, also unwanted outputs, including waste and by-products, will be generated in each of the activities deployed by the organisation (as shown in the grey box of figure B2) or outside the organization, e.g. when preparing/creating the inputs. Examples are:

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

By-products or the excessive usage of energy should be minimized.

It should be noted that the above outputs could result directly from the organization activities itself or indirectly as a result of the choices made by the organization. Examples of indirect outputs include emissions to the environment due to the generation of electrical energy and transportation of products or people.

A.1.3 Value proposition creation

A value proposition is a statement of the value to be delivered or communicated by an organization. A value proposition can apply to an entire organization, or parts thereof, to customer accounts, or goods or services.

Here an organisation will also envisage which aspects of the product (goods and services) could be optimised as to minimise environmental impacts of such product. Such aspects will be then set as targets to be established, and specific requirements will be set at the product design and development of the product.

A.1.4 Design and development

Before a product, whether goods or a service, can be supplied to an end customer it is necessary to translate the vision for the product into tangible requirements. A technical assessment will be made concerning the solutions able to deliver the environmental and other product targets such as functionality, quality, and economic parameters. This is the first phase of design and development.

In accordance with the principles of environmentally conscious design (as described in clause 4), the entire life cycle of a product needs to be considered. Therefore, whether goods, or a service, or a combination of both, the iterations between design and development and all other phases of the product life-cycle, up to and including the point of final disposal of the product should be considered. These later stages are covered in A.1.4 to A.1.8.

For services, this phase focusses on identifying ways to provide the desired experience for the customer. It can be an experience or a series of interactions (e.g. flying from A to B). In this phase the service offering will be further defined so that the interactions between service provider and receiver, the experiences, the required enablers and capabilities will be designed and developed. Design tools such as blueprint, process flows, or customer journey mapping are often used to support designing such interactions and experiences.

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. Alternatively, test panels with consumers could be set to evaluate such impacts. For example when designing a new model of a water kettle, customer reviews indicated that notification of shut-off was insufficient. Energy would be lost if water were left to cool down, and additional energy would then be consumed to reheat the water.

Although requirements for the stages described in A.1.4 through A.1.8 could change with time and as situations different from those anticipated at the outset change, it is important from the very beginning to consider and plan for possible eventualities. This is because the initial product design chosen will have major impact in the environmental impacts of all next subsequent phases. As the product moves through the various stages depicted in Fig A.1, both, goods and services can be further re-designed or re-developed (to improve the technical solution or the experience for the customer or to optimize / reduce environmental impacts).

The environmental impacts for services are directly related to the choice of enablers and capabilities and how the user or the service provider will interact with them.

A.1.5 Manufacture of goods and preparation of enablers and capabilities to deliver a service

A.1.5.1 Considerations specific to the manufacture of goods

The manufacturing phase of goods entails the processing of materials and/or parts into goods or infrastructures and, where needed, consumables and spare parts needed for use and serviceability of the product. Environmental impacts in this phase are mostly associated with used resources (materials, water) and energy as well as rejects (materials, parts or goods), wastes in terms of emissions to air, water and soil, to make such goods.

In addition, new manufacturing technologies can become available which do not necessarily affect the product itself, but could offer reduced energy consumption, reduced water consumption, or reduced emissions from the manufacturing process to land, water and air. Again, the different environmental aspects presented by these technologies should be considered to determine if there is the possibility to reduce environmental impacts.

A.1.5.2 Considerations specific to the and preparation of enablers and capabilities to deliver a service

The preparation of enablers and capabilities phase represents the integration and scale up of the needed *enablers* (the goods needed to deliver the service, e.g. telephones for a call centre) and *capabilities* (for example training people who will deliver the service in total, of parts of it, the location where the service will be delivered, etc.) as well as preparation for launch of the service.

Providing the required customer experience and interactions will have a strong impact on the required enablers and capabilities. Early clarity on concepts and their differences are therefore essential to build an environmentally conscious service that focusses on delivering best experience, while limiting environmental impacts. The enablers will require consideration of factors such as resources consumption (consumables, energy, water, etc.) and location of the place where the service will be delivered, means of transportation, building up of stocks of goods needed to deliver the service, preparation of infrastructures (e.g. building, IT, telecommunication), etc.

A.1.5.3 Considerations common to both the manufacturing of goods and the preparation of enablers and capabilities to deliver a service

As described in A.1.1, products could be singular (bespoke) or mass-produced or mass-marketed. For the manufacture of mass-produced goods in particular, this activity could extend over many years and during this time there could be multiple changes in stakeholder requirements, changes to the components and materials available for the manufacture and

other inputs. Likewise, services can be provided over an extended period and while the initial preparation of enablers and capabilities tends to be a one-off process, these capabilities and enablers can also need to be revised in accordance with changing circumstances over time.

During the manufacturing of goods and the preparation of enablers and capabilities there can be requests to change the product's design for a variety of reasons (e.g. to aid manufacturability, because of non-availability of certain components, and because of changes to stakeholder requirement). 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 and installation of goods and launch and delivery of a service

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

The market introduction of goods, including marketing advertisements, the logistics around the delivery of each (for mass-produced goods) product and its installation (if relevant) are covered in this phase.

Packaging and transport (including overseas) 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 phase.

As with the manufacturing stage, it may be necessary to change the product's design (e.g. if goods are adversely affected by the vibration in transport) or the packaging of goods. Similar to the situation with manufacturing, there could be changes in the technology of transportation of goods (e.g. availability of drones) that can affect the environmental impacts of this phase. Such considerations, together with changes to stakeholder requirements, could involve design and development (with consequential changes to environmental aspects).

A.1.6.2 Considerations specific to the launch and delivery of a service

Before introducing full service in the market for the first time, a small scale (minimal viable service) is often offered, allowing for fast optimization and better preparation for the scaling up of the service. Impacts are similar to the provisioning of the service, but are small scale and will be associated with the use of the goods needed to deliver the service, with transport, travel, energy consumption of infrastructures, etc. Learnings obtained in this phase allow for faster iteration within design and development, in case the service needs to be adapted or improved.

A.1.7 Use phase of goods and provisioning of a service

This phase involves the use of the goods, their maintenance, upgrade, and repair. Also in this phase a second life for the goods or its parts should be considered, including possibilities for reuse, or remanufacturing.

For service it means delivery (of the service), including its consumption, and collection of feedback. Every time the service is delivered, it is an opportunity to collect feedback, analyse the outcome and define the service evolution.

Note: fast feedback from the customers on the service allows for fast adjustments of the service (re-design and development) and improvements (experience for the customer), allowing for optimisation of environmental impacts.

This is likely the most intensive phase in terms of environmental impacts for both, goods and services.

This phase will also involve serviceability of the goods, namely maintenance, repair, upgrade, re-use and remanufacture of the goods (including the goods or infrastructures used to deliver the service). Choices on how they will be performed should be made in such a way to deliver the least impact to the environment.

During the use phase there can be a number of changes to the design, brought about by e.g. changes in stakeholder requirements (e.g. customer feedback and regulatory changes). These changes will require consideration for their potential impact on design and development, e.g. for products yet to be created by the manufacturing process.

A.1.8 End of Life treatment and final disposal

Once the goods reaches its end of life, it should be ensured that the used materials can be recycled or, where this is not technically or financially possible, that energy can be recovered from the materials. For the waste fractions where treatment (recycling an energy recovery) is not possible, they are then landfilled. The impacts associated with this phase are related to the loss of the materials coming out of the use-phase.

For services, the end of life will entail the discontinuation of whole or parts and features of the service involving often 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, following the goods cycle will be followed.

This phase can result in significant negative environmental impacts, for both, goods and services and optimisation at the design and development stage is important to reduce such impacts.

While it is impossible to change the as-manufactured/supplied goods or service, there could be technical matters that require the expertise of those involved in the original design and development (such as what components can be reused/recycled). Because recycling technologies, stakeholder requirements, and other requirements change with time, it is only possible to foresee some of these at the very early stage. Consequently, an assessment of the available technologies for treating products needs to be maintained throughout this phase, so that those with the most favourable environmental aspect can be selected, where economically feasible.

A.1.9 Environmental impacts

All the activities described in Fig 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

A.2 Examples of ECD strategies

Table A.1 provides examples of strategies for improving environmental performance throughout a product's lifecycle as part of ECD. The actual strategy used will vary, dependant on the type of product (e.g. goods, or service, or combination of goods and a service) 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

Design Focus Area	Options for Design Improvement
	Reduce the use of scarce materials and critical (raw) materials.
	Minimise/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 lifecycle
	Specify materials that emit low or zero volatile organic compounds (VOCs) throughout the product's lifecycle
	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
Design for Transport and Distribution	Minimise product size and weight
	Optimise shape and volume for maximum packing density
	Optimise transport/distribution in relation to fuel use and emissions
	In concert with choice of transportation used, maximise 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
	Minimise/eliminate hazardous substances in packaging
Design for Use (Including installation and maintenance)	Reduce energy consumption in use
	Reduce consumption of natural resources, including water, in use
	Optimise quantity and nature of consumables
	Maximise product lifetime by designing for durability and reliability
	Maximise product lifetime by designing for ease of maintenance
	Maximise product lifetime by designing for reparability
	Maximise product lifetime by designing for refurbishment/ remanufacturing
	Reduce emissions to air, water and soil
	Minimise/eliminate hazardous substances during use
Design for End of Life	Restrict use of substances classified as hazardous
	Maximise the ability to reuse and recycle components and materials, e.g. by design for disassembly
	Minimise 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 the environmental targets are developed (see 5.4 d). Examples of these targets 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 in providing a service by z%.

An integrated perspective achieved by including environmental aspects in product design and development can help the organization in the consideration of the trade-offs (See 4.2 c) which arise with most design decisions. Examples of trade-offs which might be encountered are given below.

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). For example, making a product more robust increases the lifetime and, as a result, may benefit the environment by reducing long-term resources use and waste generated but may also increase initial costs. This may have social as well as economic effects.

3) Between environmental, technical and/or quality aspects; for example, design decisions related to 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

Communication and information exchange facilitates the creation of solutions that only become evident when different organizations come together with one goal to reduce the adverse environmental impact (see Figure A.2)

The parties involved identify relevant functions and people and assign them with appropriate responsibilities and authorities for communication of information.

The guidance to achieve or improve environmental performance includes a manual instructing users how to best contribute to environmental matters when using the product (e.g. in the accompanying documentation).

Information exchange has become easier these days since “Smart manufacturing”, “Connected industries” and “Product life cycle management” are standardized (e.g. in IEC Systems Committee on Smart Manufacturing) and implemented, which allow online communications between actors in the value chain worldwide in a real time by fully utilizing modern technologies such as internet of things and big data. These new technologies are useful for not only improving manufacturing efficiency but also for reducing environmental impacts as a whole throughout the life cycle of a product comprehensively.

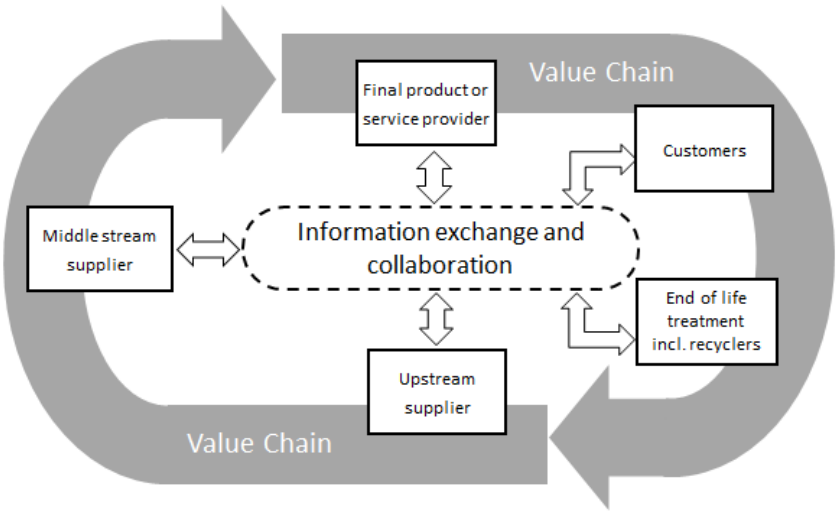

Figure A.2 – Conceptual diagram showing information exchange and collaboration across the value chain

Annex B
(informative)

ECD methods and tools selection

B.1 Overview

The ECD method or tool 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 the ECD method and tool selection is described as follows in order to assure that the appropriate one is selected.

Step 1: Identify needs and objectives to clarify and analyse the basic needs for the use of the 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 description of the criteria is better. One reason is that a detailed and specific criteria description facilitates the work with criteria and method or tool assessment. Potential criteria for an ECD method or tool are as follows

1) be easy to adopt and implement;

2) facilitate designers to fulfil specified requirements on the presumptive product;

3) reduce the risk that important elements in design and development are forgotten; and

4) ensure that the use of the method or tool reduces the total calendar time (from start to end) to solve the task.

The second and third requirements relate to a method or tool’s degree of appropriateness.

Step 3: Determine and rank criteria. Sort and rank these criteria based on the specific needs, and describe 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) and/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 standard does not recommend any specific ECD method. The principal methods and tools listed herein have been selected in accordance with the following criteria; widely available and commonly recognized; intended to be used by organizations performing design and development; understood and accepted globally (not just regionally); and 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 or impact of a product. Different checklists and guidelines can be used for example to focus on minimisation 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-off 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 stakeholders´ environmental requirements to environmental parameters of the product. It can be used in various stages in the ECD, e.g. to transform customer environmental requirements into design parameters, to set target values for product environmental improvement over extended periods of time, and to help in the identification and evaluation of environmental aspects and corresponding impacts throughout the product's life cycle.

B.2.5 Life cycle thinking-based assessment

The environmental impacts of products can be estimated by using various types of life cycle thinking based assessment methods and tools, e.g. Environmental effect analysis (EEA) and Life cycle assessment. A full assessment of the environmental impacts caused by products is performed following the principles described in the ISO 14040 series of standards. The results can be applied in the identification and evaluation of environmental aspects and corresponding impacts; in review and continual improvement; and in information sharing along the value chain. The results of performing a life cycle thinking 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 can include and consider the assumptions made and the method of assessment or analysis chosen.

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.

B.2.6.2 Material selection method and tools

Materials selection is a key step in environmentally conscious design. The target 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 preferable to use this type of method or tool when designing new products.

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