भारतीय मानक

Indian Standard

IS/ISO 14009 : 2020

पर्यावरणीय प्रबंधन पद्धतियाँ — डिजाइन और विकास में सामग्री परिसंचरण को शामिल करने के लिए दिशानिर्देश

Environmental Management Systems — Guidelines for Incorporating Material Circulation in Design and Development

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NATIONAL FOREWORD

The Indian Standard which is identical to ISO 14009 : 2020 'Environmental management systems — Guidelines for incorporating material circulation in design and development' issued by the International Organization for Standardization was adopted by the Bureau of Indian Standards on the recommendation of the Environmental Management Sectional Committee and approval of the Chemical Division Council.

This standard gives guidelines for assisting organizations in establishing, documenting, implementing, maintaining and continually improving material circulation in their design and development in a systematic manner, using an environmental management system (EMS) framework.

This standard provides guidelines for design strategies on material circulation to achieve the material efficiency objectives of an organization, by focusing on the following aspects:

a) type and quantity of materials in products;

b) product lifetime extension; and

c) recovery of products, parts and materials.

In design and development, many aspects are considered, such as safety, energy efficiency, performance and cost. Although important, they are not addressed in this document.

The text of ISO 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' appears referring to this standard, they should be read as 'Indian Standard'; and

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

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Introduction

0.1 Background

One of the major challenges that we all face in achieving sustainable development is the efficient use of resources and reuse of these resources repeatedly without diminishing their value, usability, etc. Internationally, the United Nations Environment Programme International Resource Panel (UNEP IRP) warns that, at the current pace of production and consumption, 140 billion tons of natural resources will be consumed in 2050, which is twice the amount consumed in 2005. Such use of natural resources, which does not consider material circulation, has already resulted in unstable resource supplies and serious adverse environmental impacts[34].

The UN adopted 17 sustainable development goals (SDGs) in 2015 and set specific targets for each of them to be achieved over the next 15 years. SDG 9 ("build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation"), SDG 12 ("ensure sustainable consumption and production patterns") and SDG 13 ("take urgent action to combat climate change and its impacts") are directly related to managing natural resources.

Emphasis on the transition from a linear to a circular economy in order to achieve sustainable development has been spearheaded by the European Union (EU)[33]. The concept of a circular economy encompasses a wide range of topics, from the full life cycle of products to business models. The general concept of a circular economy is closing the loop between different life cycles through the application of designs that allow for the enhancement of recycling and reuse for the more efficient use of raw materials and products, limiting (or eliminating) waste. One of the methods to consider for supporting the transition to a circular economy is implementing a design that facilitates the material circulation of products and their constituent parts (see Annex A).

Considering that products are largely composed of raw materials, the material circulation of products plays an important role in the sustainable use of resources. The widely held perception is that strategy/planning for the material circulation of products and their constituent parts should precede their design and development.

Material circulation can be understood as an approach integrated within design and development by which products, parts or materials can be continually reprocessed into the same or similar products in order to achieve material efficiency and (ultimately) the environmental objectives of the organization. In order to be of benefit to the organization and to ensure that the organization achieves its material efficiency objectives, it is intended that the improvement of material circulation be carried out as an integral part of the business operations of the organization. Material circulation can potentially have implications for all functions of an organization.

This document provides guidelines for strategies on material circulation to achieve material efficiency, i.e. minimize the use of materials, by maximizing the lifetime of products through improved design, with increased opportunities for repair, upgrade, reuse, remanufacturing and recycling by an organization.

A material circulation improvement process takes place within an organization's design and development, and it is there where the knowledge required in carrying out and managing material circulation is to be found. However, when it is intended that material circulation be carried out under the umbrella of an environmental management system (EMS), then the person responsible for the EMS is expected to have an understanding of what this process is, and how it is going to be managed and controlled. In this way, the integrity of the EMS is not jeopardized, and the material efficiency and other environmental objectives for the products can be achieved.

Incorporation of material efficiency within an EMS requires knowledge related to the following:

a) assessment of the material circulation of products in the organization;

b) identification of appropriate material circulation strategies to improve the material circulation of products and their constituent parts, and to support the achievement of the material efficiency objectives of the organization;

c) the design and development process, and an understanding of the material circulation improvement processes and how they are managed within an EMS.

0.2 Relationship with other standards

ISO 14001 is a core standard that provides the organization with a framework for establishing an EMS. There are four key elements to support users of ISO 14001. One of them is related to "policy and organizational elements" such as those related to sustainable use of resources, and further exemplified in complementary standards: ISO 14006 on ecodesign and this document (i.e. ISO 14009) on material circulation.

ISO 14006 provides guidelines to assist organizations in establishing a systematic and structured approach to the incorporation and implementation of ecodesign within an EMS such as that described in ISO 14001.

IEC 62430, on the other hand, describes principles, specifies requirements and provides guidance for organizations intending to integrate environmental aspects into design and development in order to minimize the adverse environmental impacts of products. IEC 62430 can be incorporated into an existing management system, as indicated in ISO 14006.

ISO 14051 provides guidance on a methodology [material flow cost accounting (MFCA)] that can be used for quantifying material flows in a production process or an organization. ISO 14052 has extended this concept by providing guidance on using this methodology for quantifying material flows in a supply chain. The MFCA methodology can easily be adapted and used for quantifying material flows in a product life cycle. Although this methodology could be used for quantification of material flows in a product life cycle, it is not addressed in this document.

In Europe, standards on material efficiency assessment methods (the EN 4555X group of standards) [22] to [30] have been developed to support future ecodesign requirements on, among other things, durability, reparability and recyclability of energy-related products. These standards are directly linked to this document.

ISO 14001 requires an organization to identify environmental aspects and the corresponding environmental impacts, taking a life cycle perspective into account. This involves considering aspects and impacts in each stage of the product life cycle, including design and development. ISO 9001 is focused on quality management systems, including design and development, but does not cover environmental impacts. ISO 14006 is focused on a management system to implement environmental conscious design by an organization. IEC 62430 assists with the incorporation processes to implement environmental conscious design by an organization. Lastly, the European EN 4555X group of standards focus on assessment methods related to material efficiency and material circulation, but they do not cover environmental and business management frameworks, as described in this document.

Figure 1 illustrates how ecodesign and material circulation in ISO 14006 and this document can support an EMS as described in ISO 14001.

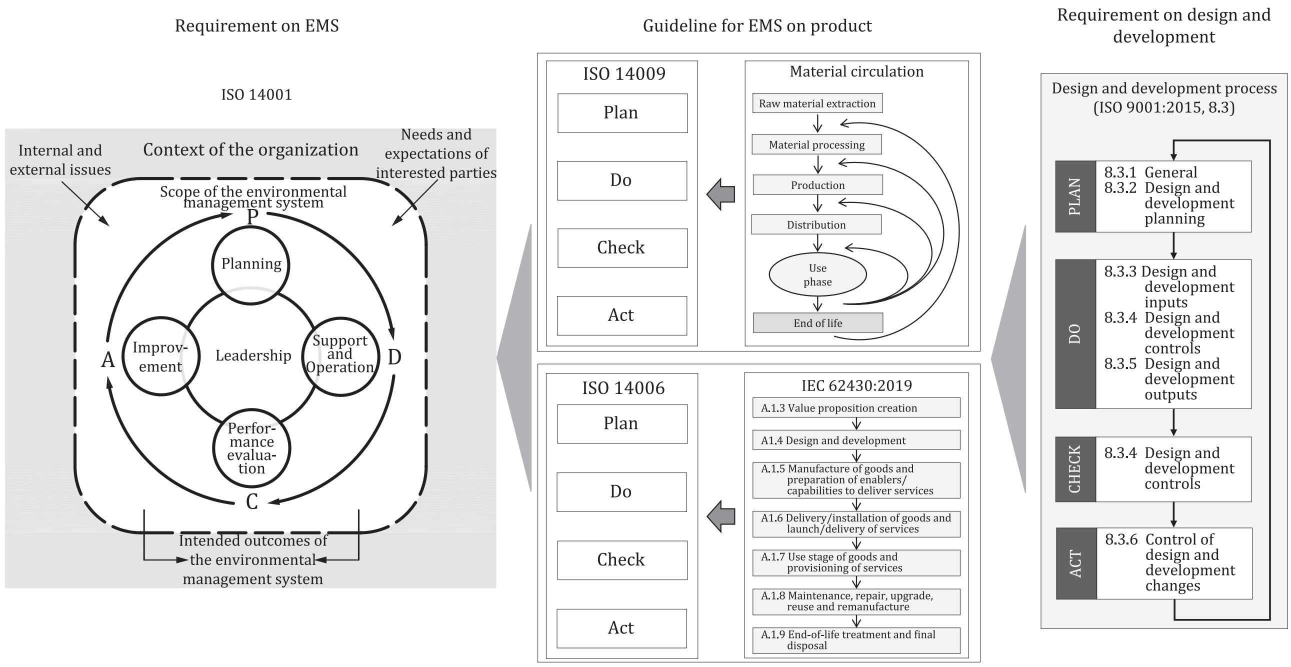

Figure 1 — Relationship between ISO 14001, ISO 14006 and this document

0.3 Overview

This document provides guidelines related to ISO 14001, a management system standard (MSS), and uses an identical structure. It places priority on the clauses of ISO 14001 for planning (Clause 6) and operation (Clause 8):

— Clauses 4, 5, and 7 cover aspects related to an EMS;

— the establishment of material circulation strategies for products is considered in Clause 6;

— creating material circulation solutions, design considerations for material circulation, and ensuring operational planning and control are provided in Clause 8.

Additionally, this document contains the following annexes to assist users in understanding material circulation:

— Annex A shows the relationship between the circular economy and material circulation;

— Annex B provides examples and an explanation of interested parties;

— Annex C illustrates material flow in material circulation and the link with material efficiency;

— Annex D provides a case study on the redesign of existing products.

Indian Standard

ENVIRONMENTAL MANAGEMENT SYSTEMS — GUIDELINES FOR INCORPORATING MATERIAL CIRCULATION IN DESIGN AND DEVELOPMENT

1 Scope

This document gives guidelines for assisting organizations in establishing, documenting, implementing, maintaining and continually improving material circulation in their design and development in a systematic manner, using an environmental management system (EMS) framework.

These guidelines are intended to be used by those organizations that implement an EMS in accordance with ISO 14001. The guidelines can also help in integrating material circulation strategies in design and development when using other management systems. The guidelines can be applied to any organization regardless of its size or activity.

This document provides guidelines for design strategies on material circulation to achieve the material efficiency objectives of an organization, by focusing on the following aspects:

— type and quantity of materials in products;

— product lifetime extension;

— recovery of products, parts and materials.

In design and development, many aspects are considered, such as safety, energy efficiency, performance and cost. Although important, they are not addressed in this document.

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 https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms related to organization and leadership

3.1.1
management system
set of interrelated or interacting elements of an *organization* (3.1.5) to establish policies and *objectives* (3.2.21) and *processes* (3.3.3) to achieve those objectives

Note 1 to entry: A management system can address a single discipline or several disciplines (e.g. quality, *environment* (3.1.3), occupational health and safety, energy, financial management).

Note 2 to entry: The system elements include the organization's structure, roles and responsibilities, planning and operation, performance evaluation and improvement.

Note 3 to entry: The scope of a management system can include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.

[SOURCE: ISO 14001:2015, 3.1.1]

3.1.2
environmental management system
EMS
part of the *management system* (3.1.1) used to manage *environmental aspects* (3.2.19), fulfil *compliance obligations* (3.2.33) and address *risks and opportunities* (3.2.34)

[SOURCE: ISO 14001:2015, 3.1.2]

3.1.3
environment
surroundings in which an *organization* (3.1.5) operates, including air, water, land, natural resources, flora, fauna, humans and their interrelationships

Note 1 to entry: Surroundings can extend from within an organization to the local, regional and global system.

Note 2 to entry: Surroundings can be described in terms of biodiversity, ecosystems, climate or other characteristics.

[SOURCE: ISO 14001:2015, 3.2.1]

3.1.4
environmental policy
intentions and direction of an *organization* (3.1.5) related to *environmental performance* (3.4.11), as formally expressed by its *top management* (3.1.6)

[SOURCE: ISO 14001:2015, 3.1.3]

3.1.5
organization
person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its *objectives* (3.2.21)

Note 1 to entry: The concept of organization includes, but is not limited to sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

[SOURCE: ISO 14001:2015, 3.1.4]

3.1.6
top management
person or group of people who directs and controls an *organization* (3.1.5) at the highest level

Note 1 to entry: Top management has the power to delegate authority and provide resources within the organization.

Note 2 to entry: If the scope of the *management system* (3.1.1) covers only part of an organization, then top management refers to those who direct and control that part of the organization.

[SOURCE: ISO 14001:2015, 3.1.5]

3.1.7
interested party
person or *organization* (3.1.5) that can affect, be affected by, or perceive itself to be affected by a decision or activity

EXAMPLE Customers, communities, suppliers, regulators, non-governmental organizations, investors and employees.

Note 1 to entry: To "perceive itself to be affected" means the perception has been made known to the organization.

[SOURCE: ISO 14001:2015, 3.1.6]

3.1.8
circular economy
economy that is restorative and regenerative by design, and which aims to keep *products* (3.2.5), components and *materials* (3.2.7) at their highest utility and value at all times, distinguishing between technical and biological cycles

[SOURCE: ISO 20400:2017, 3.1]

3.2 Terms related to planning

3.2.1
design and development
process (3.3.3) that transforms *requirements* (3.2.32) into a *product* (3.2.5)

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 new product, its possible *redesign* (3.2.2) 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.

[SOURCE: IEC 62430:2019, 3.1]

3.2.2
redesign
design of a *product* (3.2.5) based on an existing product design to improve targeted characteristics of the product

Note 1 to entry: Examples of targeted characteristics include reducing the use of *raw materials* (3.2.11), enhancing the *recycled content* (3.2.23), reducing the use of hazardous substances, energy saving, improving *material* (3.2.7) recyclability, etc.

3.2.3
ecodesign
systematic approach that considers *environmental aspects* (3.2.19) in *design and development* (3.2.1) with the aim to reduce adverse *environmental impacts* (3.2.20) throughout the *life cycle* (3.2.17) of a *product* (3.2.5)

Note 1 to entry: Other terminology used worldwide includes "environmentally conscious design (ECD)", "design for environment (DfE)", "green design" and "environmentally sustainable design".

[SOURCE: ISO 14006:2020, 3.2.2]

3.2.4
circular readiness
potential of the *product* (3.2.5) and its constituent *parts* (3.2.6) for *material circulation* (3.2.12)

3.2.5
product
any goods or service

[SOURCE: ISO 14050:2020, 3.5.12]

3.2.6
part
hardware, firmware or software constituent of a *product* (3.2.5)

[SOURCE: EN 45554:2020, 3.1.1]

3.2.7
material
substance or mixture of substances within a *product* (3.2.5) or product *part* (3.2.6)

[SOURCE: IEC 62474:2018, 3.15]

3.2.8
pre-consumer material
material (3.2.7) diverted from the waste stream during a manufacturing *process* (3.3.3)

Note 1 to entry: Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

[SOURCE: ISO 14021:2016, 7.8.1.1 a) 1), modified — Part of the text has been moved to Note 1 to entry.]

3.2.9
post-consumer material
material (3.2.7) generated by households or by commercial, industrial and institutional facilities in their role as end-users of the *product* (3.2.5) that can no longer be used for its intended purpose

Note 1 to entry: This includes returns of material from the distribution chain.

[SOURCE: ISO 14021:2016, 7.8.1.1 a) 2), modified — Part of the text has been moved to Note 1 to entry.]

3.2.10
recycled material
material (3.2.7) that has been reprocessed from recovered (reclaimed) material by means of a manufacturing *process* (3.3.3) and made into a final *product* (3.2.5) or into a component for incorporation into a product

Note 1 to entry: Recovered material could be from *pre-consumer material* (3.2.8) or *post-consumer material* (3.2.9).

Note 2 to entry: "Recovered material" and "reclaimed material" are treated as synonyms.

[SOURCE: ISO 14021:2016, 7.8.1.1 b), modified — Notes 1 and 2 to entry have been added.]

3.2.11
raw material
primary or secondary *material* (3.2.7) that is used to produce a *product* (3.2.5)

Note 1 to entry: Secondary material includes *recycled material* (3.2.10).

Note 2 to entry: Primary raw material is a material which has never been processed into any form of end-use product.

[SOURCE: ISO 14040:2006, 3.15, modified —Note 2 to entry has been added.]

3.2.12
material circulation
closed-loop approach where *products* (3.2.5) or their constituent *parts* (3.2.6) are reprocessed and brought back to use for the same or other purpose

Note 1 to entry: The term "constituent parts" refers to sub-assemblies, parts or *materials* (3.2.7) used to fabricate a product.

Note 2 to entry: Reprocessing involves the restoration or modification of the functionality of the product or its constituent parts, and may consist of repairing, rework, replacement of worn parts, and/or *upgrade* (3.2.27) of software, firmware and/or hardware as well as materials recycling. Reprocessing includes all phases of the *life cycle* (3.2.17) of a product from, for example, *repair* (3.2.26), *reuse* (3.2.28) and *remanufacturing* (3.2.29), up to *recycling* (3.3.6). It excludes disposal.

Note 3 to entry: Material circulation could improve *material efficiency* (3.2.13).

3.2.13
material efficiency
minimization of the use of (natural) resources by maximizing the lifetime of *products* (3.2.5) through optimized *material circulation* (3.2.12) strategies

3.2.14
critical raw material
CRM
materials (3.2.7) that, according to a defined classification methodology, are economically important and have a high-risk associated with their supply

[SOURCE: EN 45558:2019, 3.1.1, modified —Note 1 to entry has been deleted.]

3.2.15
disassembly
process (3.3.3) whereby a *product* (3.2.5) is taken apart in such a way that it could subsequently be reassembled and made operational

[SOURCE: IEC 62542:2013, 6.1]

3.2.16
dismantling
process (3.3.3) whereby a *product* (3.2.5) is taken apart in such a way that some *parts* (3.2.6) can be *reused* (3.2.28), although the product (and the parts not intended to be reused) can no longer be reassembled and made operational

3.2.17
life cycle
consecutive and interlinked stages of a *product* (3.2.5) (or service) system, from *raw material* (3.2.11) acquisition or generation from natural resources to final disposal

Note 1 to entry: The *life cycle stages* (3.2.18) include acquisition of raw materials, design, production, transportation/delivery, use, end-of-life treatment and final disposal.

[SOURCE: ISO 14001:2015, 3.3.3]

3.2.18
life cycle stage
element of a *life cycle* (3.2.17)

[SOURCE: ISO 14006:2020, 3.2.5, modified — Note 1 to entry has been deleted.]

3.2.19
environmental aspect
element of an *organization's* (3.1.5) activities or *products* (3.2.5) or services that interacts or can interact with the *environment* (3.1.3)

Note 1 to entry: An environmental aspect can cause (an) *environmental impact(s)* (3.2.20). 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* (3.2.1).

[SOURCE: ISO 14001:2015, 3.2.2, modified — Note 3 to entry has been added.]

3.2.20
environmental impact
change to the *environment* (3.1.3), whether adverse or beneficial, wholly or partially resulting from an *organization's* (3.1.5) *environmental aspects* (3.2.19)

[SOURCE: ISO 14001:2015, 3.2.4]

3.2.21
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* (3.2.22), or by the use of other words with similar meaning (e.g. aim, goal, or target).

[SOURCE: ISO 14001:2015, 3.2.5, modified — The original Note 2 to entry has been deleted and the notes renumbered accordingly.]

3.2.22
environmental objective
objective (3.2.21) set by the *organization* (3.1.5) consistent with its *environmental policy* (3.1.4)

[SOURCE: ISO 14001:2015, 3.2.6]

3.2.23
recycled content
proportion, by mass, of *recycled material* (3.2.10) in a *product* (3.2.5)

[SOURCE: ISO 14021:2016, 7.8.1.1 a), modified — "or packaging" has been deleted from the end of the definition.]

3.2.24
durability
<of a part or a product> ability to function as required, under defined conditions of use, *maintenance* (3.2.25) and *repair* (3.2.26), until a limiting state is reached

Note 1 to entry: The degree to which maintenance and repair are within the scope of durability will vary by *product* (3.2.5) or product group.

Note 2 to entry: Durability can be expressed in units appropriate to the *part* (3.2.6) or product concerned, e.g. calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

[SOURCE: EN 45552:2020, 3.1.1.1, modified — Note 2 to entry has been deleted.]

3.2.25
maintenance
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

Note 1 to entry: Management is assumed to include supervision activities.

[SOURCE: IEV 192-06-01]

3.2.26
repair
process (3.3.3) of returning a faulty *product* (3.2.5) to a condition where it can fulfil its intended use

[SOURCE: EN 45554:2020, 3.1.4]

3.2.27
upgrade
process (3.3.3) of enhancing the functionality, *performance* (3.4.10), capacity or aesthetics of a *product* (3.2.5)

Note 1 to entry: Upgrade may involve changes to the software, firmware and/or hardware.

[SOURCE: EN 45554:2020, 3.1.5, modified — Note 2 to entry has been deleted.]

3.2.28
reuse
process (3.3.3) by which a *product* (3.2.5) or its *parts* (3.2.6), having reached the end of their first use, are used for the same purpose for which they were conceived

Note 1 to entry: Reuse after second or subsequent usage is also considered as reuse, but normal, regular or sporadic use is not considered as reuse.

[SOURCE: EN 45554:2020, 3.1.3]

3.2.29
remanufacturing
industrial *process* (3.3.3) which produces a *product* (3.2.5) from used products or used *parts* (3.2.6) where at least one change is made which influences the safety, original performance, purpose or type of the product

Note 1 to entry: The product created by the remanufacturing process may be considered a new product when placing on the market.

[SOURCE: EN 45553:2020, 3.1.1, modified — "Refer to the EU Blue Guide for additional information" has been deleted from Note 1 to entry and Note 2 to entry has been deleted.]

3.2.30
refurbishing
functional or aesthetical *maintenance* (3.2.25) or *repair* (3.2.26) of an item to restore it to its original, or *upgraded* (3.2.27) or other, predetermined form and functionality

[SOURCE: IEV 904-04-09]

3.2.31
recovery
any operation by which waste serving a useful purpose by replacing other *materials* (3.2.7) which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

Note 1 to entry: Recovery operations include material recovery and energy recovery.

Note 2 to entry: In this document, only recovery of *products* (3.2.5), *parts* (3.2.6) and materials are considered.

[SOURCE: IEC TR 62635:2012, 3.9, modified — Note 1 and 2 to entry have been added.]

3.2.32
requirement
need or expectation that is stated, generally implied or obligatory

Note 1 to entry: "Generally implied" means that it is custom or common practice for the *organization* (3.1.5) and *interested parties* (3.1.7) that the need or expectation under consideration is implied.

Note 2 to entry: A specified requirement is one that is stated, for example in *documented information* (3.3.2).

Note 3 to entry: Requirements other than legal requirements become obligatory when the organization decides to comply with them.

[SOURCE: ISO 14001:2015, 3.2.8]

3.2.33
compliance obligations (preferred term)
legal requirements and other requirements (admitted term)
legal *requirements* (3.2.32) that an *organization* (3.1.5) has to comply with and other requirements that an organization has to or chooses to comply with

Note 1 to entry: Compliance obligations are related to *the environmental management system* (3.1.2).

Note 2 to entry: Compliance obligations can arise from mandatory requirements, such as applicable laws and regulations, or voluntary commitments, such as organizational and industry standards, contractual relationships, codes of practice and agreements with community groups or non-governmental organizations.

[SOURCE: ISO 14001:2015, 3.2.9]

3.2.34
risks and opportunities
potential adverse effects (threats) and potential beneficial effects (opportunities)

[SOURCE: ISO 14001:2015, 3.2.11]

3.3 Terms related to support and operation

3.3.1
competence
ability to apply knowledge and skills to achieve intended results

[SOURCE: ISO 14001:2015, 3.3.1]

3.3.2
documented information
information required to be controlled and maintained by an *organization* (3.1.5) 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 *environmental management system* (3.1.2), including related *processes* (3.3.3);

— information created in order for the organization to operate (can be referred to as documentation);

— evidence of results achieved (can be referred to as records).

[SOURCE: ISO 14001:2015, 3.3.2]

3.3.3
process
set of interrelated or interacting activities which transforms inputs into outputs

Note 1 to entry: A process can be documented or not.

[SOURCE: ISO 14001:2015, 3.3.5]

3.3.4
supply chain
those involved, through upstream and downstream linkages, in activities delivering value in the form of a *product* (3.2.5) to different *interested parties* (3.1.7)

Note 1 to entry: In practice, the expression “interlinked chain” applies from suppliers to those involved in end-of-life processing.

[SOURCE: ISO 14006:2020, 3.3.5]

3.3.5
value chain
entire sequence of activities or parties that create or receive value through the provision of a *product* (3.2.5)

[SOURCE: ISO 26000:2010, 2.25, modified — "create or receive value through the provision of a product" has replaced "provide or receive value in the form of products and services" and Notes 1 and 2 the entry have been deleted.]

3.3.6
recycling
processing of waste *materials* (3.2.7) for the original purpose or for other purposes, excluding energy *recovery* (3.2.31)

[SOURCE: IEV 901-07-10, modified — Note 1 to entry has been deleted.]

3.4 Terms related to performance evaluation and improvement

3.4.1
audit
systematic, independent and documented *process* (3.3.3) for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled

Note 1 to entry: An internal audit is conducted by the *organization* (3.1.5) itself, or by an external party on its behalf.

Note 2 to entry: An audit can be a combined audit (combining two or more disciplines).

Note 3 to entry: Independence can be demonstrated by the freedom from responsibility for the activity being audited or freedom from bias and conflict of interest.

Note 4 to entry: "Audit evidence" consists of records, statements of fact or other information which are relevant to the audit criteria and are verifiable; and "audit criteria" are the set of policies, procedures or *requirements* (3.2.32) used as a reference against which audit evidence is compared, as defined in ISO 19011:2011, 3.3 and 3.2, respectively.

[SOURCE: ISO 14001:2015, 3.4.1]

3.4.2
conformity
fulfilment of a *requirement* (3.2.32)

[SOURCE: ISO 14001:2015, 3.4.2]

3.4.3
nonconformity
non-fulfilment of a *requirement* (3.2.32)

Note 1 to entry: Nonconformity relates to requirements in this document and additional *environmental management system* (3.1.2) requirements that an *organization* (3.1.5) establishes for itself.

[SOURCE: ISO 14001:2015, 3.4.3]

3.4.4
corrective action
action to eliminate the cause of a *nonconformity* (3.4.3) and to prevent recurrence

Note 1 to entry: There can be more than one cause for a nonconformity.

[SOURCE: ISO 14001:2015, 3.4.4]

3.4.5
continual improvement
recurring activity to enhance *performance* (3.4.10)

Note 1 to entry: Enhancing performance relates to the use of the *environmental management system* (3.1.2) to enhance *environmental performance* (3.4.11) consistent with the *organization's* (3.1.5) *environmental policy* (3.1.4).

Note 2 to entry: The activity need not take place in all areas simultaneously, or without interruption.

[SOURCE: ISO 14001:2015, 3.4.5]

3.4.6
effectiveness
extent to which planned activities are realized and planned results achieved

[SOURCE: ISO 14001:2015, 3.4.6]

3.4.7
indicator
measurable representation of the condition or status of operations, management or conditions

Note 1 to entry: This document is concerned with indicators related to *products* (3.2.5).

[SOURCE: ISO 14031:2013, 3.15, modified — Note 1 to entry has been added.]

3.4.8
monitoring
determining the status of a system, a *process* (3.3.3) or an activity

Note 1 to entry: To determine the status, there might be a need to check, supervise or critically observe.

[SOURCE: ISO 14001:2015, 3.4.8]

3.4.9
measurement
process (3.3.3) to determine a value

[SOURCE: ISO 14001:2015, 3.4.9]

3.4.10
performance
measurable result

Note 1 to entry: Performance can relate either to quantitative or qualitative findings.

Note 2 to entry: Performance can relate to the management of activities, *processes* (3.3.3), *products* (3.2.5), systems or *organizations* (3.1.5).

[SOURCE: ISO 14001:2015, 3.4.10, modified — "including services" has been deleted in Note 2 to entry.]

3.4.11
environmental performance
performance (3.4.10) related to the management of *environmental aspects* (3.2.19)

Note 1 to entry: For an *environmental management system* (3.1.2), results can be measured against the *organization's* (3.1.5) *environmental policy* (3.1.4), *environmental objectives* (3.2.22) or other criteria, using *indicators* (3.4.7).

Note 2 to entry: This document is concerned with the environmental performance of *products* (3.2.5).

Note 3 to entry: ISO 14031 gives information on types of environmental performance indicators (EPEs) and provides guidance on usage of EPEs.

[SOURCE: ISO 14001:2015, 3.4.11, modified — Note 2 and Note 3 to entry has been added.]

3.4.12
trade-off
decision-making actions that select from various *requirements* (3.2.32) and alternative solutions on the basis of net benefit to *interested parties* (3.1.7)

[SOURCE: ISO 14006:2020, 3.4.11]

4 Context of the organization

4.1 Understanding the organization and its context

The ability of an organization to enhance the material circulation of products and their constituent parts depends on internal and external issues that can affect such ability. These issues should be identified in order to achieve the intended material efficiency objectives.

Improving the material circulation of products and their constituent parts should be addressed to deal with the pressing matter of using resources in an efficient way. Considering a life cycle perspective, the adverse environmental impact of use of materials (and risk of depletion) can be mitigated by maintaining materials longer in the use phase, which can contribute to the achievement of the overall environmental performance goals of an organization.

Identifying the internal and external issues of an organization that are related to the material circulation of products and their constituent parts may be considered as a critical activity for planning an efficient and effective EMS. The identified internal and external issues should be used as the basis for embedding the material circulation of products and their constituent parts in design and development.

The internal issues that can influence the material circulation of a product and its constituent parts include, but are not limited to, the following:

— product-related strategy of the organization;

— product design capability;

— production capability;

— size of the organization and its ability to invest in design and development;

— capability to adopt a new business-model considering material circulation;

— control over the materials used in the parts and the product.

In addition, external issues can include the following:

— supply chain, price volatility and supply stability of the raw material;

— logistical systems for returning used products for, for example, reuse, refurbishment or recycling;

— usability and environmental friendliness of the materials;

— production technology that is used to process the materials;

— consistency between legislations;

— requirements of customers.

The continual improvement of the environmental performance of products should consider a life cycle perspective and not be limited to those processes under the control of the organization.

4.2 Understanding the needs and expectations of interested parties

One of the objectives of the EMS is to meet the needs and expectations of the relevant interested parties. The reason for enhancing material circulation is to build a more sustainable economy through the reduction of resource use. Therefore, a product that is more environmentally sound can be an important factor in the purchasing decision-making process of an interested party (e.g. user), and can have a substantial effect on the goals of the organization and the achievement of its EMS performance.

The organization should determine whether the identified needs and expectations of interested parties in relation to the enhancement of material circulation are covered by current or future compliance obligations. The organization should therefore determine if these compliance obligations are reflected in its environmental performance objectives.

The organization should voluntarily assess the needs and expectations of interested parties when considering its compliance obligations, as a means to address the risks and opportunities related to the material circulation of products and their constituent parts (see Table 1). Annex B provides an extended list of interested parties.

Table 1 — Example of needs and expectations of interested parties

Relationship	Examples of interested parties	Examples of needs and expectations
By responsibility	Investors and shareholders	Expect the organization to manage its risks and opportunities that can affect an investment
By influence	Customers	Expect the product to have long lifetime without diminishing value/function
	End-of-life actors	Need ease of disassembly or dismantling of the product Expect the organization to increase use of secondary material
	Regulatory or statutory agencies	Expect behaviour of product life cycle actors to be in line with governmental policy programmes and objectives
By proximity	Community	Need creation of new jobs related to material circulation Expect to see the number of landfills and/or incinerators significantly decrease thanks to much more developed recycling practices
By dependency	Supplier	Need for collaboration on developing a circular supply chain
By representation	Professional networks (technical centre, chamber of commerce and industry, etc.)	Need for communication among the interested parties involved in particular circular economy issues
By authority	Regulatory or statutory agencies	Expect demonstration of legal compliance

4.3 Determining the scope of the environmental management system

The organization should determine the boundaries and applicability of its EMS to establish the scope, in accordance with the requirements of ISO 14001.

The organization should determine the material circulation strategies needed to achieve its material efficiency objectives in its EMS, including aspects such as compliance obligations, authorities and responsibilities of the various business functions, the organization’s activities and products affected, etc. The organization will also consider what it can control or influence at the various life cycle stages of the product, with respect to the material circulation strategies it envisages to implement.

4.4 Environmental management system

The organization should establish, implement and continually improve an EMS that includes material efficiency objectives. The EMS should also cover the environmental aspects of its activities and products that it can control and those that it can influence, and the associated environmental impacts, considering the life cycle of the product(s) to be designed or redesigned.

5 Leadership

5.1 Leadership and commitment

5.1.1 General

The organization's top management should ensure that strategies for improving material circulation are planned, implemented and maintained. Material circulation strategies should consider all stages in the life cycle of a product that the organization can control or can influence.

In the development of its strategy, especially around material circulation, top management should consider the various business models that support a circular economy in relation to material circulation (see Annex A).

Top management should take into account the supply chain and the expectations of interested parties from upstream to downstream, as well as the life cycle of activities and products, which reinforces the material circulation strategy of the organization.

Top management should regularly inform employees as well as other interested parties about the progress in addressing environmental issues based upon the material circulation strategy.

Top management is responsible for the effectiveness of material circulation. It should establish, implement and maintain the environmental policy, which includes material efficiency consistent with the organization's strategy. Management should therefore be involved and committed to decisions made to improve the organization's environmental performance. The goal is that the EMS reaches the intended results.

5.1.2 Considerations when establishing material circulation strategy

The material circulation strategy to be adopted in a design and development project stems both from the actual material circulation policy and the circular readiness status (see 6.2.2.2).

This strategy should enable economic, technical and human resources to be established.

The strategy can vary depending on the degree of maturity of the organization's EMS, and takes into account the following:

— prioritizing objectives, targets and environmental impacts that are specific to the product;

— the scope of the system to be improved;

— the accessibility of the information;

— the guidance solutions;

— the needs and expectations of interested parties.

The strategy also differs with regard to the organization and its products, e.g. use of recycled material, quantity of used material, use of CRMs, the durability of products.

5.1.3 Tasks to introduce material circulation strategy within an organization

For the implementation of material circulation based on a life cycle perspective, the material circulation strategy should consider the following tasks.

a) The first task concerns setting the objectives for the material efficiency of the organization and the related material circulation strategies, such as:

   1) strategic product planning and integration of material circulation strategies into all relevant operations of the organization;

   2) allocating resources (human, technical and financial) for the planning, implementation and improvement of material circulation;

   3) anticipating changes in external market conditions and opportunities arising from technological developments, and supply chain risks;

   4) setting objectives for environmental performance;

   5) promoting innovation;

   6) establishing new business models;

   7) contributing to value creation;

   8) ensuring circular design is applied in design and development.

b) The second task is the management of the internal processes once the material circulation strategies and the material efficiency objectives have been set. This includes:

   1) integration and implementation of the chosen material circulation strategies in all relevant procedures, programmes and roadmaps;

   2) ensuring a cross-functional approach, to ensure that relevant life cycle related data are shared within business functions;

   3) involving the value chain in the chosen material circulation strategies, both upstream (suppliers) and downstream (distributors, customers and users, end-of-life actors);

   4) fostering two-way communication, both in the internal and external value chain.

These lead to an action programme that guides the methodology, including objectives, responsibilities (actors), timeframes, resources and expected performance.

The organization may consider using resources from within the organization or external resources to drive the material circulation strategy.

In an EMS framework, risks and opportunities related to material circulation should be addressed from two perspectives:

— when planning actions to address identified risks and opportunities, material circulation should be considered as a way to manage the risks and opportunities;

— the risks and opportunities associated with material circulation should be identified and adequately managed.

5.2 Environmental policy

Since a material circulation strategy improves environmental performance in a life cycle perspective, an organization should consider the guidelines in ISO 14006:2020, 5.2.

The ambition of the organization in relation to the material efficiency objectives (part of the environmental policy) to deal with issues of circularity can be expressed as follows:

— circular ready design is applied to X % of our products;

— X % of our revenue comes from refurbished products by year “YYYY”;

— X % of our internally generated waste will be recycled or reused;

— the recycled content of our products is up to X %.

5.3 Organizational roles, responsibilities and authorities

Top management should ensure that the responsibilities and authorities for relevant roles are assigned and communicated within the organization (see ISO 14001:2015, 5.3).

Not only design and development, but also other business functions and external interested parties (see Figure B.1), should be involved in the material circulation-related activities.

Performance of material circulation has to be reported to top management.

6 Planning

6.1 Actions to address risks and opportunities

6.1.1 General

The organization should consider the issues relevant to the material circulation strategies of products and their constituent parts identified in 4.1 and 4.2 when planning its EMS. The organization should also determine the risks and opportunities related to its environmental aspects (see 6.1.2), compliance obligations (see 6.1.3) and other issues (identified in 4.1 and 4.2), considering the material circulation of products and their constituent parts. The risks and opportunities related to the material circulation of products and their constituent parts are inputs for the environmental objectives (see 6.2). Examples of risks and opportunities are summarized in Table 2.

Table 2 — Examples of risks and opportunities relevant to the material circulation strategies of products and their constituent parts

Strategy	Risk (potential adverse effect)	Opportunity (potential beneficial effect)
Increase recycled content	Potential damage of organization’s reputation in the case of non-compliance of recycled materials Potential damage of product’s reputation in the case of poor quality of recycled materials Limitation on the amount of the recycled content able to be used due to, for example, safety, performance and durability risks Identical product functionality may not be reached due to a potential quality differences between virgin material and recycled material	Reputation and green image gain of the organization by using an increased amount of recycled content leading to increased acceptance/popularity of the product with identical function and quality Limiting the use of raw materials by using recycled material and, in the long term, saving costs Make a better use and control of the value chain and potential hiccups in the supply by giving preference to recycled materials

Table 2 *(continued)*

Strategy	Risk (potential adverse effect)	Opportunity (potential beneficial effect)
Select materials that can be easily recycled	Cost increase Limited supplier selection	Extended producer responsibility cost reduction Increase the availability of secondary material in general Increased chance to recover and reuse materials from own products, limiting possibility for poor quality and nonconformities
Avoid the use of problematic substances, e.g. hazardous substances, flame retardants	Cost increase	Cost reduction of disposal Easy recycling and recovery of own materials Reduced health and safety risks
Ensure availability of spare parts	Decline in sales of new products Finance risk due to failure of stock management Risk of uncontrolled repair or upgrade of products directly by the users or unauthorized repair centres	Promotion of green image of the organization, by allowing for lifetime extension of products Develop new business of spare parts
Reuse of parts	Damage of organization's reputation in the event of poor safety or performance of the reused parts Damage of product's reputation because of poor quality	Promotion of the green image of the organization New business model by the organization
Product reuse/remanufacture	Decline in sales of new products	Opportunity for a new business model Promotion of the green image of the organization Establishment of a long-lasting relationship with customers
Legal requirements for products or parts to be reused, remanufactured or, otherwise, recycled	Damage to organization's reputation or fine due to failure to comply with the requirements Limited freedom for the product design	Going beyond the legal requirements and so demonstrating superiority of products or services and strong commitment to the environment Limited chance for greenwashing

The organization can choose its approach according to its own situation when determining risks and opportunities (see ISO 14004).

NOTE The principles and guidelines for risk management are provided in ISO 31000. Examples of approaches to determining the risks and opportunities to be addressed are provided in ISO 14004.

6.1.2 Environmental aspects from the material efficiency perspective

Within the defined scope of the EMS as described in ISO 14001:2015, 4.3, the organization should determine the environmental aspects of its activities and products that it can control and those that it can influence, and the associated environmental impacts, considering the life cycle of the product(s) to be designed, or redesigned.

This document, however, limits its focus to the use of raw materials and the opportunities for material efficiency that are part of the broader environmental objectives of an organization. In other words, it is limited to aspects associated with the use or the circulation of materials that have an impact on the environment. To that extent, the following considerations are important:

a) understanding the life cycle of product(s) and the relationship with the life cycle of materials;

b) identifying the readiness for material circulation in relation to the life cycle of the product(s) that can be controlled or influenced by the organization;

c) for each life cycle stage, identifying how inputs (the consumption of energy and other natural resources such as raw materials, water and other non-regenerative resources) and outputs (e.g. non-recyclable physical waste, emissions) can result in environmental impacts (e.g. material resource depletion, pollution associated with waste generation, in particular to soil);

d) determining which material circulation strategy (or strategies) will be likely to influence opportunities for material efficiency.

In order to determine which material circulation strategies affect (positively or negatively) material efficiency, the organization should establish a method, based mainly on material circulation criteria, which should take into account various ways to reduce the use of raw materials and eliminate physical waste.

NOTE 1 Evaluation can be based on expert opinion (which needs to be cross-checked) and existing data (organization-specific data, bibliography, databases, etc.). It is conducted with caution and discernment, e.g. by cross-referencing available information or conducting peer review. For example, the evaluation could lead to a qualitative assessment, of the "favourable" / "very favourable" / "unfavourable" type, or be quantitative and subject to a simplified or complete life cycle assessment (LCA).

NOTE 2 Energy efficiency is not included in this document. However, trade-offs between material and energy efficiency are important and can be considered as part of the overall environmental strategy.

For these, the material life cycle should be considered, including, for example:

— extraction of materials from natural resources and their processing;

— conversion of materials into products and their distribution;

— use and performance of the product over its functional lifetime;

— end-of-life of the product and either its reuse, upgrade or disposal;

— end-of-life of a material and either its recycling and reuse or disposal.

Opportunities for material efficiency may be evaluated on the basis of comparison with a previous model of the product, a similar product on the market, a prototype or a hypothetical reference, while considering legal requirements, the environmental policy of the organization and the requirements of interested parties (such as recycling firms or the recycled materials market). This comparison starts with the assessment of the circular readiness (material circularity potential) of the product and its constituent parts. The result of the evaluation should be reproducible and consistent.

The circular readiness of products and their constituent parts can impact the environment at some or all stages of the product life cycle. For assessing the potential for material circulation of a product or its constituent parts, the following should be considered:

— raw material extraction: indirect influence;

  NOTE 3 In principle, raw material extraction is out of scope of the organization developing the product. A possibility for the organization to influence is choosing materials from sustainable sources.

— materials processing: three aspects of material circulation can be distinguished in this phase as follows:

  — materials selection, i.e. selection of materials to optimize the lifetime of parts and optimize their potential for recycling;

  - limit the quantity of materials used;
  - recycled content, i.e. the use of recycled materials in (new) products;
- production: effective manufacturing (avoid scrap and rejects during manufacturing process);
- distribution: effective logistics (local sourcing, avoid damaged products, etc.);
- use phase: product lifetime extension strategies should be considered (e.g. repair, reuse, upgrade);
- end-of-life: reuse of products and their constituent parts, and recycling of materials.

For opportunities for material efficiency, the organization should take into account all relevant material circulation strategies, ensuring that significant ones are considered in setting its material efficiency objectives (as part of the overall environmental objectives).

It should be taken into consideration that material circulation strategies may be different for different products, according to the characteristics of the products. The organization should acknowledge that each material circulation strategy is not independent, and should also consider trade-offs.

NOTE 4 Some of the material circulation strategies can impact vulnerable populations, e.g. waste pickers having a role in the collection and processing of waste material, and can be also taken into consideration.

The organization should consider not only the aspects that it can manage directly but also the aspects it can influence through other interested parties in the supply chain.

6.1.3 Compliance obligations

The compliance obligations relevant to the material circulation of products and their constituent parts can lead to risks and/or opportunities that should be addressed by the organization. The organization should establish, implement and maintain a process to identify and have access to compliance obligations that are related to material circulation strategies, relevant legal requirements and the requirements of other interested parties.

The organization should ensure communication with the persons that are relevant to the fulfilment of compliance obligations related to the material circulation of products and their constituent parts, and those whose actions can influence the fulfilment of compliance obligations.

The requirements related to the material circulation strategies of products and their constituent parts need special attention as they may pose risks to the organization.

The organization should determine the relationship between the requirements of interested parties other than the legal requirements and the material circulation strategies of products and their constituent parts. The organization should recognize that these can be risks and opportunities.

6.1.4 Planning action

To deal with the significant environmental aspects of the material circulation of products and their constituent parts, compliance obligations, and the risks and opportunities identified in 6.1.1, the organization should consider and plan actions with respect to (re)design. The organization should plan to take action in a wide range of ways by using the EMS processes or other business processes. The organization should determine the effectiveness of its actions.

In planning actions, the organization should consider technological options and feasibilities, and financial, operational and business requirements. The planning actions should consider the possibility of unintended consequences, e.g. high energy consumption or other adverse impacts on the environment including those resulting from an unintentional shift within the life cycle of a product or a system.

6.2 Environmental objectives and planning to achieve them

6.2.1 Material efficiency objectives as part of the environmental objectives

An organization's material efficiency objectives should be integrated in its overall environmental objectives (see ISO 14001). They are limited in focus, considering only aspects that have a relation to raw materials use or impact on natural resources. Material circulation is a means to achieve the material efficiency objectives of an organization. Material efficiency and design for material circulation require a holistic assessment over the whole lifetime of products or the systems where the products are embedded.

The organization should establish material efficiency objectives (as part of the environmental objectives) taking into account associated environmental aspects from the material efficiency perspective (see 6.1.2), compliance obligations (see 6.1.3) and also considering risks and opportunities derived from the material circulation strategies (see 6.1.1).

The material efficiency objectives should be consistent with the environmental policy of the organization, measurable (if practical), regularly monitored, communicated and continuously reviewed/improved. The organization should also maintain documented information of its material efficiency objectives.

Trade-offs are important to be considered when establishing material efficiency objectives, e.g. additional logistics associated with collecting or cleaning processes to make products fit to be reused or refurbished.

This document provides an approach to the design and development of products to achieve a circular ready design, starting with the identification of circular readiness status (see 6.2.2.2), establishment of material circulation strategies (see 6.2.2.3) and implementation of material circulation design of products and their constituent parts (see 6.2.2.4 and 8.1.3). This approach is depicted in Figure 2.

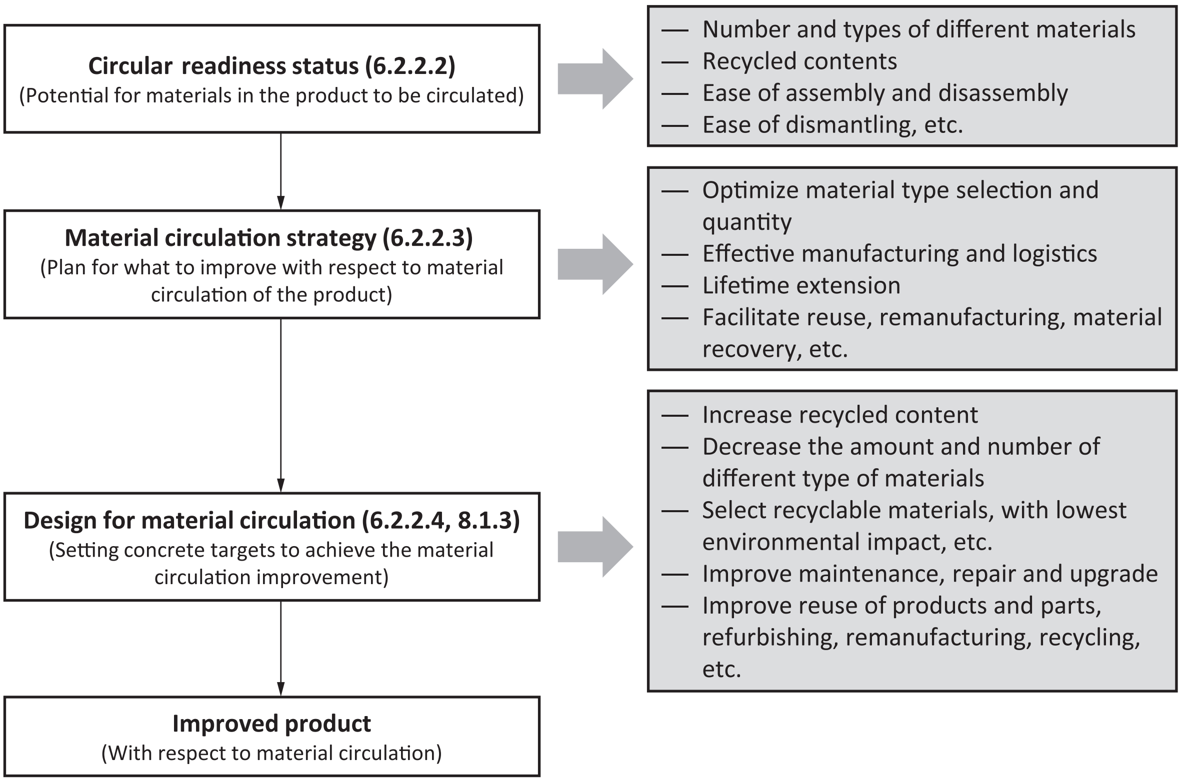

Figure 2 — Approach for a circular ready design

6.2.2 Planning actions to achieve the material efficiency objectives

6.2.2.1 General

The organization should plan and define concrete actions on how to achieve the material efficiency objectives and targets for material circulation of products and their constituent parts.

The plans should include processes, roles and actions according to the function, resources, timeframe and performance indicators necessary for achieving the material efficiency objectives. The plans should also address different priorities accordingly.

The organization's environmental performance indicators are important tools for monitoring its progress in achieving environmental objectives and continual improvement. They should be consistent with the environmental objectives and planning actions of the organization. They should also cover specific material efficiency targets, be measurable, and produce objective, verifiable and reproducible results.

6.2.2.2 Identifying circular readiness status

The organization should identify the circular readiness status of its products and their constituent parts. The circular readiness status gives the potential for materials in products and their constituent parts to be circulated, in a closed-loop. This can be then used as input for establishing a material circulation strategy (or strategies) and design strategies for the products and their constituent parts, based on risks and opportunities (see 6.1.1) associated with them.

For example, the following can be considered to identify circular readiness of products and their constituent parts:

a) number and types of different materials used: a higher diversity in material types is likely to decrease the potential for the product and its constituent parts to be (fully) recycled;

b) recycled contents: the higher the potential for recycled material to be used in production, the higher the circular readiness of the product and its constituent parts;

c) ease of assembly and disassembly, e.g. to facilitate repair, upgrade, refurbishing, remanufacturing or parts reuse;

d) ease of dismantling for recycling.

6.2.2.3 Establishing material circulation strategies

Based on risks and opportunities (see 6.1) and circular readiness status (see 6.2.2.2), the organization can now establish the material circulation strategies appropriate for its products and their constituent parts throughout their entire life cycle. Material circulation strategies are strategies to improve the material circulation of a product by means of design. The following can be reflected in the material circulation strategies of an organization:

a) optimizing material type selection and quantity, where the use of recycled material is maximized, while reducing use of virgin materials; materials are selected to improve the potential for reuse or recycling;

b) effective manufacturing, where defective or scrap production is minimized;

c) effective logistics: minimizing the resources required for packaging and transport, as well as improving transport safety that minimizes damage;

d) lifetime extension by facilitating repair, upgrade, reuse or refurbishing;

e) at the end-of-life, facilitating parts reuse and remanufacturing as well as material recovery.

The considerations for material circulation strategies above can be applied after prioritizing them in accordance with a product's specific features and business strategies.

NOTE 1 One of the objectives of the circular economy is to reduce, and ultimately eliminate, waste. Material circulation strategies as given above will support this.

The following should be considered when material circulation strategies for products and their constituent parts are established:

— the lifetime of products and their constituent parts and model change intervals;

— the material circulation of products and their constituent parts throughout the entire life cycle and the related infrastructure of the region in relation to the material circulation;

— trade-offs among different material circulation strategies;

— trade-offs between material circulation strategies and the environmental impacts in a life cycle perspective (e.g. energy consumption during production or the use of the product);

— the organization's influence on the material circulation of products and their constituent parts;

— new business models for the product in relation to material circulation (e.g. product lease);

— the speed of technology development;

— legal requirements.

NOTE 2 Material flow in material circulation is described in Annex C.

6.2.2.4 Planning design strategies for material circulation

Once the organization has determined the material circulation strategies suitable for its business and products (as presented in 6.2.2.3) for each material circulation strategy, a number of design strategies for material circulation should be planned, as appropriate for its business. Through the design strategies, the material circulation strategies can be implemented in practice to achieve the material efficiency objectives of the organization.

Here are some examples intended to guide organizations on the intention of this subclause:

a) optimizing material type selection and quantity:

   1) choose easily recyclable materials, materials with the lowest environmental impact, and materials that can be easily separated at end-of-life treatment;

   2) decrease the quantity and the number of different types of materials in the product and avoid/eliminate materials that have adverse impacts on recycling;

   3) replace physical parts or functions with digital service;

   4) avoid the inclusion of hazardous substances that could decrease the recyclability of materials;

   5) maximize recycled contents;

b) effective manufacturing:

   1) increase control points throughout assembly lines to avoid mistakes;

   2) provide visual guidance to operators to avoid mistakes in manufacturing and to reduce scrap;

   3) choose designs that are easy to assemble/manufacture;

c) effective logistics:

   1) introduce transportation approaches/incentives that reduce product damage during delivery;

2) reduce the quantity of single-use packaging during transportation, etc.;

3) favour local production and delivery to the users;

d) lifetime extension:

1) extend the lifetime of products by introducing planned maintenance and servicing;

2) design products and their constituent parts so that they can be upgraded, reused or refurbished;

e) end-of-life treatment:

1) plan the harvesting of reusable parts from end-of-life products;

2) plan the recovery of noble, critical and hazardous materials;

3) plan the material recycling;

4) design products and their constituent parts so that they can be remanufactured;

5) design parts so that they can be reused (in used or new) products.

6.2.2.5 Planning actions

As a result of above-mentioned actions (see 6.2.2.2, 6.2.2.3 and 6.2.2.4), the organization should make action plans to achieve the material efficiency objectives. This includes, but is not limited to:

— what will be done (the material efficiency objectives);

— which resources will be required;

— who will be responsible;

— when it is planned to be completed;

— how the results will be evaluated, including measurable indicators for monitoring of progress and the achievement of the above-mentioned material efficiency objectives.

Examples of action plans to achieve material efficiency objectives are given in Figure 3.

Environmental objectives	Responsibility	Resources	Etc.
Decrease the number of different materials in the product — 2017y: 2 → 1 (steel, ABS → ABS) — 2018y: 1 → 1 (virgin material → recycled material)	Project manager: John Division: R&D centre	Planning period: 2 years Budget: $ 3 000 Personnel: 500 MM Equipment:	....

Action planning

Milestones			Remark		Output
Action plan	**Period**	**Division**			
— Selection and usage of ABS without brominated flame retardant — Usage of the same material as other components —	— 6 months — 10 months —	— Purchasing office/developing office — Developing office —	—	→	Single material product on the market

Figure 3 — Examples of action plans to achieve material efficiency objectives

7 Support

7.1 Resources

An analysis should be performed to identify all the resources required for the implementation of the material circulation strategy, including human, technical or financial.

— For human resources, this means listing all the competences required to successfully complete the material circulation strategy and to identify training needs for the implementation of the material circulation strategy.

— For technical resources, this means listing all the material circulation tools and methods to be employed in the implementation of the material circulation strategy.

— For economic resources, this means anticipating all the investments that will be necessary for the implementation of the material circulation strategy, such as for training or purchasing of tools.

If certain resources do not exist or are not available in the organization, top management should support seeking out the possible solutions and competencies from outside of the organization.

Funding may also be sought from various associations and organizations.

7.2 Competence

As the material circulation strategy is focused on improving environmental performance from a life cycle perspective, an organization can consider the guidelines in ISO 14006:2020, 7.2, based on the EMS in ISO 14001, to define the competences needed.

7.3 Awareness

The organization should identify which functions in the organization have a role in the implementation of material circulation strategies and make those persons with responsibility for these functions aware of the importance of material circulation, the impacts on the environmental performance, and how this can be influenced by their work.

The implementation of material efficiency objectives can have influence on several functions in the organization, for example, the following.

— R&D: In most cases, the implementation of material circulation strategies requires a redesign of products and sometimes the production process. Creativity and perseverance are needed to find solutions and convince different interested parties in the supply chain regarding the changes that are often needed. The R&D functions should be aware of the importance of material circulation for the environmental performance of the organization.

— Commerce: The implementation of material circulation strategies will often have consequences for the composition, features and treatment of products. Potential customers have to be convinced that the modified products are beneficial for them. The commercial functions should be aware of the importance of material circulation and know what the benefits are, e.g. for the environmental performance of the customers.

— IT: Material circulation also requires the exchange of data between different parties in the supply chain, for instance, the composition of materials and products (e.g. by using material declaration formats such as IEC 62474 or material passports) and sometimes also the place where certain materials are located in the product. Material circulation will often depend on IT solutions. That makes it important that the IT department is aware of the importance of material circulation for the organization and the improvement of the environmental performance, and their important role in this process.

— Purchasing: The implementation of material circulation has consequences for the purchasing process. Detailed information is needed from suppliers about (raw) materials used in products. It can be necessary to find new suppliers of different materials needed for a better environmental performance. This means that changes in the purchasing process are inescapable. The purchasing department should be aware of the important role they have in finding the right materials and suppliers to realize material circulation objectives.

— Production: Material circulation can have consequences for the production process, e.g. by the use of recycled materials instead of virgin material, or the use of other materials to improve the possibilities for recycling in the end-of-life stage. It is important that people in the production function are aware of the importance of material circulation and their role in finding solutions for the use of different materials.

7.4 Communication

Material circulation requires an intensive exchange of information between different functions within the organization as well as with interested parties outside the organization. This means that communication processes are essential for the realization of material circulation strategies. ISO 14001 requires processes for internal and external communication. This means that the organization should identify which information has to be exchanged, with whom, how, etc., in order to realize the environmental objectives.

Examples of external communication related to the material circulation and environmental performance are as follows.

— Suppliers: Communication with suppliers is needed, for example, about the specification and origin of basic materials and materials used in products and the possibilities to use fewer (different) materials, or materials that are more suitable for recycling and have a lower impact on the environment. Several parties in the value chain are involved in the development of products that are based on material efficiency objectives. An intensive process of communication may be needed, for example, in relation to the use and reuse of new materials with better environmental performance.

NOTE 1 Minimum social compliance requirements (e.g. for the processing and the recovery of materials) have to be addressed in the supply chain. Although this is an important aspect, it is not covered in this document.

— Customers: When buying products, customers must be informed about material circulation-related aspects. In the decision-making process, customers often need arguments and information about the environmental advantages of the products based on circular principles, e.g. information about recycled content. The organization needs to know which information is mandatory by legislation or expected by customers and has to implement processes to guarantee the reliability of this information.

— Users: Communication is needed about the way a product has to be handled in the end-of-life phase. Communication is needed about what the user has to do with the product to guarantee that material circulation is possible.

— End-of-life actors:

  — in the phase of product development, information from recycling companies is needed about the constraints for recycling; the materials which are more or less suitable for recycling; the combination of materials which will positively or negatively influence the result of recycling, etc.;

  — organizations involved in the dismantling of products require information about the composition of products to optimize dismantling and to prevent loss of material; the organization has to think about the way this information is available.

Examples of internal communication related to material circulation and environmental performance are as follows.

— Communication is an important instrument for the creation of awareness (see 7.3) and involvement of personnel in the organization in realizing material circulation. Top management can communicate internally about the objectives in relation to material circulation. The communication of the initial results of the implementation of material circulation can be important to motivate the personnel involved.

— The implementation of material circulation requires the collaboration of several functions within the organization. Communication processes are important to guarantee an efficient and effective exchange of information.

All communication should be:

— relevant: address the real issues/problems of the product;

— exact: ensure the reliability and accuracy of the information;

— verifiable: ensure transparency by giving the possibility to check the information;

— not misleading: avoid vague, ambiguous arguments.

NOTE 2 The user can also receive material circulation information according to the three types of communication defined by ISO 14021, ISO 14024 and ISO 14025. In addition, as regulations evolve to meet consumer demand for environmental information, certain types of communication could become mandatory depending on the sector. It is therefore important for an organization to anticipate and organize itself to be able to meet these new requirements.

7.5 Documented information

7.5.1 General

In addition to ISO 14001:2015, 7.5.1, it is important to note that documented information covering traceability of materials can support material circulation.

7.5.2 Creating and updating

There is no additional guidance on 7.5.2. The requirements in ISO 14001:2015, 7.5.2, fully cover the needs for material circulation.

7.5.3 Control of documented information

There is no additional guidance on 7.5.3. The requirements in ISO 14001:2015, 7.5.3, fully cover the needs for material circulation.

8 Operation

8.1 Operational planning and control

8.1.1 General

The organization should use the existing design and development processes to implement the measures identified in 6.1 and 6.2. It should also establish, implement and maintain documented procedures to ensure the design of new products and redesign of existing products, and their constituent parts, for material circulation in those processes.

8.1.2 Creating material circulation solutions

During the design and development of products and their constituent parts, an organization should develop material circulation strategies and set concrete targets to achieve the material circulation improvement according to material efficiency objectives (see 6.2.1). Design strategies should then be established to achieve such material circulation strategies.

Design strategies should be evaluated over the entire life cycle considering the trade-offs of environmental impacts throughout the different life cycle stages. Trade-offs due to additional process steps, e.g. extra logistics and cleaning, are also needed. A LCA can be used to quantify and distinguish among different strategies and potential trade-offs.

Table 3 provides examples of material circulation strategies and the respective design for material circulation strategies throughout the life cycle. In some cases, other considerations are included.

Table 3 — The relation between material circulation strategies and design strategies (non-exhaustive)

Life cycle phase	Material circulation strategies	Design strategies	Other considerations	Reference subclause
Raw material extraction	n/a	No or only minimal influence on material circulation strategies	n/a	
Material processing	Optimizing materials selection	Choose easily recyclable materials		8.1.3.1
		Choose materials that can be easily separated during recycling		8.1.3.1
		Decrease the number of different types of materials		8.1.3.1
		Select materials that contribute to the extension of the lifetime of the product	High-performance materials	8.1.3.2
		Choose materials with the lowest environmental impact	High-performance materials	8.1.3.2
		Reduce/avoid/eliminate materials that have an adverse impact on recycling, including hazardous substances	Material compatibility	8.1.3.3
	Optimizing materials usage	Reduce the quantity of material inputs, including CRMs	Trade-offs in respect to product durability, performance and safety needed	8.1.3.4
		Replace physical parts or functions with digital service (dematerialization)	Trade-offs in respect to environmental impact within a whole system	8.1.3.4
		Maximize recycled content		8.1.3.5
Production	Effective manufacturing	Eliminate/reduce pre-consumer materials (production scrap and product rejects)		
		Reuse any production scraps in the same or other process		
Distribution	Effective logistics	Avoid product damages during transportation		
		Limit the quantity of single-use packaging, etc.		

Table 3 *(continued)*

Life cycle phase	Material circulation strategies	Design strategies	Other considerations	Reference subclause
Use phase	Lifetime extension	Extend the lifetime of a product by proper maintenance and servicing	Information provision on maintenance and servicing Ease of disassembly and reassembly	8.1.3.6
		Improve the ability of a product or parts thereof to be repaired	Ease of disassembly and reassembly Modular design Provision of repair information Availability of spare parts	8.1.3.7
		Improve the ability of products or parts thereof to be upgraded	Modular design Provision of upgrade information	8.1.3.8
	Facilitating product reuse	Design products thereof so that they can be reused	Ease of disassembly and reassembly for part reuse Use of standard parts	8.1.3.9
		Design products to be refurbished or remanufactured	Ease of disassembly and (re-)assembly Modular designs	8.1.3.10
End-of-life	Facilitating parts reuse	Design parts thereof so that they can be reused	Ease of disassembly for part reuse Use of standard parts	8.1.3.9
		Design parts to be refurbished or remanufactured	Ease of disassembly and (re-)assembly Modular designs	8.1.3.10
		Harvesting of reusable parts from end-of-life product	Traceability and storage systems	8.1.3.11
	Facilitating materials recovery	Plan recovery of CRMs and hazardous substances	Information (e.g. label, product passport) about CRM and hazardous substances presence and location Easy access/ disassembly/ dismantling	8.1.3.12
		Plan for material recycling	Facilitate recycling by collection systems Easy access/ disassembly/ dismantling	8.1.3.13

NOTE Raw material extraction, production and distribution have minimum or no relation to material circulation and are not discussed in detail in this document.

8.1.3 Design considerations for material circulation

8.1.3.1 Choosing materials that can be more easily recycled

Materials that can be easily recycled should be chosen in the design and development process. When considering the recyclability of materials, recycling technology and the market trends of the material should be taken into consideration.

Several techniques may be used in material recycling, such as mechanical recycling, feedstock recycling or biological recycling. Materials used in products or their parts can be easily separated during recycling. In addition to the recyclability of materials independently, the interrelations and compatibility of these materials should be considered. These may also be important for the end-of-life options for a product. For example, materials with high recyclability may not be recycled if they cannot be separated from other non-compatible materials in recycling processes[36].

As the optimal recycling methods depend on many prevailing circumstances, life cycle analysis considering environmental friendliness and sustainability should be applied to decide a priority for the recycling method depending on the type and composition of the waste.

For easy separation of materials in support of recycling, the number of different types of materials in a product or part should be minimized.

Examples of standards with guidelines on how to choose materials to benefit recycling are:

— GB/T 32886-2016, which specifies a concrete method for the selection of recoverable materials (only available in Chinese);

— GB/T 31249-2014, which provides considerations for material selection while doing ECD, and also includes functions, cost and some other environmental aspects (only available in Chinese).

8.1.3.2 Selecting materials that contribute to the extension of the lifetime of the product

Selecting among high-performance materials should be considered for the extension of the lifetime of a product or part. The material should meet the robustness requirement not to be damaged during product use (including reuse) as well as disassembly and reassembly, allowing for maintenance, repair, refurbishing or remanufacturing. The materials used to make products and parts should be stable. They should not react. They should resist damage during the cleaning operation due to factors such as the use of moisture or solvents, temperature, need for aggressive cleaning agents, agitation, scratching and duration of the cleaning process[36].

Product lifetime extension using high-performance materials can often require a trade-off with recyclability. Therefore, when selecting materials, consideration should also be given as to how the use of such materials will affect the environment at all stages of the product's life cycle. As much as possible, materials with the best environmental performance should be selected.

Different assessment methods evaluate materials by means of indicators, which facilitates a comparison of different materials with a view to their environmental performance. For example, indicators calculated from a LCA can be used to select the best available material (see ISO 14040 and ISO 14044). There is currently very little data available on the environmental impacts of new types of high-performance materials. However, the existing data can be used as a basis for the improvement of products with respect to environmental aspects.

Organizations should also consider trade-offs in respect to business and technological aspects such as:

— will customers prefer a longer life product and will they be willing to pay more for it?

— will the high-performance materials be critical or scarce in nature? (see 8.1.3.4)

— will the use of a high-performance material imply an increased energy consumption during manufacturing or product usage?

NOTE High-performance materials are materials that help to meet specific engineering performance in different areas such as strength, functionality, deformation resistance, lightweight, corrosion resistance, high temperature capability, processing efficiency, environmental friendliness and multi-functionality.

8.1.3.3 Reduce/avoid/eliminate materials that are hazardous or have negative impact to recycling

To successfully achieve the material efficiency objectives and facilitate material circulation, hazardous or other substances that can have an adverse impact on recycling or cannot be removed or extracted easily in a recycling process should be avoided or phased out in both virgin and recycled material. In particular, pollution by "dilution" will diminish the value of recycled material, and the contamination of clean material should be avoided. The materials which have an adverse impact on recycling in a product and its constituent parts should be identified with consideration of the end-of life treatment process (e.g. automated or manually disassembly/dismantling), see EN 45555[20].

Hazardous substances may have adverse impact to health, safety or the environment, even if used in small quantities. If possible, their use should be limited during the whole life cycle of the product. In particular, the use of substances that are known to be carcinogenic, mutagenic or reprotoxic (CMR), or (very) persistent, or (very) bio-accumulative (vPvB) should be avoided.

For plastic parts, the following should be considered to reduce adverse impact on recycling:

- promote the use of parts constituted of a single polymer or a blend of compatible polymers;
- avoid the use of fillers that could impact the recyclability of these plastics (e.g. glass fibre, vegetal fibre);
- prevent the use of coatings or other attached materials such as labels that could disturb detection and/or are not compatible with the plastic;
- avoid the use of black or very dark plastics that cannot be detected and separated by optical detection systems.

Traceability is important in recovery operations, in particular with reference to materials containing, for example, critical or hazardous substances or that were produced in contact with harmful substances.

8.1.3.4 Reduce quantity of material inputs including CRMs

The quantity of primary raw materials used in a product or part should be reduced with consideration for applicable technologies. An organization should consider the optimal use of materials in the design and development process, e.g. by reduction of the volume and mass of the product.

Where a technology uses materials that have significant impact on the environment, alternative technologies should be sought.

Making a product or part smaller or more lightweight can be taken into account to curtail primary raw materials used in products or parts.

Reduced use of primary raw materials can be applied to the strategy of using fewer resources along with the use of recycled materials.

The status of the CRM used in a product or part should be considered. CRMs tend to have unstable supplies and risks of price fluctuation, thereby requiring a precise understanding of their application in products and their constituent parts. The organization should find an alternative to these raw materials and draw up a measure to reduce their consumption, if irreplaceable.

Reducing the quantity of material input can contribute to material efficiency. However, trade-offs should be made, taking into account strategies such as reducing the quantity of material input and product durability versus the needed performance and safety.

Replacement of physical parts or functions by digital service (dematerialization) should be considered, for example[37]:

— optimization: maximize material efficiency by reducing the mass or material types in the product (e.g. hard disc replaced by cloud storage);

— digitalization: sell the product electronically or virtually (e.g. video tape, CD, or DVD replaced by digital media);

NOTE Streaming a video or music can require high amounts of energy compared to a one-time download. Therefore, before using digitization to accomplish material circulation strategies, a trade-off assessment is necessary.

— servitization: sell the utility of the product as a service, or a product service system (PSS), instead of ownership (e.g. lease of home appliances and furniture).

Trade-offs with respect to environmental impacts of the complete system should be taken into consideration. For instance, digitalization or dematerialization can result in the transfer of the environmental impacts from the initial product to elsewhere in the whole system (e.g. increase in energy consumption in data centres).

8.1.3.5 Maximize recycled content

The use of recycled materials should be considered when a product or part is made. The more recycled materials are integrated in a product or part, the less primary raw materials are consumed. It should be regarded as one of the material circulation strategies in an organization using an EMS.

If recycled materials are to be used, they should be checked for any hazardous chemicals in the targeted market. There are some specific materials or substances that are restricted or banned from use internationally or nationally. Therefore, the evaluation process should consider not only the contents of chemicals that are currently restricted, but also all chemicals contained to prepare for any potential restrictions.

Although recycling is important, it should be applied as a last resort after all other material circulation strategies. It can be inefficient to increase recycled content if it, for example, does not meet the quality and performance requirements. A holistic approach is needed.

Particular attention should be paid to the traceability of the various substances included in the recycled materials in order to manage the quality of these materials for the next recycling cycles.

NOTE See ISO 14021:2016, Annex A, for the calculation of recycled content.

8.1.3.6 Extend lifetime of a product by proper maintenance and servicing

Maintenance can consist of two actions: monitoring the condition of the product in a pre-defined interval and changing worn-out parts. Appropriate maintenance can extend the lifetime of a product or part and improve environmental performance during the use phase.

Durability and high quality of parts can extend the maintenance interval. For effective maintenance, finding the key checking points should be made easy to execute. In case there are existing needs to change worn-out parts, it could be facilitated by design for easy disassembly and reassembly.

For maintaining the functions of a product or part, safety, total maintenance time and part replacement effort should be checked.

Information to users about maintenance is needed to prevent a shortened lifetime of the product. This may include parts or location where maintenance is needed, intervals for maintenance, tools and methods, and other maintenance (and operation) related issues.

8.1.3.7 Improve the ability of a product or parts thereof to be repaired

If a product can be easily repaired, its lifetime can be extended. To improve the reparability of products, an organization should identify vulnerable parts that are likely to need replacement during the lifetime of the product, in order to make them available as spare parts. Parts can be vulnerable due to improper use (e.g. glass plate of a microwave) or because they wear out before the end-of-life of the product[35].

Easy disassembly and reassembly should be considered in the design process to improve reparability.

To enhance material circulation through product repair, the use of reused or remanufactured parts can also be applied. Backwards compatibility of parts between old and new models should be safeguarded to make this possible. In addition, the use of standard parts will support the reparability of such products.

The concept of modular design can also improve the product's ability to be repaired, which facilitates appropriate disassembly and reassembly.

NOTE Modular design is a design approach that creates things out of independent parts with standard interfaces. This allows designs to be upgraded and repaired, and for parts to be reused and remanufactured.

Providing information to users about servicing and repair can help improve the reparability of a product or parts. This information can include a process to identify the cause of the failure (including helpdesk contact), a repair centre contact, the purchase of spare parts and repair manuals.

8.1.3.8 Improve the ability of products or parts thereof to be upgraded

Upgrades can be applied to two different functions of the product: hardware and software. For a hardware upgrade, a new part is added or one or more parts of a product are replaced by other parts with improved performance or functionality. Ease of disassembly and reassembly are key to allow for easy upgrade, and should be taken into consideration. For a software upgrade, disassembly and reassembly are less relevant.

Modular design concepts can also improve the product's ability to be upgraded.

The information for an upgrade will support the extension of the life of the product. This may include functions or parts that can be upgraded, guidance on the upgrade, availability of upgrade parts, etc.

8.1.3.9 Design products and their constituent parts so that they can be reused

For a product to be reused, it should have a long lifetime or be easily maintained and/or repaired, and it is necessary that any personal data can be deleted from it. For increasing the attractiveness of a product to be reused, the ability of it to be upgraded is important.

In order for parts to be (easily) reused, they should have relative long-life expectancy, sufficient to survive multiple product lifetimes. Also, they should be robust enough to resist multiple disassembly and reassembly iterations without being damaged.

This should be considered when defining the structure of a product and assembly method of a part. Additionally, the concept of modular design can also improve the ability of products and their constituent parts to be reused by facilitating disassembly and reassembly.

For the wide reuse of parts, compatibility of parts among different product models can be necessary. In that case, parts of a model can be used for the repair of other models. The use of standard parts is likely to facilitate this process.

In some cases, software compatibility is necessary to improve the reuse of parts.

8.1.3.10 Design products and their constituent parts to be refurbished or remanufactured

Different processes are necessary for product remanufacturing, such as disassembly, inspection, reprocessing, change of parts, assembly (to a new product) and test of a product.

Refurbishing and remanufacturing are generally facilitated by appropriate product design choices.

The complexity of the components and of the whole assembly can influence the ease of disassembly and replacement. Modular designs are likely to facilitate (dis- and re-) assembly and should be preferred.

In addition, avoiding combining materials with significantly different strengths, as well as avoiding constraining mechanical assemblies (such as gluing or over-moulding), often allows for more efficient refurbishing and remanufacturing operations due to easier (dis- and re-) assembly as well as cleaning. The degree of difficulty in locating access points or fasteners will influence positively or negatively the ability of a product to be remanufactured.

The lifetime and wear and capacity of parts and materials used in the product will strongly influence its capacity to be refurbished and remanufactured. Choosing “standard components/parts” also increases the chances to find replacement parts when refurbishing or remanufacturing the product.

The availability of information such as design, (dis- and re-) assembly process and availability of spare parts can also increase the chance and efficiency of refurbishing and remanufacturing operations.

Trade-offs due to additional process steps such as extra logistics and cleaning are also needed. A LCA can help to assess them.

8.1.3.11 Harvesting of reusable parts from end-of-life product

For repair or remanufacturing, harvesting of reusable parts from end-of-life products should be considered. The parts with relative long-life expectancy from end-of-life products can be used for repair or remanufacturing, even though the product has a little value for reuse or remanufacturing itself.

The identification and tracking of harvested parts is imperative to ensure traceability. Traceability should extend to the final product or lot identifiers for sourced parts. A storage system with traceability should be established for the harvesting of reusable parts and appropriate use.

Particular attention should be paid to the traceability of the various parts harvested from end-of-life products in support of material circulation management.

8.1.3.12 Plan recovery of certain substances or materials

Where the use of certain substances or materials such as CRMs or hazardous substances is needed in the product, an organization should make it easy to identify the presence and, where possible, the approximate location of these substances or materials in the product, e.g. to facilitate recycling.

To facilitate the recycling process, it is important to consider the different possible recycling paths for each of these substances and, where possible, design the product to use substances and materials that, for example, can be recycled together or easily separated.

Easy access to, and easy disassembly and dismantling of, parts and materials containing such substances or materials should be considered for efficient recovery.

8.1.3.13 Plan for material recycling

To improve the recyclability of products, an organization should determine target parts or materials which can be recovered for reuse, while other parts may be selected for recycling.

The organization should also consider that materials sometimes need to be recycled more than once without loss of their inherent value or properties. For this, the organization should limit the number of the types of different materials used so that enough quantity of each material is available for the recycling operations.

For some materials, it is possible there are no recycling facilities available in certain areas. Thus, in particular, when producing and delivering locally, organizations should take into account regional recycling infrastructures when choosing materials for a product.

The way materials are “attached” to each other to form a part or product can influence the extent to which they can be recycled. For example, if they are glued or strongly welded together, recyclability would be impaired or even impossible, which would require disposal at the end-of-life of the product.

When an organization designs a product, the easy access to and easy dismantling of target parts should be considered in order to facilitate recycling.

Setting up a system that allows the traceability of materials used in products will support recycling. This knowledge will facilitate the decision on, for example, the separation of materials according to their category or type and to maintain their intrinsic quality.

8.2 Emergency preparedness and response

There is no additional guidance on 8.2. The requirements in ISO 14001:2015, 8.2, sufficiently address the needs for the scope of this document.

9 Performance evaluation

9.1 Monitoring, measurement, analysis and evaluation

9.1.1 General

The organization should monitor, measure, analyse and evaluate its improvement of material circulation performance in the design and development process.

According to ISO 14031, two categories of indicators (management performance indicators and operational performance indicators) can be used to monitor and measure the progress of the environmental performance of the organization. Indicators can be determined differently for each life cycle stage.

There is no additional guidance on 9.1.1. The requirements in ISO 14001:2015, 9.1.1, sufficiently address the needs for the scope of this document.

9.1.2 Evaluation of compliance

The organization should evaluate compliance with the material circulation strategy regarding the demands and expectations of different interested parties.

9.2 Internal audit

There is no additional guidance on 9.2. The requirements in ISO 14001:2015, 9.2, sufficiently address the needs for the scope for this document.

9.3 Management review

There is no additional guidance on 9.3. The requirements in ISO 14001:2015, 9.3, sufficiently address the needs for the scope for this document

10 Improvement

10.1 General

The organization should determine (see 9.1, 9.2 and 9.3) opportunities for improvement of its material circulation performance and implement necessary actions to achieve the intended outcomes of its EMS.

If necessary, the organization should consider the redesign of products and their constituent parts to improve material circulation.

10.2 Nonconformity and corrective action

When nonconformities are identified, the organization should:

— take corrective actions in the design and development process concerning material circulation in order that they do not reoccur or occur elsewhere;

— use them as learning to prevent potential new nonconformities from occurring.

10.3 Continual improvement

The organization should continually improve the suitability, adequacy and effectiveness of the EMS in relation to material circulation performance.

Annex A
(informative)

Relationship between the circular economy and material circulation

This document proposes strategies to improve material efficiency in all life cycle aspects of the product. It seeks to achieve the circular economy through the circulation of materials to other value chains even after the end-of-life. Figure A.1 describes the material circulation in a closed loop as a means to achieve a circular economy.

Although a circular economy covers both biological and technical cycles, this document focuses mostly on technical cycles.

An organization can incorporate the guidelines set out in this document into its existing EMS to establish strategies to achieve its material efficiency objectives.

When an organization establishes its material circulation strategies, it can create a variety of business models (e.g. creation of new markets, conversion of the existing markets) such as the following.

a) Material acquisition: If the use of recycled content is increased, the market for secondary materials can be activated. Additionally, circular supplies where the waste of one sector becomes the resource for another sector can be realized. In particular, when dealing with scarce commodities, circular supplies are essential.

b) Production: Creation of a business for by-products that are normally eliminated as waste to become valuable resources for other sectors.

c) Distribution: Optimization of the use of storage resources in the logistics systems is needed to improve circulation of materials, avoiding the need for large storage systems. Reverse logistics is fundamental to achieve circularity of materials.

d) Use phase: Considerations of the life extension of products are needed when designing products to allow for easy repair, upgrade or reuse (including refurbish and remanufacture). Business models such as the spare parts market, product service systems market, resell, rental/lease and sharing of the products may be activated.

e) End-of-life: Considering the reuse of products and their constituent parts, the remanufacturing and reuse market can be activated. In addition, a system considering traceability may be developed for the efficient collection of recycled materials.

The above list of examples is not intended to be exhaustive.

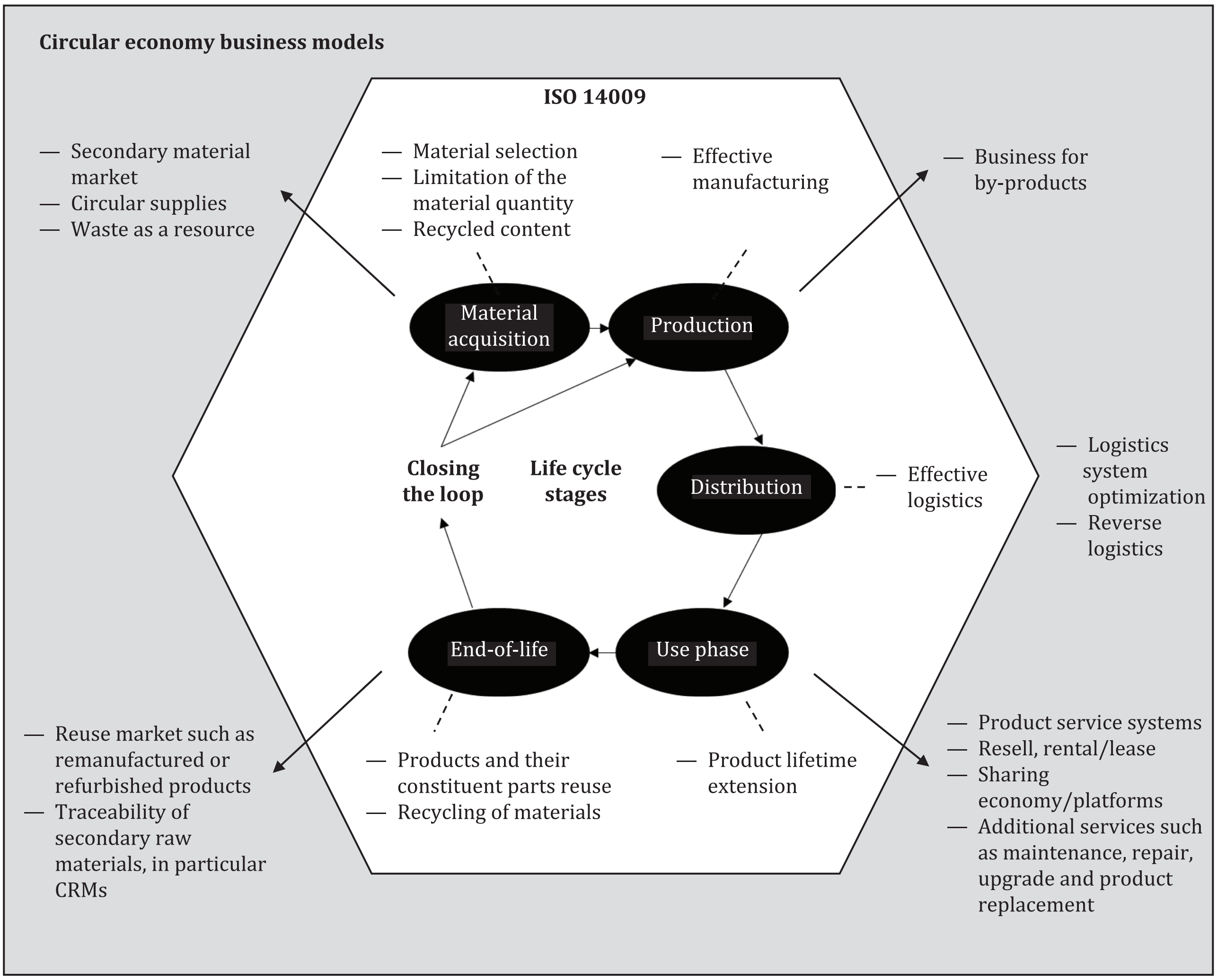

Figure A.1 — Business models in support of material circulation

Annex B
(informative)

Examples of interested parties

When an organization introduces material circulation, the involvement of many different functions is required. The project managers will include both the internal and external actors involved in the product's value chain.

This interdisciplinary approach helps to create a shared vision of material circulation throughout the organization and to mobilize all of the actors concerned based on a project that provides a structure and makes it easier to reach the stated objectives within a reasonable amount of time.

The optimization of overall environmental performance in the value chain depends on access to product information. Partnerships and practices for exchanging information are then developed, in particular through the use of information systems. This may result in customer–customer relationships.

The involved actors may be placed in different categories depending on where they are located in the organization's structure: upstream or downstream, internal or external. The successful implementation of material circulation at the organization depends on the motivation and commitment of all the actors.

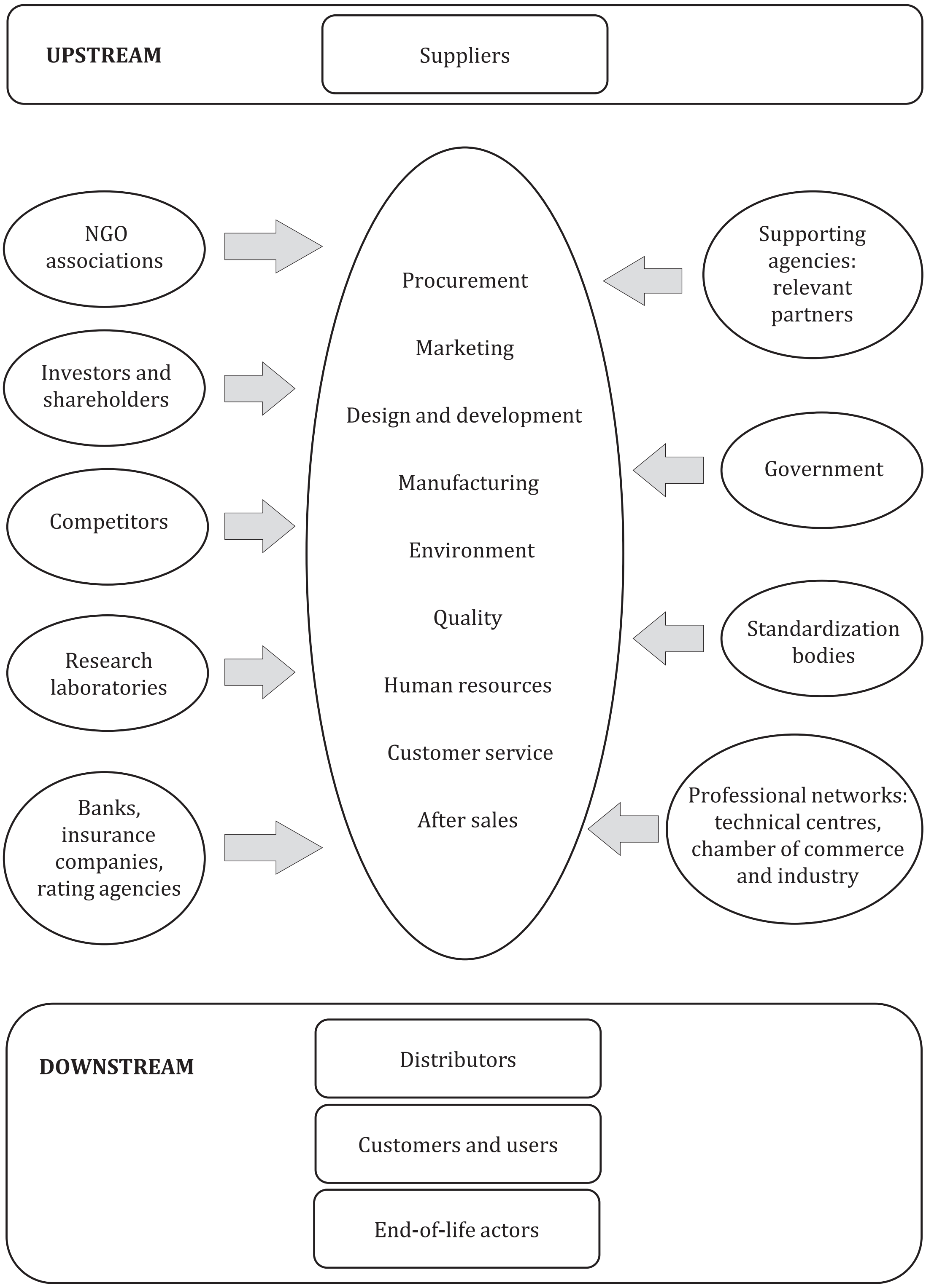

Figure B.1 — Involved actors in the product life cycle

Annex C
(informative)

Material flow in material circulation

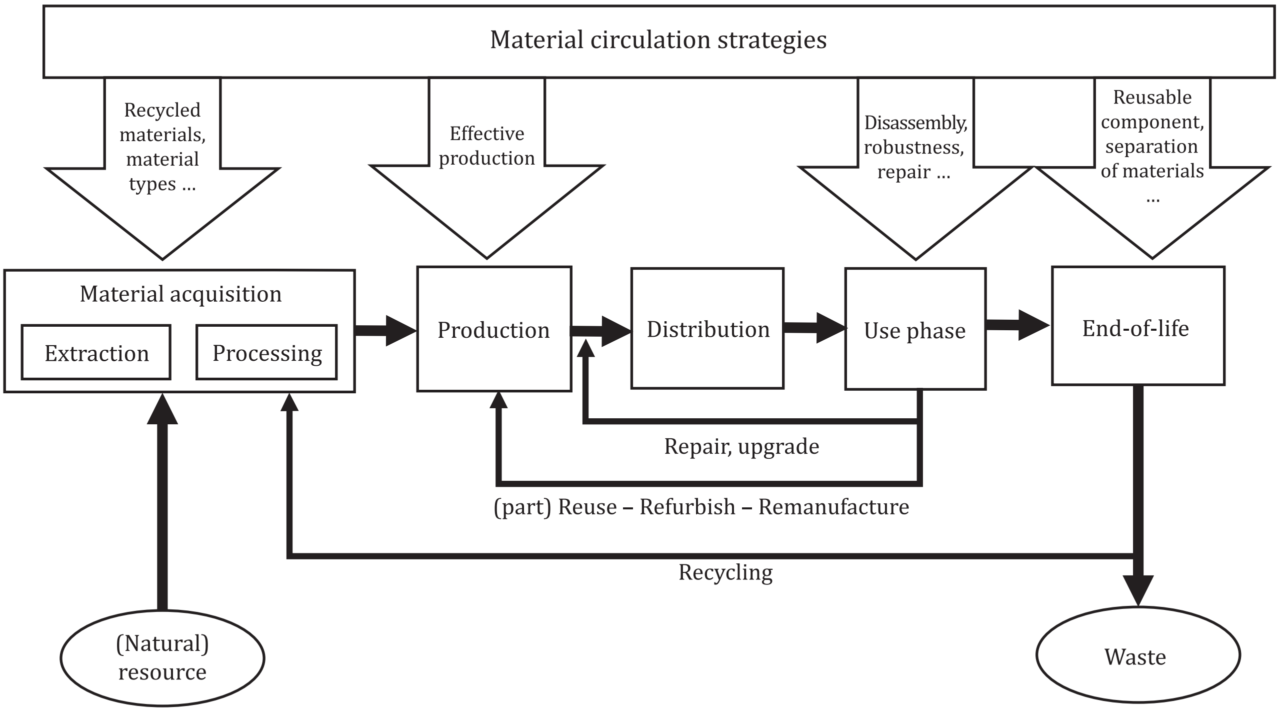

Figure C.1 — Material efficiency opportunities in the life cycle of materials and products

Annex D
(informative)

Case study on the redesign of an existing product

This case study gives an example of the redesign of a small thermal printer for printing receipts, etc. The focus of the redesign is mostly uni-materialization.

The bottom cover of the redesigned product was changed to recycled ABS to unify the material of the other external parts of the product.

In order to reinforce the strength of the part, originally made of steel, the rib structure was redesigned in the new product in such a way that its strength is guaranteed, as shown in Figure D.1.

The choice of replacing steel by ABS has pros and cons in terms of materials circulation. This is part of the trade-offs to be done during the design or redesign of a product. Applying a qualitative or quantitative environmental life cycle impact assessment (e.g. simplified or full) can help select the most relevant design strategies.

a) Existing design of the product **b) New design of the product**

Key

1 base cover: (before) ABS + fluorine-based flame retardant

2 bottom cover: (before) steel

3 base cover: (after) recycled ABS (70 %) + non-halogenated flame retardant

4 Bottom cover: (after) recycled ABS (70 %)

Figure D.1 — Redesign of a small thermal printer for printing receipts

The material circulation and design strategies are shown in Table D.1.

Table D.1 — Material circulation and design strategies

Life cycle phase	Material circulation strategies	Design for material circulation	
		Design strategies	Strategy examples for the product
Raw material extraction	n/a	No or only minimal influence on material circulation strategies	
Material processing	Materials selection	Choose easily recyclable materials	Usage of the non-halogenated flame retardant increases recyclability
		Choose materials that can be easily separated during recycling	
		Decrease the number of different types of materials	Decrease of the number of materials types by substitution
		Select materials that contribute to the extension of the lifetime of the product	
		Choose materials with the lowest environmental impact	Life cycle analysis on the substitution of raw materials to recycled contents
		Avoid/eliminate materials that have negative impact to recycling including hazardous substances	Elimination of halogenated flame retardant
	Materials usage	Reduce the quantity of material inputs including CRMs	
		Replace physical parts or functions by digital service (dematerialization)	
	Recycled content	Maximize the use of recycled materials	Recycled material will be or could be applied
Production	Effective manufacturing	Eliminate/reduce pre-consumer materials (production scrap and product rejects)	
Distribution	Effective logistics	Avoid product damages during transportation	
		Limit the quantity of single-use packaging, etc.	
Use phase	Lifetime extension	Extend the lifetime of a product by proper maintenance and servicing	
		Improve the ability of a product or parts thereof to be repaired	
		Improve the ability of products or parts thereof to be upgraded	
	Product reuse	Design products so that they can be reused	
		Design products to be refurbished or remanufactured	

Table D.1 *(continued)*

<table>
<tr><th rowspan="2">Life cycle phase</th><th rowspan="2">Material circulation strategies</th><th colspan="2">Design for material circulation</th></tr>
<tr><th>Design strategies</th><th>Strategy examples for the product</th></tr>
<tr><td rowspan="5">End-of-life</td><td rowspan="3">Parts reuse</td><td>Design parts so that they can be reused</td><td></td></tr>
<tr><td>Design parts to be refurbished or remanufactured</td><td></td></tr>
<tr><td>Allow for the harvesting of reusable parts from the end-of-life product</td><td></td></tr>
<tr><td rowspan="2">Materials recovery</td><td>Plan recovery of CRMs and hazardous substances</td><td></td></tr>
<tr><td>Plan for material recycling</td><td>Design for recycling, by reducing the number of different materials and removal of halogenated flame retardants</td></tr>
<tr><td colspan="4">NOTE The replacement of steel by recycled ABS for the bottom cover aims at decreasing:
— the number of material types, to ease the sorting and recycling steps of the product at end-of-life;
— the raw materials consumption by increasing the recycled content, and therefore decreasing the overall environmental impact of the product.
Note, however, that the impact can be limited as steel alloys often contain a certain amount of recycled material (e.g. recycled content that can even be close to 100 % for some alloys). Moreover, steel is a material that is easy to sort (given its magnetic properties) and recyclable for several cycles with limited quality downgrading (unlike polymers).
It is also important to note that recycled plastics grades are generally available in a limited colour range (generally either black or dark grey, except if specific colour sorting efforts are applied upstream in the recycling chain).</td></tr>
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