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Mechanical products — Methodology for reduction of environmental impacts in product design and development

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National foreword

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Mechanical products - Methodology for reduction of environmental impacts in product design and development

Produits mécaniques - Méthodologie de réduction des impacts environnementaux à la conception et au développement des produits

Mechanische Produkte - Methodik zur Verminderung der Umweltauswirkungen bei Produktgestaltung und Entwicklung

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Foreword

This document (CEN/TS 16524:2013) has been prepared by Technical Committee CEN/TC 406 “Project Committee - Mechanical products - Ecodesign methodology”, the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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Introduction

Eco-design methodologies can be divided into three types, depending on whether their purpose is the environmental assessment of products, the environmental improvement of products or to enable the two phases to be carried out during the same eco-design project.

The environmental assessment phase of products in the eco-design process can be an impediment for enterprises (owing to need for expertise, time and resources). Therefore, the methodology discussed in this document has been developed with the aim of helping designers to identify ways of improving the environmental performance of a product without carrying out a complete environmental assessment of the product (in terms of LCA).

The approach therefore consists of restricting the scope of analysis to the area defined by the constraints of the product-enterprise pair, which takes into account the technical factors of the product, economic constraints, the practices of an enterprise and its development strategies. Secondly, it consists of exploring the potential for environmental improvement within this restricted field.

This Technical Specification is intended to give enterprises, in particular SMEs, a pragmatic methodology to consider environmental aspects during their product design. It allows them to:

— identify the environmental aspects of a product, including but not limited to energy aspects;

— be able to make progress in product design (for environmental impact reduction), taking into account capabilities of the enterprise;

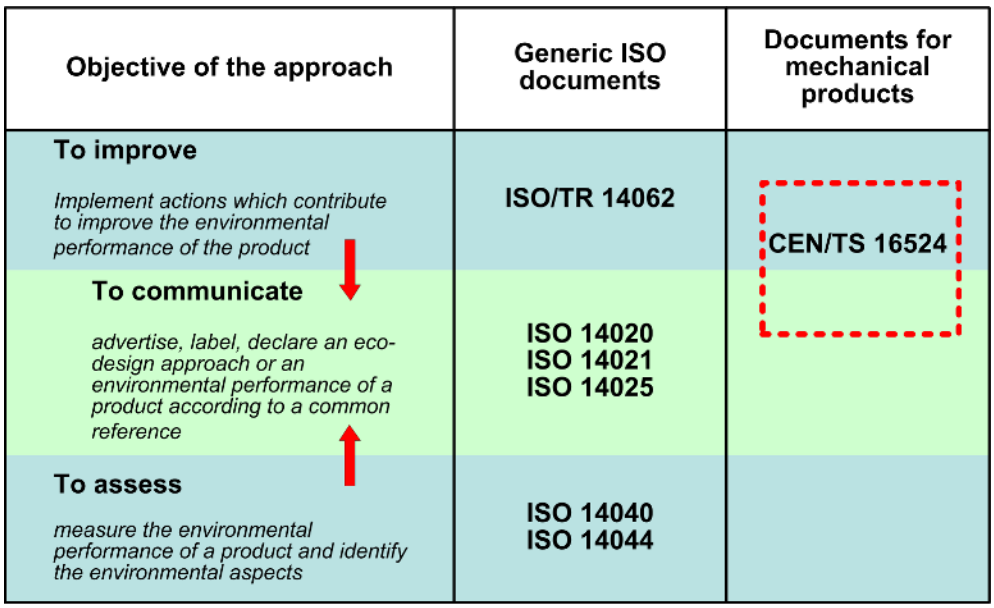
— promote to clients and public authorities the environmental improvement approach on a mechanical product with this methodology (environmental claim).

The improvement of the environmental impact implies that the intended performance of the product (fitness for use, durability, etc.) is maintained.

To implement this methodology, it is necessary that the enterprise staff have knowledge and expertise in environmental issues; if not, external expertise should be available. When applying this methodology, management of the enterprise may enter a learning process with the aim of defining and/or confirming its strategy for eco-design, modifying its design process to enable the environmental issue to be taken into account, and creating new knowledge.

The aim of this Technical Specification is not to measure the actual environmental performance of a product, nor to conduct a full life cycle assessment according to ISO 14040.

Figure 1 shows the relationship between this document and existing documents from ISO.



NOTE More specific methodologies might exist for specific mechanical products.

Figure 1 - Relationship between this document and existing documents from ISO

This Technical Specification can assist the enterprise to comply with the requirement of EN ISO 14001 and the recommendations of EN ISO 14006, to establish, implement and maintain a procedure to identify the environmental aspects of its products.

This Technical Specification is not intended to support any specific product implementing measures of Directive 2009/125/EC (Energy related Products). It may provide methodologies for identifying the more relevant environmental aspects in order to propose alternative design options to improve the environmental performance of the product.

This document is not intended for calculation of environmental footprint.

1 Scope

This Technical Specification describes a methodology for reducing the overall environmental impact through product design and development that is tailored to mechanical products as defined in 2.1.

This methodology is particularly well suited to the redesign of an existing product; it can also be applied for the design of a new product provided the necessary assumptions regarding a (virtual) reference product are taken.

It addresses enterprises which have decided to integrate an eco-design approach to optimise environmental impacts within the product life cycle, in relation to the other product aspects, such as functionality, quality, costs, etc.

NOTE 1 This document targets persons who are directly involved in the design and development of mechanical products, as well as managers responsible for defining corporate policies, and decision-makers. The proposed methodology is intended to kick-start eco-design initiatives within companies as part of a teaching and continuous improvement approach.

This document also includes a template that enterprises may use as part of the communication on their environmental approach.

This document is neither intended nor suitable to compare products (even similar) of other suppliers.

This document is neither intended nor suitable for certification purposes.

NOTE 2 An example of implementation of the methodology is given in Annex D; the basic principles for the establishment of this method are given in Annex E.

2 Terms and definitions

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

2.1
mechanical product
product manufactured by enterprises from mechanical engineering and metalworking industry, such as capital goods (machinery, production systems, components), tools, household goods, optical parts, measuring instruments

2.2
reference product
existing product of the company to be re-designed, with the same intended use

Note 1 to entry: It can be also a similar product existing on the market, or the Technical Specification of a product.

2.3
environmental aspect
EA
element of an organisation's activities, products or services that can interact with the environment

Note 1 to entry: For this document, environmental aspects are categorised into Raw Materials acquisition, Manufacturing, Use, Product End-of-life, Hazardous substances, Transport and distribution, Packaging.

[SOURCE: ISO 14001:2004, 3.6, modified – Note 1 to entry has been adapted]

2.4
(environmental) design option
DO
measure intended to improve a specific environmental aspect within the product life cycle, in relation to the other product aspects, such as functionality, quality, costs, etc

2.5
scoring of environmental aspects
SEA
representation of the relative importance of the product's environmental aspects over its life cycle

Note 1 to entry: This SEA does not express the environmental performance of the product.

2.6
design option indicator
DO indicator
qualitative or quantitative indicator representative of a given design option, used to track this option during the design phase

2.7
environmental aspect indicator
EA indicator
qualitative or quantitative indicator associated with a particular environmental aspect, as representative as possible of this environmental aspect, used to keep a multi-criteria view of the environmental performance of the product during its development

Note 1 to entry: "Multi criteria view" means the consideration of all environmental aspects, to avoid a shift of impact (e.g. change of material can result in lower recyclability rate).

2.8
recoverability
ability of component parts, materials or both that can be diverted from an end-of-life stream to be recovered (see Figure 2)

[SOURCE: ISO 22628:2002, 3.9]

2.9
recyclability
ability of component parts, materials or both that can be diverted from an end-of-life stream to be recycled (see Figure 2)

[SOURCE: ISO 22628:2002, 3.7]

2.10
material recyclability coefficient
r
percentage by mass (mass fraction in percent) of a material potentially able to be recycled

[SOURCE: ISO 22628: 2002, 3.8, modified – vehicle has been replaced by material]

2.11
reusability
ability of component parts that can be diverted from an end-of-life stream to be reused (see Figure 2)

[SOURCE: ISO 22628:2002, 3.6]

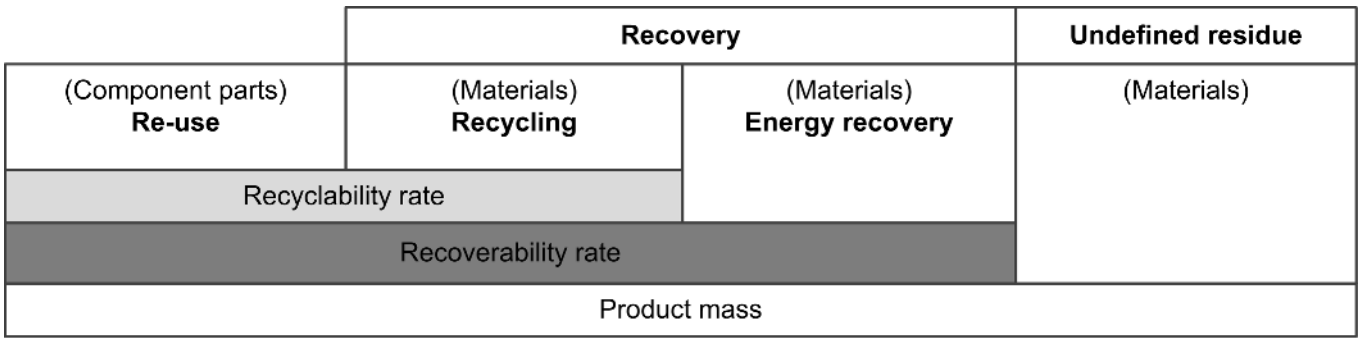


Figure 2 — Overview of key terms

2.12
ecodesign
integration of environmental aspects into product design with the aim of improving the environmental performance of the product throughout its whole life cycle

[SOURCE: Directive 2009/125/EC]

3 Abbreviated terms

The abbreviated terms necessary for the understanding of this Technical Specification are the following:

BOM	Bill Of Materials
DO	Design Option
EA	Environmental Aspect
ErP	Energy related Products (European Directive)
ELV	End-of-Life Vehicles (European Directive)
M	Manufacturing aspect
Pkg	Packaging aspect
PEL	Product End-of-Life aspect
RM	Raw Material aspect
S	Hazardous Substances aspect
SEA	Scoring of Environmental Aspect
T	Transport and distribution aspect
U	Use aspect
RoHS	Restriction on Hazardous Substances (European Directive)
WEEE	Waste Electrical and Electronic Equipment (European Directive)

4 Requirements

4.1 Application of the methodology

The methodology described in this document shall be applied by a multidisciplinary project team with recognised environmental competencies, supported by management, and involving all corporate functions likely to be impacted (e.g. R&D, Design Office, Purchasing, Manufacture, Logistics, Marketing, etc.).

Management of the enterprise shall be involved at the key steps of the methodology, especially when ranking the design options. It shall ensure the availability of resources essential to implement the project.

NOTE The team concept is used with the purpose of combining different competencies and functions, and does not necessarily require different physical persons.

4.2 Description of the methodology

4.2.1 General

The methodology described in this document is based on the five steps set out below, which are also part of the design and development process (see Figures 3 and 4), and which shall be applied successively:

— Step 1: determination of the scoring of the environmental aspects of the reference product,

— Step 2: selection/ranking of design options,

— Step 3: choice of suitable DO end EA indicators related to the reference product,

— Step 4: evaluation of the redesign using DO and EA indicators,

— Step 5: final assessment and consideration for future activities.

The objective of each step is described in 4.2.2 to 4.2.5, where the procedure which shall be followed is stated (written as direct instructions).

The output documents of each step are input for the next step and shall be validated by the project team before going to this next step.

NOTE In this document, “methodology” is used for the overall approach of reducing environmental impacts; “method” is used for specific tasks, such as indicator calculation.

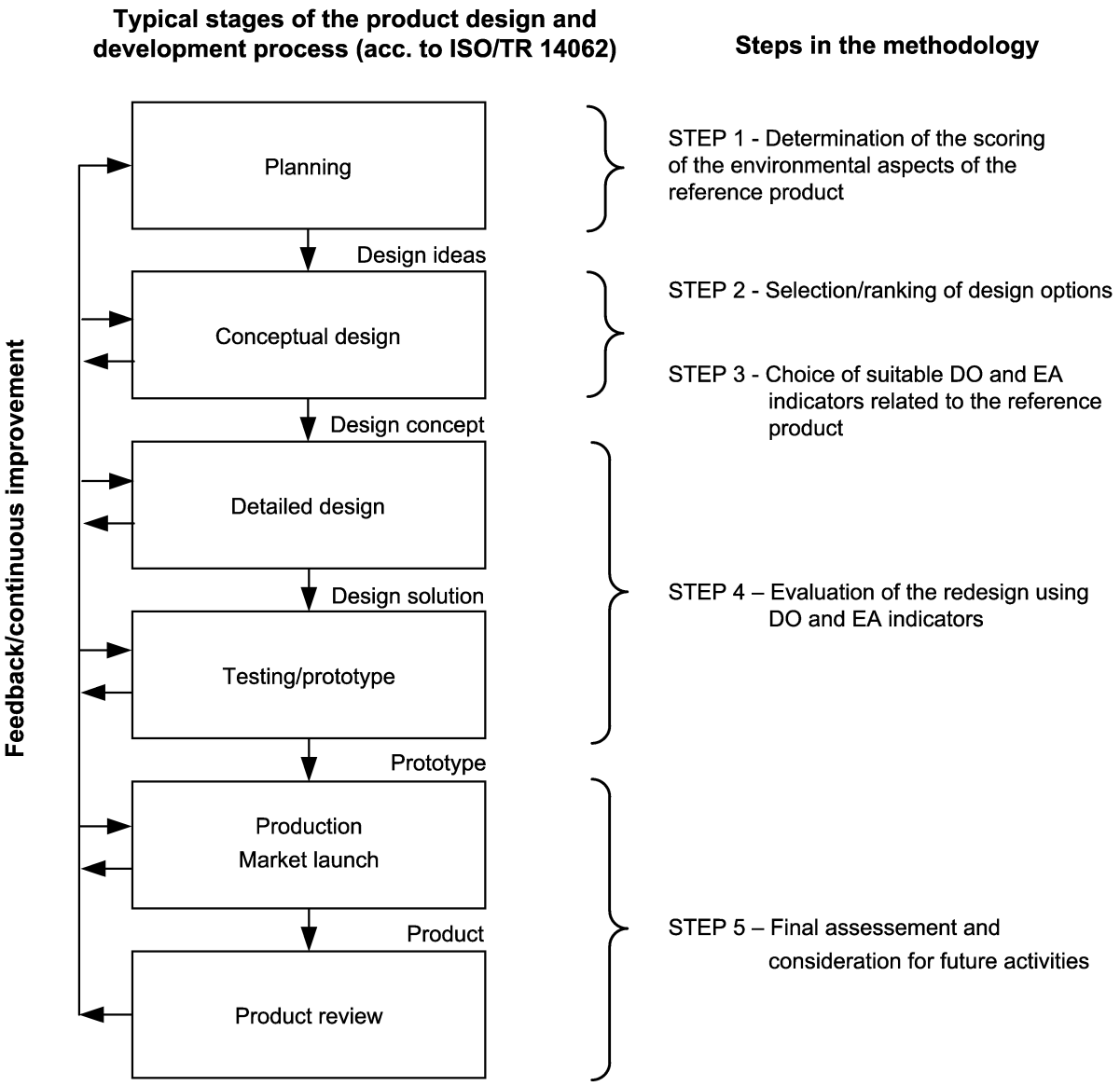


Figure 3 — Interrelation of the methodology with the design and development process

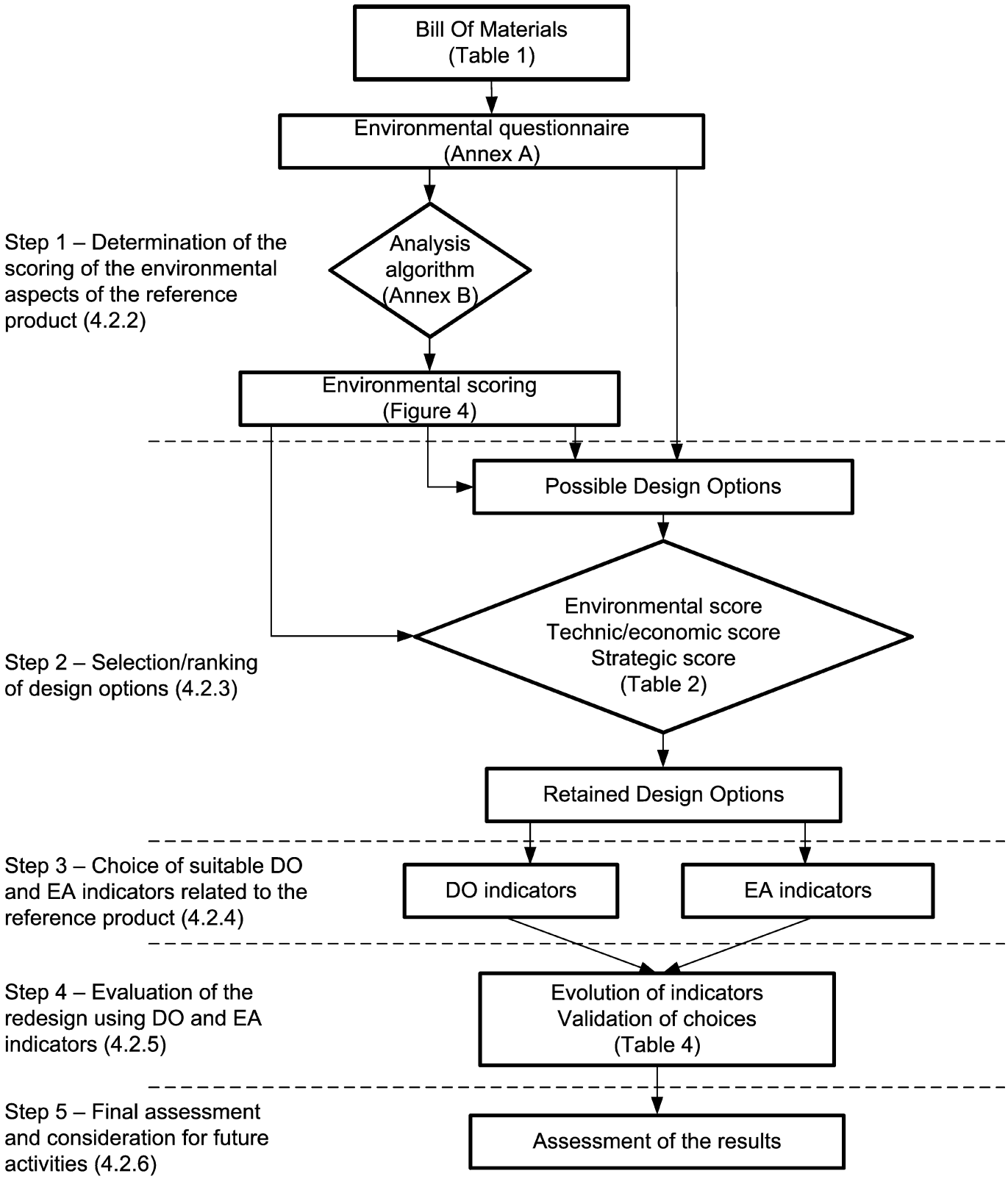


Figure 4 — Schematic illustration of the methodology

4.2.2 Step 1: determination of the scoring of the environmental aspects of the reference product

4.2.2.1 Objective

This step shall make it possible to determine the scoring of the environmental aspect (SEA) of the reference product which will be the base line for further improvements, i.e. to rank the seven environmental aspects listed below according to their relative importance for the environmental impact of the product:

— Raw materials (RM): aspect relating to the choice of materials, components (purchased), and fluids used in the product composition (excluding packaging).

— Manufacturing (M): aspect relating to all the processes required to develop/manufacture the complete product (excluding packaging), internally and externally (number of parts, "polluting" operations, etc.).

— Use (U): aspect relating to all the resources required to use the product (energy consumption, type of energy source, influence on energy consumption within an assembly, product requiring consumables, servicing, product lifetime, etc.).

NOTE 1 This aspect combines the phases "installation and maintenance" and "use" of the 2009/125/EC Directive.

— End-of-life (PEL): aspect taking account of the reduction of the product impact at end-of-life and of its recyclability rate.

— Hazardous substances (S): aspect relating to substances contained in a product likely to be regulated by European legislation (for instance, heavy metals classified as hazardous or flame retardants classified as hazardous).

NOTE 2 The phase "End-of-life" of the 2009/125/EC Directive is split into two aspects: end-of-life and hazardous substances.

— Transport and distribution (T): aspect relating to the geographic distribution (regional, national, European, worldwide) of the number of suppliers and subcontractors, shipment volumes, etc.

— Packaging (Pkg.): aspect taking into account the amount, reuse, recyclability, biodegradability of packaging, etc.

NOTE 3 The phase "Packaging, transport and distribution" of the 2009/125/EC Directive is split into two aspects.

NOTE 4 The proposed SEA is not aimed to compare two products, even similar. It is not intended to measure the actual environmental performance of the product.

4.2.2.2 Procedure

4.2.2.2.1 Describe the reference product and the project perimeter:

a) product name (trade designation, project reference, etc);

b) description of the reference product;

c) main technical characteristics of the product;

d) types of markets aimed for the product:

   1) B to B, state the industrial sectors;

   2) B to C;

e) known (stated) expectations from relevant market players in terms of strategies for optimising the environmental impact of the product (see Table C.1 for those strategies and examples of related design options).

4.2.2.2.2 Draw up the Bill Of Materials (BOM) of the product and its packaging, comprising the list of parts, their mass, their material(s), their material recyclability coefficient, the identified hazardous substances, and in case of purchased components, the supplier name and location. A proposed template is given in Table 1.

NOTE 1 In case of design of a new product, the BOM of a similar product can be used as reference for the analysis.

Decompose the product and its components up to the necessary level to represent:

— the recyclability rate (refer to question QB9 in Table A.1);

— the number of parts (refer to question QB1 in Table A.1);

— the knowledge of possible hazardous substances (refer to question QB10 in Table A.1).

For assemblies and other components that are not broken down to their most elementary level, such as purchased components, assess the number of parts, nature and quantity of materials from technical data sheet and maintenance notice, or by asking the supplier.

NOTE 2 Without this information, the component will be considered as one single non-homogeneous material, and thus will penalise the recyclability rate.

For fasteners, count one single part per type of fastener of the same material.

For products with a high number of parts (e.g. more than 100), in order to optimise the time needed to create the BOM, the decomposition into parts can stop at subassembly level; in such cases, the subassembly may be decomposed into homogeneous materials rather than parts; columns 2 to 4 of Table 1 are not filled.

NOTE 3 For such products, the relevance of meeting the exact numbers/masses of the parts diminishes regarding its impact on the results of the environmental questionnaire D.2.3 and the analysis algorithm D.2.4.

Coating including painting can be counted as a separate part to pay specific attention to its environmental impact.

Table 1 — Example of Bill of Materials

Product											
Part	**Amount of constituent subparts of a part** ***n***	**Quantity of parts in the product** ***N***	**Total number of parts** ***N·n***	**Unit mass** ***m*** **(kg)**	**Total mass** ***N·m*** **(kg)**	**Material**	**Material recyclability coefficient** [a] ***r***	**Mass of recyclable material** ***N·m·r*** **(kg)**	**Identified hazardous substance**	**Supplier name** [b]	**Supplier location** [b]
Total			**Σ *N·n* =**								
Total product mass [c] **M_{tot} (kg) =**		**Identified mass of the product, (kg) Σ *N·m* =**									
% identified mass of the product = %		**Identified product recyclability rate, T_r** [d] **=**									
Packaging											
Part	**Amount of constituent subparts of a part** ***n***	**Quantity of parts in the product** ***N***	**Total number of parts** ***N·n***	**Unit mass** ***m*** **(kg)**	**Total mass** ***N·m*** **(kg)**	**Material**	**Material recyclability coefficient** [a] ***r***	**Mass of recyclable material** ***N·m·r*** **(kg)**	**Identified hazardous substance**	**Supplier name** [b]	**Supplier location** [b]

a Recognised (standardized) recyclability coefficient for the given material, or the estimated recyclability rate stated in this subclause.
b In case of purchased parts.
c Measured value of the product mass.
d Estimated rate using a recognised (standardized) formula for the given product, or the simplified formula stated in this subclause, excluding packaging.

When no recognised formula and data are available for the recyclability rate of the reference product, use the following simplified formula:

$$T_r = \frac{\left(\sum N \cdot m \cdot r\right)}{M_{tot}} \cdot 100\ \% \quad (1)$$

where

T_r is the estimated recyclability rate (expressed in %);

M_{tot} is the measured value of the total product mass (excluding packaging) (expressed in kg);

N is the quantity of parts in the product;

m is the unit mass of a part (expressed in kg);

r is the material recyclability coefficient, with the following estimated values, except specific data known by the enterprise:

r = 1 for metallic materials,

r = 0,3 for plastic materials,

r = 0,8 for parts made of several unidentified metals,

r = 0,5 for parts made mainly of metals, plus 1 or 2 other non metallic materials,

r = 0 for parts made of several plastics, for dual parts or metallic parts encased with plastics, for electronic components, for composite materials and elastomers,

r = 1 for glass.

NOTE 4 An example is given in Annex D.

NOTE 5 This simplified formula can be used as DO or EA indicator, subject to be based on specific data for *r*.

4.2.2.2.3 Complete the environmental questionnaire stated in Annex A, answering all the questions using the choices given in the questionnaire only (the answer "don't know" is ranked the most unfavourable) and justify your answers where applicable. These answers are used to produce the reference product's SEA from the algorithm given in Annex B and also to provide input to the enterprise's thinking on design options and on the overall assessment.

4.2.2.2.4 Apply the analysis algorithm given in Annex B based on the answers to the questions (the reference of the question from Annex A is identified on the algorithm).

4.2.2.2.5 Register the scores (1 to 4) obtained for each environmental aspect.

NOTE 1 At this stage of the methodology, it is important to understand that the obtained SEA gives a description of the most important environmental aspects to consider during the eco-design of the product, even if these aspects are already partly considered by the enterprise. This SEA is not aimed to identify strong and weak points of the product.

EXAMPLE 1 A product is made of renewable RM; however, the score for RM environmental aspect is at level 4 in the SEA. This score of 4 means that RM aspect plays a very important role in the global SEA of the product, compared with the other aspects. If enterprise has already chosen renewable RM, it shows that this choice was relevant and it will be possible to take advantage of it when ranking the design options (see 4.2.3.2), but this choice does not modify the SEA.

EXAMPLE 2 A product has a very low energy consumption compared with another product of the product line; however, the score for the environmental aspect U is at level 4 for both. The score of 4 means that U aspect (related to energy consumption) plays a very important role in the SEA of both products, compared with the other environmental aspects. This score does not allow the conclusion that one of both products is more energy-efficient. For that, the use of indicators is necessary (see 4.2.4).

NOTE 2 These scores can be given in graph format (see Figure 5).

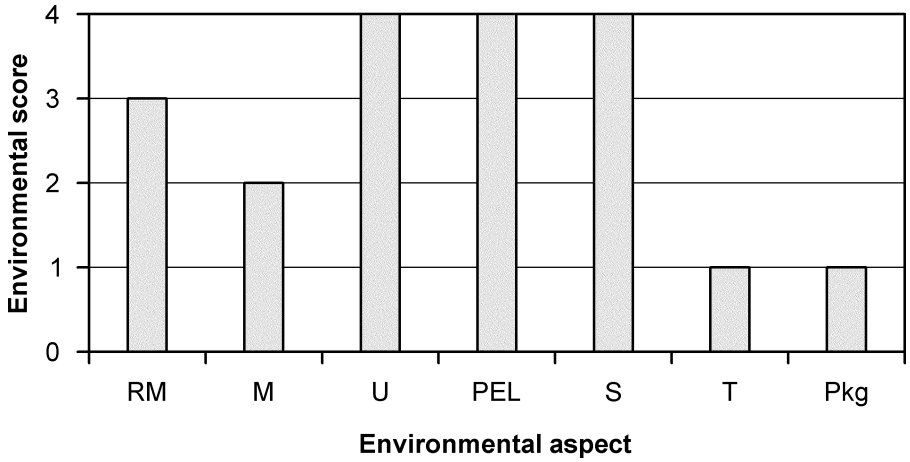


Figure 5 — Example for recording the result of scoring of the environmental aspects

4.2.2.3 Documentation of Step 1

The following documents shall be available as result of Step 1:

— BOM of the reference product;

— completed questionnaire;

— SEA of the reference product.

They have to be used as input for Step 2.

4.2.3 Step 2: selection/ranking of design options

4.2.3.1 Objective

For each environmental aspect derived from Step 1, relevant design options (DO) on how to improve the product's environmental performance shall be selected and ranked, taking into account the other technical, economic and strategic constraints relating to the design project.

4.2.3.2 Procedure

4.2.3.2.1 Using Annex C, select, for each environmental aspect, the design options (DO) that are most relevant to the reference product's SEA and register these options as specified in Table 2.

The DO proposed in Annex C are general design options. The enterprise should reconsider these general options and adapt them (where necessary) to be appropriate for the product under study.

4.2.3.2.2 Rank the design options (DO) by weighting them using the environmental, technical/economic and strategic scores, as stated in Table 2.

NOTE 1 Technical/economic score allows to prioritise the design solutions which confer to the product good environmental performances. When a product characteristic is already very good, possible action to improve it is low. This does not contradict the fact that this environmental aspect is relevant and should not be downgraded; consequently, the corresponding DO is relevant from a technical perspective.

NOTE 2 Consistency between enterprise strategy and environmental DOs is a key factor of the methodology. It makes it necessary to engage and involve the top management of the enterprise to ensure appropriate support when the essential design choices are made.

4.2.3.2.3 Decide which DOs shall be retained. For each EA with a significant environmental score, retain those DOs which have a higher final score.

NOTE A number of three DOs is considered to be reasonable.

Table 2 — Selection and ranking of design options

EA	STEP 2						STEP 3	STEP 4
	Design option (DO)	Environmental score [a]	Technical/ economic score [b]	Strategic score [c]	Final score [d]	Design option retained [e]		

[a] Allocate each DO with the environmental score (0 to 4) as obtained from the SEA.

[b] Allocate each DO with a technical/economical score (0 to 4) defined as follows:
0: improvement direction not technically feasible; not compatible with customer specifications;
1: DO that creates no conflict from a technical perspective, but the improvement directions could conflict with other major constraints (large-scale investments, safety, etc.);
2: improvement direction likely to be considered, but preliminary R&D studies required; medium to long-term;
3: existing technical solution; feasibility to be tested; fairly high implementation cost;
4: solution that can be rolled out to a short timescale and at an acceptable cost, or solution already rolled out by the enterprise, or product characteristic that the enterprise wants to promote.

[c] Allocate each DO with a strategic score (1 to 3) defined as follows:
1: solution that conflicts with other enterprise strategic directions or with market expectation;
2: solution of "neutral" strategic importance but that offers certain advantages in terms of brand image (in relation to other business sectors, stakeholder demands, etc.);
3: solution with a top-ranking strategic advantage (regulations/specifications/customer requests, savings on certain steps in the life cycle, etc.).

[d] Determine the final score for each of the design options by multiplying the 3 previous scores (the project team may adapt the formula by weighting some of the scores, considering that the environmental score shall not be weighted lower than the technical/economical and strategic scores).

[e] Answer by Yes or No.

4.2.3.3 Documentation of Step 2

The following documents shall be available as result of Step 2:

— selection and ranking of considered design options;

— list of design options which have been retained for further consideration.

They have to be used as input for Step 3.

4.2.4 Step 3: choice of suitable DO and EA indicators related to the reference product

4.2.4.1 Objective

Each design option, which has been retained, shall be linked to a qualitative or quantitative indicator, referred to as the "DO indicator" (see examples in Annex C.1), which is used to track the various possible scenarios during the design phase. This indicator may be linked to a quantitative target.

NOTE The target can be determined via market benchmarking, economic consideration, etc.

Each relevant Environmental Aspect (EA) shall also be represented by an indicator called "EA indicator" (see examples in Annex C.2); the objective is to maintain a multi-criteria view by considering all environmental aspects, to avoid a shift of impact (see also NOTE 2 in 4.2.4.2).

4.2.4.2 Procedure

4.2.4.2.1 Define an indicator for each design option ("DO indicator") (examples are given in Table C.1).

NOTE 1 It is not required to characterise every "DO indicator" in quantitative terms. A decision can be taken based on a simple upwards or downwards "trend".

Define an "EA indicator" for each Environmental Aspect. This indicator shall be as representative as possible of the environmental impact of the relevant aspect; it can be chosen from the list of DO indicators (see Table C.1) or specifically defined (examples are provided in Table C.2).

NOTE 2 An "EA indicator" may combine several "DO indicators". If there is only one single Priority Design option for the given Environmental Aspect, the DO indicator may also be used as the EA indicator provided that this indicator is representative of the environmental impact for this particular aspect.

Register the indicator types and names as specified in Table 3.

4.2.4.2.2 Define the methods required to characterise the DO indicators and EA indicators, such as:

— measurement or test methods (with indication of the standard or technical document to be used);

— calculation formula;

— calculation method (with indication of the standard or technical document to be used, and particular application conditions, if any).

Make sure that the methods relating to DO indicators and EA indicators are suitable for the project.

4.2.4.2.3 Determine the values of the indicators on the reference product.

Table 3 — Choice of suitable DO and EA indicators related to the reference product

EA	STEP 2	STEP 3				STEP 4
		Type of indicator (DO or EA)	Indicator name	Related methods	Indicator value of the reference product	

4.2.4.3 Documentation of Step 3

The following documents shall be available as result of Step 3:

— list of selected DO indicators and EA indicators, together with any targets and reasons for the choices;

— list of corresponding methods;

— values of DO indicators and EA indicators for the reference product.

They have to be used as input for Step 4.

4.2.5 Step 4: evaluation of the redesign using DO and EA indicators

4.2.5.1 Objective

Design choices shall be assessed using DO and EA indicators in order to confirm the defined directions, identify any problems (e.g. any potential opposing impact) and propose the necessary actions.

4.2.5.2 Procedure

Throughout the whole design process, consider the chosen design options (during project reviews, for example) and check their relevancy through the DO and EA indicators, taking into account the other product specifications. Once the design option is stabilised, register the indicator values as specified in Table 4.

Record any difficulties relating to use of the methods.

Table 4 — Evaluation of the redesign using DO and EA indicators

EA	STEP 2	STEP 3	STEP 4	
			Indicator value after redesign	Remarks

4.2.5.3 Documentation of Step 4

The following documents shall be available as result of Step 4:

— DO indicators for chosen design options after the redesign of the product;

— EA indicators for environmental aspects after the redesign of the product;

— recording of difficulties related to use of the methods.

They have to be used as input for Step 5.

4.2.6 Step 5: final assessment and consideration for future activities

4.2.6.1 Objective

The results of Steps 1 to 4 shall be assessed considering the following points:

— improvement of product environmental quality – considering both pre and post-design (compliance with indicators for the retained design options, no downgrading of EA indicators);

— implementation of the methodology (organisation, methods, etc.).

NOTE The enterprise can also take advantage of the project to manage the knowledge acquired, so as to be able to reuse it for new projects in the view of building up a set of "routine" practices during the design process. Modifications can be proposed to the design process to allow consideration of the environmental issues.

4.2.6.2 Procedure

4.2.6.2.1 Environmental quality

Characterise changes in DO and EA indicators realised as result of the redesign of the product.

Identify which answers in the environmental questionnaire (see Annex A) have changed, and as result of this whether changes in the product's SEA have appeared.

4.2.6.2.2 Implementation of the methodology

Analyse the reliability and relevance of methods used to implement this methodology (e.g. method to calculate indicators, method to assess the recyclability rate).

Review the design options chosen against the other design options that were not selected for the current project, but could have some potential for the future.

4.2.6.3 Documentation of Step 5

The following documents shall be available at the end of Step 5:

— complete documentation of the project as detailed at the previous steps;

— assessment of the relevance of the methods used and the selected design options.

5 Environmental claim

The manufacturer may decide to benefit from the implementation of this approach by issuing a self-declared environmental claim according to ISO 14021 for the relevant redesigned product(s). The manufacturer is free to decide on the format of this claim (physical marking on the product, label on the product, information included in the product instruction leaflet, etc.).

The content of this claim shall include the following:

— the scope of the claim (complete range of products or unique product, complete product or only a product component or its packaging) and identification of the product such as trade designation or reference;

— a reference to this document: "Product subject to an environmental improvement approach in accordance with CEN/TS 16524";

— a table or diagram summarising changes in DO indicators and EA indicators as result of the redesign. This document shall also state the reference to the methods used for calculating or measuring these indicators (an example is provided in Table 5). The reference product shall be identified (previous company product with a version reference, or Technical Specification with a date, see definition 2.2).

NOTE 1 This claim does not replace the environmental labelling or marking which can be requested by a specific regulation (for instance, consumer products or products covered by the directive ErP).

NOTE 2 For an environmental claim according to this document, it is not required to communicate the complete documentation stated in 4.2.6.3.

Table 5 — Example of documentation of DO indicators and EA indicators (pre and post-redesign)

EA	DO indicator for design option	Value of DO indicator		EA indicator	Value of EA indicator		Calculation or measurement method
		Pre-redesign	*Post-redesign*		*Pre-redesign*	*Post-redesign*	
RM	*Mass (kg)*	*105*	*98*	*CO2 impact for the materials used in the product (kg CO2 eq.)*	*288*	*257*	*Internal method XXX*
..	..	..	..	..	..	..	..

Annex A
(normative)

Environmental Questionnaire

This annex contains the environmental questionnaire (Table A.1) to be completed by the enterprise. This questionnaire is split into two parts: on the left-hand column, the questions/answers which are used to produce the product's SEA from the algorithm given in Annex B (the label of the questions is identified on the algorithm of Annex B); on the right-hand column, other questions which are related to the choice of design options according to Table C.1 (the label of the questions is identified in this table).

Answer all the questions using only the choices given in the questionnaire (the answer "don't know" takes the lowest ranking); justify your answers where applicable.

Table A.1 — Questionnaire *(1 of 7)*

Inputs to the algorithm in Annex B	**Interrelation with the choice of DO in Table C.1**
Environmental assessment	
Raw materials (excluding packaging)	
	QC1) Does your product contain any rare materials [a]? ☐ *Yes* ☐ *Zinc* ☐ *Copper* ☐ *Nickel* ☐ *Lead* ☐ *Silver* ☐ *Tin* ☐ *Other* ☐ *No* QC2) Does your product contain any recycled materials [b]? ☐ *Yes* ☐ *No* ☐ *Don't know* QC3) Does your product contain any renewable materials [c]? ☐ *Yes* ☐ *No*

[a] In the absence of any specific definition for the given industrial sector, materials are considered as rare materials when their known stock is less than 50 years of use at their rate of current consumption.

[b] Material which has been reintegrated into the production process by taking a material reclaimed via a manufacturing process and then re-processed into a finished product, or into a component to be integrated into a product (ISO 14021:1999). It includes materials from manufacturing waste, also called pre-consumer material, as well as materials from products at end of life, also called post-consumer material.

[c] Material which can be restocked in a short timeframe, at human scale and at a an interval at least equal to their rate of consumption (animal, plant production, etc.). Petrol, natural gas and metal ores are all non-renewable resources, as is water which has a cycle that can largely exceed a human lifetime.

Table A.1 — Questionnaire *(2 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
Manufacture [d] (excluding packaging)	
QB1) How many parts does your product contain [e]? ☐ *≤ 100* ☐ *> 100*	QC4) Of all the manufacturing operations covering the product and its components, is the greatest number of operations presenting an environmental risk [f] performed: ☐ *Mostly at suppliers and subcontractors* ☐ *Mostly at internal manufacturing site* QC5) Does the manufacture process use substances subject (or candidate) to authorisation? ☐ *Yes, give details* ☐ *No*
Use	
QB2) Does your product need energy for its intended use? ☐ *Yes* ☐ *No*	QC6) If yes, what type of energy does it use (direct product power source)? ☐ *Electricity* ☐ *Primary energy (petroleum products, gas, etc.)* ☐ *Alternative source* ☐ *Renewable* ☐ *Reclamation process* ☐ *Other*
QB3) Is your product intended to be integrated into a larger assembly (vehicle, hydraulic circuit, refrigeration system, machinery, etc.)? ☐ *Yes* ☐ *No*	
QB4) If your product is integrated into a larger assembly (equipment, machine, etc.), is it likely to modify the normal operating performance of this assembly (efficiency [g] lifetime, etc.)? ☐ *Yes* ☐ *No*	
QB5) If your product is integrated into an assembly, what is its lifetime compared with this assembly (for normal operating, according to the recommendation of use)? ☐ *Longer lifetime* ☐ *Similar lifetime* ☐ *Shorter lifetime or don't know*	

[d] Manufacturing includes material working and treatment as well as the assembly of products and components. It does not take into account raw materials digging and making.

[e] Information obtained from the BOM ($\Sigma\ N{\cdot}n$).

[f] Operation that generates emissions in the air, water or ground that present a risk to the environment, or that generates hazardous waste and/or that is highly energy intensive (e.g.: operations involving heat treatments, surface treatments, degreasing, lubricated machining, etc.).

[g] Example: a tire is a component which has effect on the energy consumption of a machinery due to its rolling friction (coming from overheating); a gas-loaded accumulator installed in a hydraulic circuit of a mobile machinery saves energy from braking and restores it for starting.

Table A.1 — Questionnaire *(3 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
Use *(continued)*	
QB6) Does your product operate with consumables [h] (fluids, seals, etc.) or is it used to apply another product (paint, liquid fertiliser, adhesive, etc.) or does it need to be regularly maintained with specific products during its use phase (example: cleaning products)? ☐ *Yes* ☐ *No*	*Give details* QC7) If yes, does this use generate: C7a) waste [i] ☐ Yes ☐ *Hazardous* [j] ☐ *Non-hazardous* ☐ *No* C7b) emissions or leakages (to air, water or ground) ☐ Yes: Draw up a list of these emissions and identify those that present a risk to the environment: ☐ *Air* ☐ *Greenhouse gas (CO_2, methane, HFC, etc.)* ☐ *Sulphur oxides (SOx)* ☐ *Nitrogen oxides (NOx)* ☐ *VOC* [k] ☐ *Carbon monoxide (CO)* ☐ *Particles* ☐ *Other* ☐ *Water* ☐ *Heavy metals* [l] ☐ *Hydrocarbons* ☐ *Nitrates* ☐ *Phosphates* ☐ *Nitrogen compounds* ☐ *PCB* ☐ *Other* ☐ *Ground* ☐ *Heavy metals* [m] ☐ *Hydrocarbons* ☐ *Halogen-containing substances* ☐ *Other* ☐ *Other* ☐ *No*

[h] Product, element or substance required for operation, with a limited life to be renewed or replaced (e.g. battery, oil filter, printer cartridge, etc.).

[i] Waste being considered is any residue from a process involving production, processing or use; any substance, material, product or, more generally, any movable property that has been abandoned or that its owner intends to abandon.

[j] See the European Waste Catalogue (EWC) – Annex to Decision 94/3/EC.

[k] As defined in directive 1999/13/EC.

[l] Main hazardous heavy metals for aquatic environment : Ag, Al, As, Cd, Cr VI, Cr III, Cu, Fe, Hg, Ni, Pb, Sn, Zn.

[m] Main hazardous heavy metals for ground : As, Cd, Cr, Cu, Hg, Ni, Pb, Zn.

Table A.1 — Questionnaire *(4 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
Use *(continued)*	
QB7) What is the lifetime of your product? State, where applicable, the unit and ranges of associated values considering equivalent products on the market ☐ *0-2 years or X cycles of operation* ☐ *2-5 years or X cycles of operation* ☐ *> 5 years.* QB8) Is your product (several possible answers): ☐ *Single use (cartridge for cartridge-operated fixing tool, etc.)* ☐ *Occasional use (lawn-mower, etc)* ☐ *Frequent Intermittent or Continuous use (pump, machine tool, etc.)*	QC8) Does the product require preventive maintenance during normal operation throughout its lifetime? ☐ *Yes – Give details* ☐ *No*
Product end-of-life (excluding packaging)	
QB9) Indicate the product's estimated recyclability rate [n] ☐ $r < 80\ \%$ ☐ $80\ \% \leq r < 90\ \%$ ☐ $r \geq 90\ \%$	QC9) Does your product include components or sub-assemblies which can be re-used at the end of life of the product? ☐ *Yes – Give details* ☐ *No* QC10) If your product includes components or sub-assemblies which can be re-used at the end of life of the product, is your company organised to collect these used components or subassemblies for retro-fitting? ☐ *Yes* ☐ *No* QC11) How is maintenance considered during product design? ☐ By replacement of product parts ☐ By making repair easy ☐ By instructing the user on correct use ☐ Other

[n] Information obtained from the BOM.

Table A.1 — Questionnaire *(5 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
Hazardous substances	
QB10) Does your product contain any electric or electronic components [o]? ☐ *Yes* ☐ *No* QB11) According to your knowledge, does your product (product / components / packaging) contain [p] any of the following: B11a) Metals or derived metallic elements, classified as hazardous (such as regulated metals: lead, mercury, cadmium, chromium 6)? ☐ *Yes or don't know* ☐ *No* B11b) Flame retardants classified as hazardous [q] ☐ *Yes or don't know* ☐ *No* B11c) Halogenated materials ☐ *Yes or don't know* ☐ *No* B11d) Other [r] hazardous regulated or at-risk substances on the market? ☐ *Yes or don't know* ☐ *No*	
Transport	
QB12) Give the geographic distribution of your direct suppliers of materials, parts and components, and of your subcontractors, as a percentage of their volume (number or mass of purchased products) (Total = 100%): ☐ *Regional : …%* ☐ *National : …%* ☐ *European : … %* ☐ *Worldwide : … %*	QC12) Give the geographic distribution of your shipments, as a percentage of their volume (number or mass of sold products; total = 100 %): ☐ *Regional : %* ☐ *National : …%* ☐ *European : … %* ☐ *Worldwide : … %*

[o] Electric and electronic components can contain several substances considered as hazardous by Regulation 1272/2008.

[p] Regarding its materials, alloy elements, coatings, surface treatments, inks, dyes, additives, substances used in the manufacturing process of the product are not considered.

[q] Plastics used in industry can contain flame retardants considered as hazardous.

[r] Example: phtalates in toys, azo dyes, nickel, etc. See also the Regulation EC 1907/2006 (REACH) and the list of substances subject to authorisation (http://echa.europa.eu).

Table A.1 — Questionnaire *(6 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
Packaging	
QB13) Is the product delivered to the client in packaging [u]? ☐ *Yes* ☐ *No* QB14) If the product is delivered in packaging, is this packaging recyclable? ☐ *Yes, 100%* ☐ *Yes, partly* ☐ *No*	QC13) Is your purchase packaging: C13a) reusable [s]? ☐ *Yes, 100%* ☐ *Yes, partly* ☐ *No* C13b) recyclable [t]? ☐ *Yes, 100%* ☐ *Yes, partly* ☐ *No* C13c) If the packaging is recyclable, is a sorting process for recycling carried out? ☐ *Yes* ☐ *No* QC14) Is packaging for grouping and transport (pallet, plastic film-wrap, shuttle boxes, etc.): C14a) Reusable? ☐ *Yes, 100%* ☐ *Yes, partly* ☐ *No* C14b) Recyclable? ☐ *Yes, 100%* ☐ *Yes, partly* ☐ *No* QC15) Specify other characteristics of the packaging ☐ *Number of packaging materials, biodegradable materials* [v] *…* ☐ *Number of packaging components, reusable components, …*

[s] Characteristics of a packaging to accomplish within its life cycle a minimum number of trips or rotations, for the same purpose for which it was conceived.(see EN 13429).

[t] Characteristic of a packaging that can be picked from the waste flow by the available processes and programmes, and which can be collected, processed and returned to use in the form of a raw material. (see EN 13430).

[u] Sales packaging or primary packaging, i. e. packaging conceived so as to constitute a sales unit to the final user or consumer at the point of purchase (see Directive 94/62/EC).

[v] A material is considered to be biodegradable when it can be 100% biodegraded, i.e. converted totally into carbon dioxide and/or methane, water and biomass.

Table A.1 — Questionnaire *(7 of 7)*

Inputs to the algorithm in Annex B	Interrelation with the choice of DO in Table C.1
European legislation	
▪ WEEE Is your product covered by Directive 2012/19/EU governing waste electrical and electronic equipment (WEEE)? ☐ *Yes* ☐ *No* ▪ RoHS Is your product covered by Directive 2011/65/EU governing the restriction on the use of hazardous substances (including indirect use in the form of a component of a system covered by this directive)? ☐ *Yes* ☐ *No* ▪ End-of-life vehicles (ELV) Is your product covered by Directive 2000/53/EC governing end-of-life vehicles (including indirectly in the form of a component of a system covered by this directive)? ☐ *Yes* ☐ *No* ▪ ErP Is your product subject to any execution measure under Directive 2009/125/EC governing the eco-design of energy related products? ☐ *Yes* ☐ *No*	▪ Packaging Is your product delivered as a packaged product and covered by Directive 2004/12/EC governing packaging? ☐ *Yes* ☐ *No* ▪ Other regulations (in particular, regulations for placing "products" on the market) Is your product subject to any other regulation covering one or more environmental aspects? ☐ *Yes – Give details* ☐ *No*

Annex B
(normative)

Analysis algorithm

This annex provides the analysis algorithm to be applied to Step 1 in order to rank environmental aspects, based on the answers to the environment questionnaire from Annex A (question numbers are identified on the algorithm). When the product is subject to European legislation covering one or more of the seven environmental aspects, this aspect takes priority status and its score shall be adjusted to 4 as stated in table B.1. The aim is to ensure that European legislation is systematically considered in the projects as priority aspects, whatever the environmental score of this aspect.

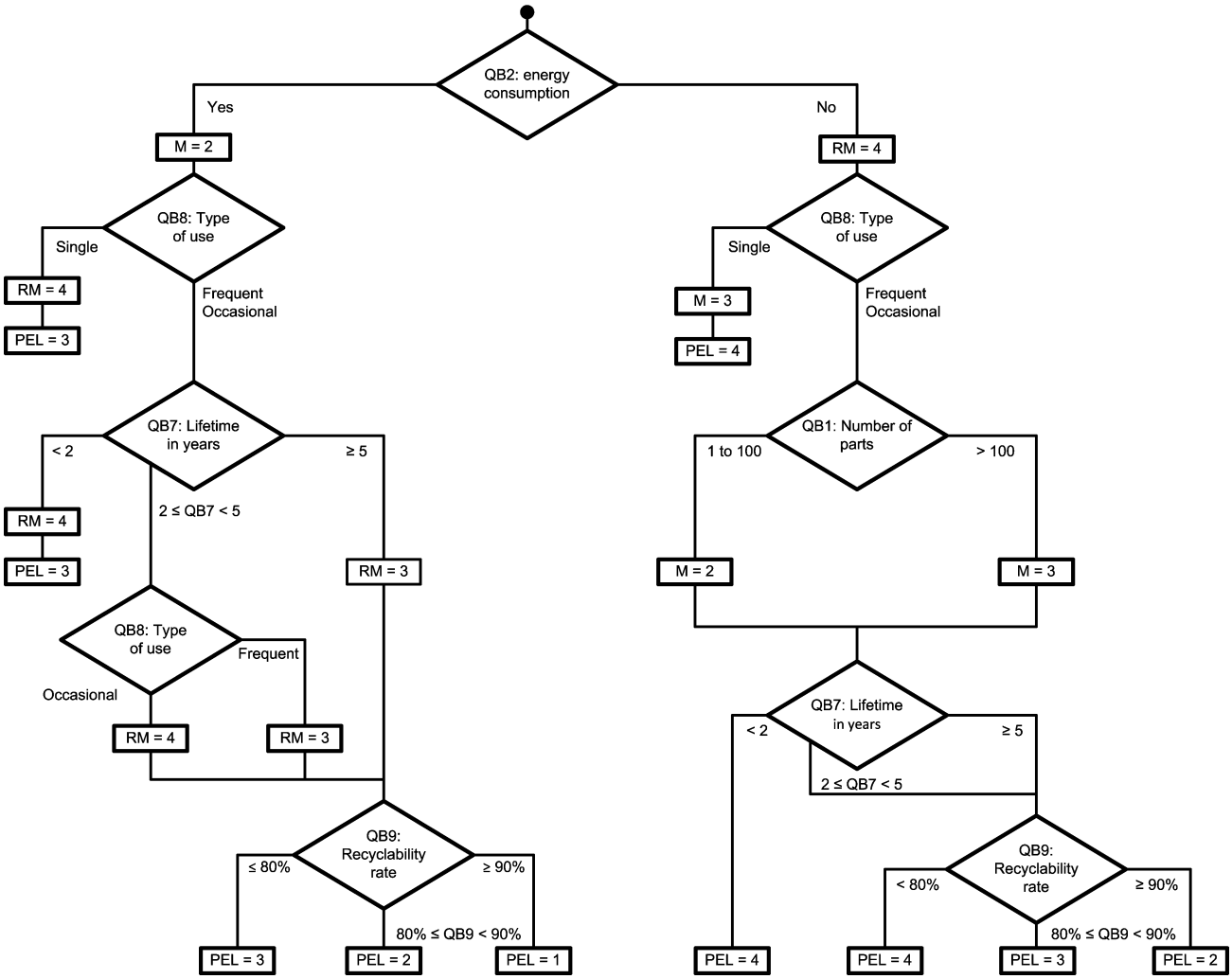


Figure B.1 — Algorithm for assessing the environmental aspects RM, M and PEL

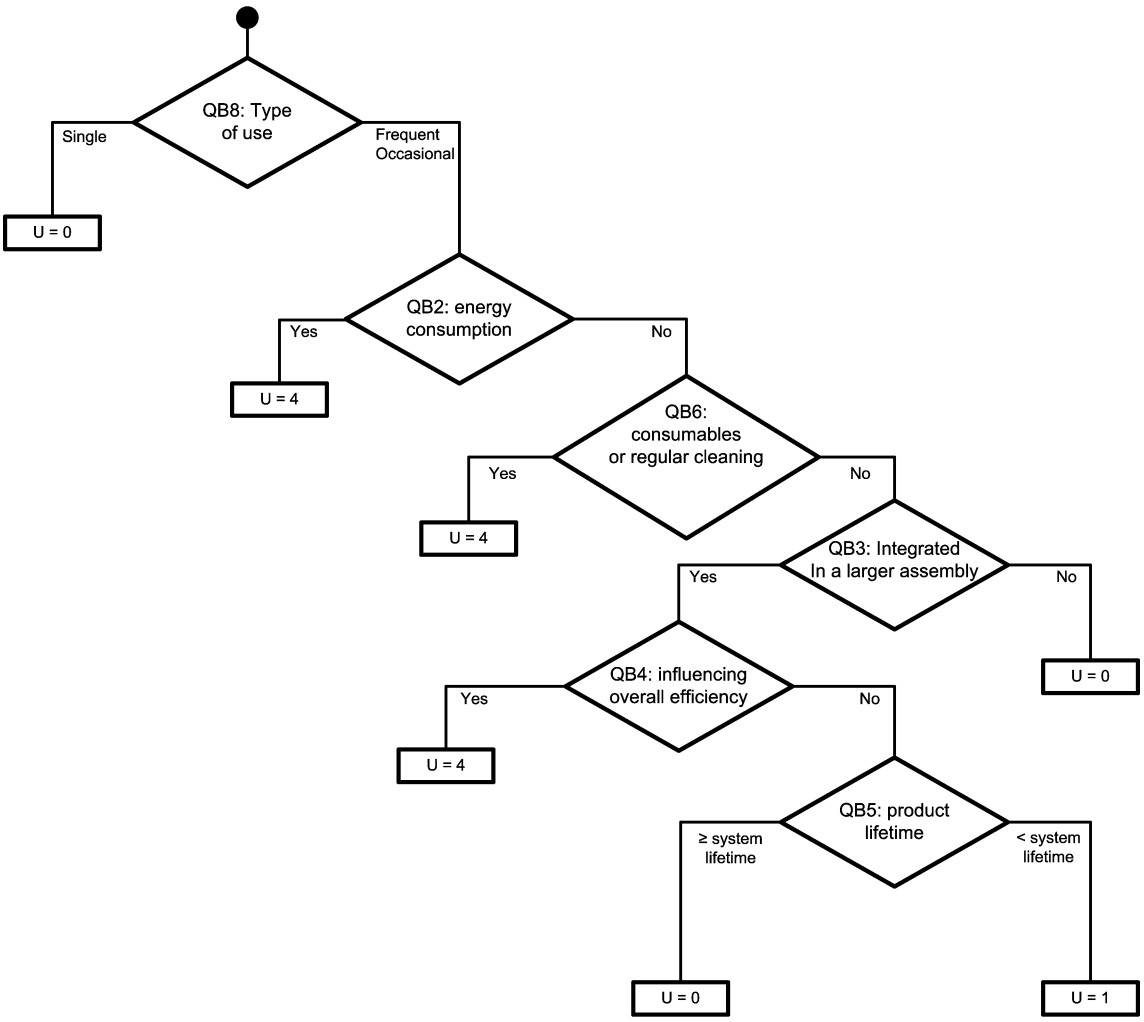


Figure B.2 — Algorithm for assessing the environmental aspect U

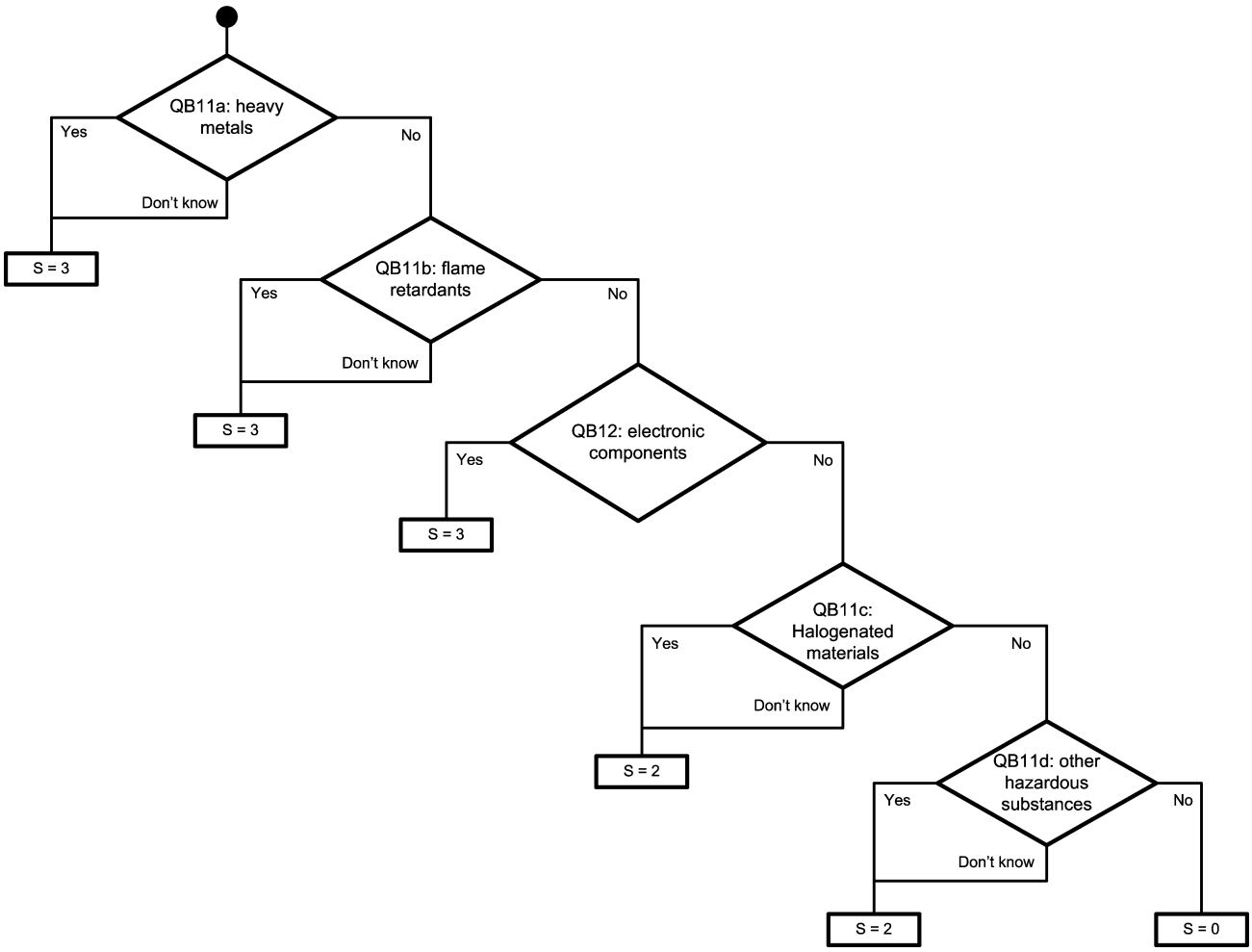


Figure B.3 — Algorithm for assessing the environmental aspect S

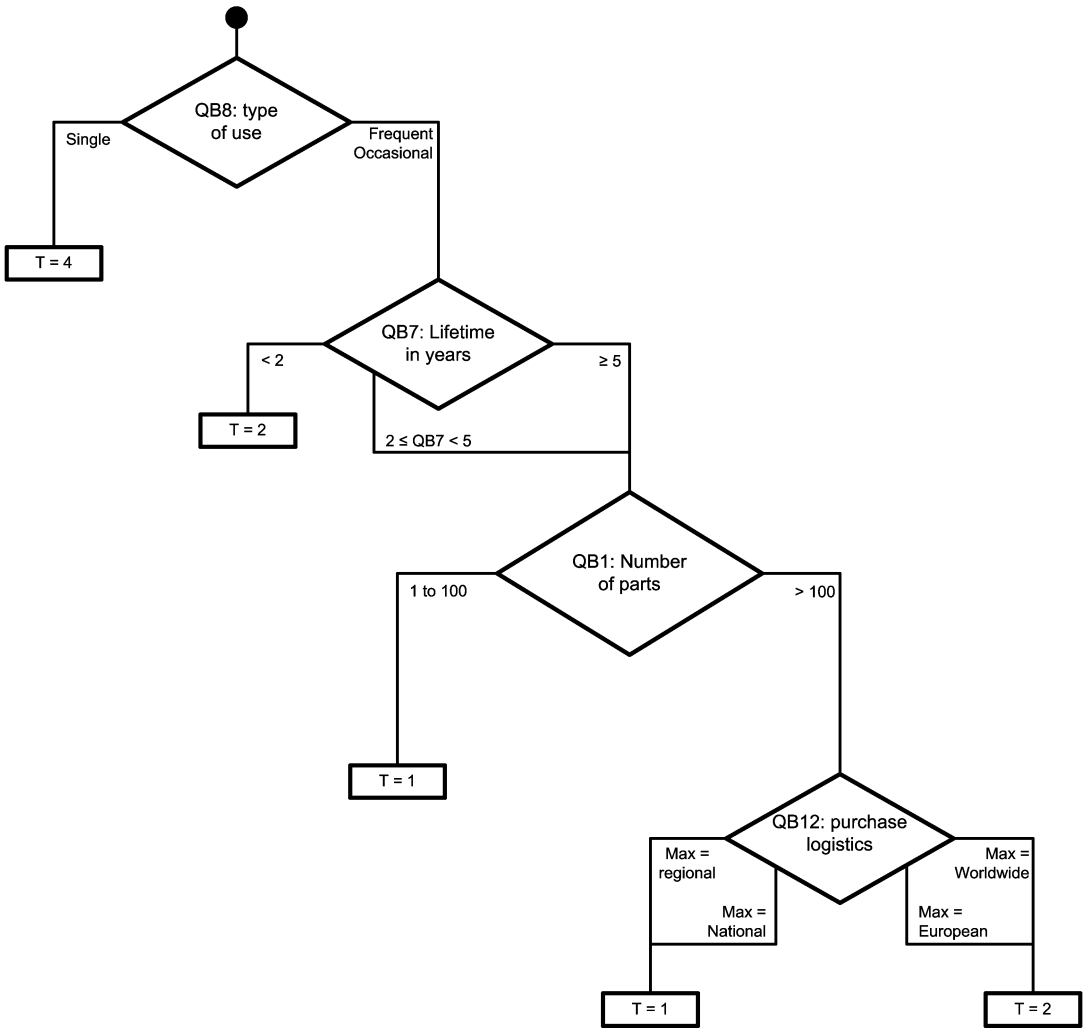


Figure B.4 — Algorithm for assessing the environmental aspect T

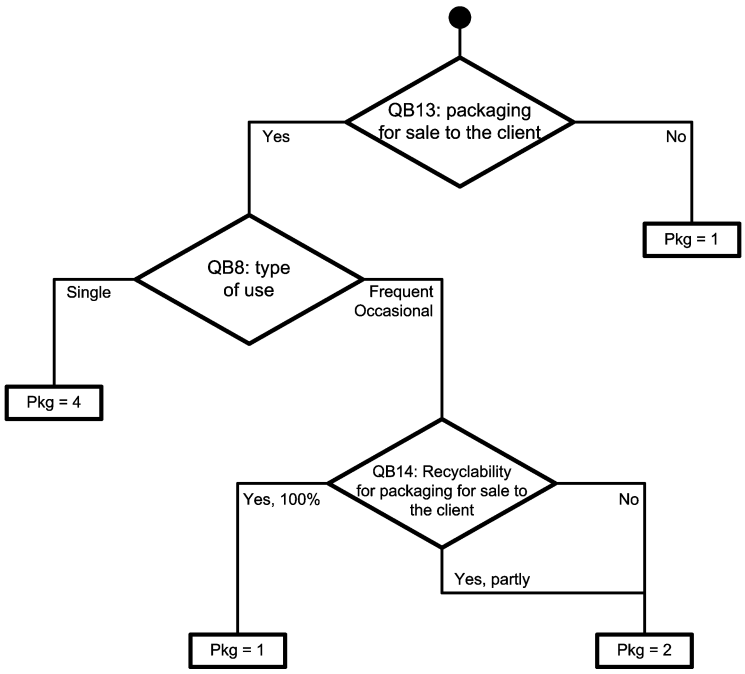


Figure B.5 — Algorithm for assessing the environmental aspect Pkg

Table B.1 — Adjustment of the scoring regarding specific rules linked to European legislation

The product is covered by Directive 2012/19/EC governing waste electrical and electronic equipment (WEEE).	PEL = 4
The product is covered by Directive 2011/65/EU governing the restriction on hazardous substances (RoHS) (including indirectly).	S = 4
The product is covered by Directive 2000/53/EC governing the end-of-life vehicles (ELV) (including indirectly).	PEL = 4 and S = 4
The product is subject to execution measure under Directive 2009/125/EC governing the eco-design of energy related products (ErP)	No adjustment needed; already taken into account by the algorithm (U=4 for answer yes to QB2 "energy consumption" and QB4 "modification of the efficiency of a larger assembly")

Annex C
(informative)

Examples of design options for environmental improvement of the product, and associated DO indicators and EA indicators

This annex provides in Table C.1 a summary of the strategies that can be deployed for each environmental aspect, and identifies some general design options (giving the question numbers from the environmental questionnaire, where applicable).

When choosing design options from Table C.1, potential negative impact, which is not stated in this table, needs to be taken into account (e.g. for the Design Option " Use materials with the lowest carbon footprint", some alternative materials with better carbon footprint can include hazardous substances or can have a negative effect on the manufacturing process).

Examples for associated indicators are also given (DO indicators in Table C.1 and EA indicators in Table C.2).

Table C.1 — Examples for design options and associated DO indicators *(1 of 5)*

Environmental aspects	Strategies	Example of design options[a]	Example of DO indicators
Raw materials (RM)	Select suitable materials with the lowest environmental impact	Use materials with the lowest carbon footprint	CO_2 content (kg CO_2 equivalent)
		Use renewable materials *(QC3)*	Number, mass, % of renewable materials
		Use recycled materials *(QC2)*	Number, mass, % of recycled materials
		Use recyclable materials	Number, mass, % of recyclable materials
		Use materials with the lowest possible energy content	Total energy content (MJ/product) or per material (MJ/kg of material)
	Minimise use of materials (*QC1*)	Reduce mass	Mass (kg)
		Reduce volume	Volume (l, m^3)

[a] The design options are considered according the intended use of the product, as specified by the manufacturer.

Table C.1 — Design options and DO indicators *(2 of 5)*

Environmental aspects	Strategies	Example of design options[a]	Example of DO indicators
Raw materials (RM) *(continued)*	Develop new concepts	Plan shared use of the product: one product for multiple users replacing several products, in total less material	Average use rate (hours of product use per day) Number of people with access to the product (person/product)
		Integrate additional product functions related to the intended use of the product, in total less material to cover a certain amount of functions	Number of functions per product
		Optimise product functions, minimise the number of components	Number of functions per product or per component
		Consider re-use of parts or retro-fitting	Ratio of number of re-usable parts against total number of parts
Manufacture (M)	Optimise manufacturing techniques *(QC4-QC5)*	Use alternative manufacturing technologies (BAT: Best Available Techniques)	Number of on-site BAT per product % of BAT per product / total number of on-site processes Number, % of BAT per product / number of processes throughout the product life cycle
		Limit the number of manufacturing steps	Number of on-site production steps Number of manufacturing steps along the supply chain
		Minimise energy consumption	Energy consumption for the manufacture of a product (kWh or MJ / product)
		Opt for renewable energy solutions	% kWh renewable energy / kWh total energy Quantity of greenhouse gas (t eq CO_2) / product
		Minimise the quantity of waste	Total mass of waste (kg) / product Mass or % of hazardous industrial wastes and non-hazardous industrial wastes/product
		Minimise consumables	Total mass of consumables (kg) per product
		Choose consumables with lower inherent environmental impact	% of reduction of the environmental impact due to consumables
	Set up good management practices	Encourage suppliers and subcontractors to apply the methodology specified in this document	Number, % of subcontractors having set up an ecodesign approach

[a] The design options are considered according the intended use of the product, as specified by the manufacturer.

Table C.1 — Design options and DO indicators *(3 of 5)*

Environmental aspects	Strategies	Example of design options[a]	Example of DO indicators
Usage (U)	Minimise the environmental impact of product use	Improve the energy performance (consumption / efficiency) of the product – or assembly integrating the product *(QB4)*	Product energy consumption Product energy efficiency, load losses, etc.
		Use less polluting energy sources *(QC6)*	Quantity of greenhouse gas emitted during use Use of renewable energy: yes / no
		Minimise the quantities of consumables *(QB6)*	Total mass of consumables (kg) per product Consumable use efficiency
		Use less polluting consumables *(QC7)*	Number, mass, % of polluting consumables per product
		Minimise emissions (including noise emissions) and the quantities of waste generated by the product *(QC7)*	Quantity, % of polluting emissions generated throughout the product life cycle Quantity, % of waste generated throughout the product life cycle
		Encourage correct use of the product *(QC11)*	% of proper use of the product among users
	Optimise product lifetime	Improve product durability and reliability *(QB5-QB7)*	Programmed product lifetime Effective product lifetime
		Facilitate product servicing and repairs *(QC8)*	Rate of products effectively repaired Time between two servicing operations Repair times Repair and servicing costs for each product lifetime
		Work on the product's modular structure and its adaptability	Number, % mass of interchangeable modules/product
		Minimise the product's overall dimensions	Overall product volume
		Strengthen the product – user link	User satisfaction rate Indicator for user-perceived quality

[a] The design options are considered according the intended use of the product, as specified by the manufacturer.

Table C.1 — Design options and DO indicators *(4 of 5)*

Environmental aspects	Strategies	Example of design options[a]	Example of DO indicators
Usage (U) *(continued)*	Develop new concepts	Plan shared use of the product: one product = multiple users	Average use rate (hours of product use per day) Number of people with access to the product (person/product)
		Integrate new product functions	Number of functions per product
		Optimise product functions, minimise the number of components	Number of functions per product or per component
		Design in order to facilitate reuse of the product (robustness, design) *(QC9-QC10)*	Product reuse rate
End-of-life recyclability (PEL)	Improve recyclability (including recoverability) at product end-of-life (see Figure 2)	Design in order to facilitate product disassembly *(QC11)*	Potential product separation rate
		Design in order to facilitate reuse of parts and components (robustness, design) *(QC9-QC10)*	Number, mass, % of reusable parts/components per product
		Design in order to facilitate recycling materials *(QB9)*	% of recyclable materials Product recyclability rate % of material recycling
	Use existing disposal systems	Inform the final user about the existing disposal systems to be used	Statement on the product or in the instructions for use
Substances (S)	Manage hazardous substances *(QB11)*	Minimise or substitute hazardous substances	Number, mass, % of hazardous substances per product
		Facilitate "safe" (less polluting) product incineration	Number, mass, % of materials contributing to the formation of hazardous substances during incineration
		Facilitate "safe" (less polluting) product disposal at a landfill site	Number, mass, % of materials contributing to the formation of hazardous substances during disposal at a landfill site

[a] The design options are considered according the intended use of the product, as specified by the manufacturer.

Table C.1 — Design options and DO indicators *(5 of 5)*

Environmental aspects	Strategies	Example of design options[a]	Example of DO indicators
Transport (T)	Minimise the impact of overall logistics operations	Opt for less polluting means of transport	Rate of less polluting transport means (% t.km) per product
		Minimise product logistics *(QB12-QC12)*	Supply rate per area (local, national, Europe, world) per product Number of km involved from raw materials procurements up putting on the market
	Optimise the product to minimise its impact during transportation	Minimise product mass	Product mass
		Minimise the product's overall dimensions	Overall product volume
		Reduce the quantities, number and mass of packaging *(QC15)*	Number of packagings per product Number of packaging materials per product Mass of packaging per product Volume of the packaged product
Packaging (Pkg)	Minimise the impact of product packaging	Use reusable packaging *(QC13a-QC14a-QC15)*	Rate of reusable packaging Frequency of packaging reuse
		Use less polluting packaging materials (raw material and end-of-life) *(QC13b-QC13c-QC14b-QB14-QC15)*	Rate of recyclable packagings per product Rate of biodegradable packagings per product Environmental impact of packaging materials per product

[a] The design options are considered according the intended use of the product, as specified by the manufacturer.

Table C.2 — Examples of environmental aspect indicators (EA indicators)

Environmental aspects	Examples of EA indicators
Raw materials	- CO_2 impact of product materials - Energy content of product materials - Recycled material content
Manufacture	- Production-related energy consumption per product - Mass of waste per product - Mass of polluting emissions per product (air, water, ground) - CO_2 impact of product manufacture
Usage	- Product energy consumption - Product lifetime - Mass of generated waste - CO_2 impact of product use
Substances	- % of hazardous substances in the product - Conformity of the product to the European legislation
End-of-life recyclability	- Potential or actual recyclability rate - Disassembly time
Transport	- t.km per product - Energy efficiency of transportation means - Efficient use of transportation means (available volume /used volume for transport)
Packaging	- Global environmental impact of packaging materials per product - CO_2 impact of packaging materials per product - % of biodegradable packaging materials
NOTE Some sources for EA indicator calculation are given in the Bibliography.	

Annex D
(informative)

Example of implementation of the methodology

D.1 General

This annex illustrates the application of the methodology described in this Technical Specification to a single-stage centrifugal pump complying with standards EN 733 and ISO 5199.

D.2 Step 1

D.2.1 Description of the reference product and the project perimeter

— Product name : XXX pump type NOS;

— Main characteristics of the reference product:

  — Flow at Best Efficiency Point (BEP): 30 m^3/h;

  — Typical head at BEP: 30 m;

  — Total annual energy consumption: 8 631 kWh/year;

  — Total weight: 43 750 g;

  — Operating time: 2 250 h/year;

  — Operating efficiency at duty point: 60 %;

— Type of market: B to B (water pumping in the industry or agricultural sector);

— Known expectations from these markets: product carbon footprint, compliance to regulation (ErP, …).

D.2.2 Bill of Materials

See Table D.1.

Table D.1 — Bill of Materials *(1 of 2)*

Product											
Part	**Amount of constituent subparts of a part** ***n***	**Quantity of parts in the product** ***N***	**Total number of parts** ***N·n***	**Unit mass** ***m*** **(kg)**	**Total mass** ***N·m*** **(kg)**	**Material**	**Material recyclability coefficient** ***r***	**Mass of recyclable material** ***N·m·r*** **(kg)**	**Identified hazardous substance**	**Supplier name**	**Supplier location**
Impeller	1	1	1	12	12	Cast iron	1	12			
Pump housing	1	1	1	55	55	Cast iron	1	55			
Adapter/ Bearing housing/ Feet	1	1	1	97	97	Cast iron	1	97			
Shaft	1	1	1	8	8	Stainless steel	1	8			
Bearings	4	3	12	1	3	Stainless steel	1	3		XX	Europe
Mechani-cal seals	10	1	10	0,2	0,2	Elastomer and carbide	0	0		YY	Europe
Metal fixings	3	1	3	0,6	0,6	Alloy steel	1	0,6		ZZ	Europe
Paint	1	1	1	0,1	0,1	Powder coating	0	0	lead		
Instruction manual	1	1	1	0,1	0,1	Office paper	1	0,1			
Total			**Σ *N·n* =** 31								
Total product mass M_{tot} **(kg) =** 181		**Identified mass of the product, (kg)** **Σ *N·m* =** 176									
% identified mass of the product = 97,2 %		**Identified product recyclability rate,** T_r = 175,7/181 = 97 %,									

Table D.1 *(2 of 2)*

Packaging											
Part	**Amount of constituent subparts of a part *n***	**Quantity of parts in the product *N***	**Total number of parts *N·n***	**Unit mass *m* (kg)**	**Total mass *N·m* (kg)**	**Material**	**Material recyclability coefficient *r***	**Mass of recyclable material *N·m·r* (kg)**	**Identified hazardous substance**	**Supplier name**	**Supplier location**
Protective covering	1	1	1	1	1	LDPE	0	0			
Pallet	1	1	1	1	7	Cardboard	1	7		XY	Europe

D.2.3 Environmental questionnaire

Table D.2 gives the answers to the complete environmental questionnaire and Table D.3 the summary of the answers which are inputs to the algorithm.

Table D.2 — Completed environmental questionnaire

Inputs to the algorithm	Interrelation with the choice of DO
Environmental assessment	
Raw materials (excluding packaging)	
	QC1) Does your product contain any rare materials? ☒ *Yes* ☐ *Zinc* ☐ *Copper* ☒ *Nickel (coating)* ☒ *Lead* ☐ *Silver* ☐ *Tin* ☐ *Other* ☐ *No* QC2) Does your product contain any recycled materials? ☒ *Yes (cast iron, stainless steel)* ☐ *No* ☐ *Don't know* QC3) Does your product contain any renewable materials? ☐ *Yes* ☒ *No*
Manufacture (excluding packaging)	
QB1) How many parts does your product contain?. ☒ ≤ *100* (31) ☐ *> 100*	QC4) Of all the manufacturing operations covering the product and its components, is the greatest number of operations presenting an environmental risk performed: ☐ *Mostly at suppliers and subcontractors* ☒ *Mostly at internal manufacturing site* QC5) Does the manufacture process use substances subject (or candidate) to authorisation? ☐ *Yes, give details* ☒ *No*

Use	
QB2) Does your product need energy for its intended use? ☒ *Yes* ☐ *No*	QC6) If yes, what type of energy does it use (direct product power source)? ☐ *Electricity* ☐ *Primary energy (petroleum products, gas, etc.)* ☐ *Alternative source* ☐ *Renewable* ☒ *Reclamation process* ☐ *Other*
QB3) Is your product intended to be integrated into a larger assembly (vehicle, hydraulic circuit, refrigeration system, machinery, etc.)? ☒ *Yes* ☐ *No*	
QB4) If your product is integrated into a larger assembly (equipment, machine, etc.), is it likely to modify the normal operating performance of this assembly (efficiency lifetime, etc.)? ☒ *Yes* ☐ *No*	
QB5) If your product is integrated into an assembly, what is its lifetime compared with this assembly (for normal operating, according to the recommendation of use)? ☐ *Longer lifetime* ☐ *Similar lifetime* ☒ *Shorter lifetime or don't know*	
QB6) Does your product operate with consumables (fluids, seals, etc.) or is it used to apply another product (paint, liquid fertiliser, adhesive, etc.) or does it need to be regularly maintained with specific products during its use phase (example: cleaning products) ? ☒ *Yes* ☐ *No*	*Give details: roll bearings, oil, …* QC7) If yes, does this use generate: C7a) waste ☒ *Yes* ☐ *Hazardous* ☒ *Non-hazardous* ☐ *No* C7b) emissions or leakages (to air, water or ground) ☒ *Yes*: Draw up a list of these emissions and identify those that present a risk to the environment:

	☐ *Air* ☐ *Greenhouse gas (CO_2, methane, HFC, etc.)* ☐ *Sulphur oxides (SOx)* ☐ *Nitrogen oxides (NOx)* ☐ *VOC* ☐ *Carbon monoxide (CO)* ☐ *Particles* ☐ *Other* ☒ *Water* ☐ *Heavy metals* ☐ *Hydrocarbons* ☐ *Nitrates* ☐ *Phosphates* ☐ *Nitrogen compounds* ☐ *PCB* ☒ *Other: grease, oil* ☒ *Ground* ☐ *Heavy metal* ☐ *Hydrocarbons* ☐ *Halogen-containing substances* ☒ *Other: water* ☐ *Other* ☐ *No*
QB7) What is the lifetime of your product? State, where applicable, the unit and ranges of associated values considering equivalent products on the market ☐ *0-2 years or X cycles of operation* ☐ *2-5 years or X cycles of operation* ☒ *> 5 years* QB8) Is your product (several possible answers): ☐ *Single use (cartridge for cartridge-operated fixing tool, etc.)* ☐ *Occasional use (lawn-mower, etc)* ☒ *Frequent Intermittent or Continuous use (pump, machine tool, etc.)*	QC8) Does the product require preventive maintenance during normal operation throughout its lifetime? ☒ *Yes – Give details: sealing, roll bearings replacement* ☐ *No*
Product end-of-life (excluding packaging)	
QB9) Indicate the product's estimated recyclability rate : ☐ $r < 80\ \%$ ☐ $80\ \% \leq r < 90\ \%$ ☒ $r \geq 90\ \%$	QC9) Does your product include components or sub-assemblies which can be re-used at the end of life of the product? ☒ *Yes – Give details: casing* ☐ *No*

	QC10) If your product includes components or sub-assemblies which can be re-used at the end of life of the product, is your company organised to collect these used components or subassemblies for retro-fitting? ☒ *Yes* ☐ *No* QC11) How is maintenance considered during product design? ☒ By replacement of product parts ☐ By making repair easy ☐ By instructing the user on correct use ☐ Other
Hazardous substances	
QB10) Does your product contain any electric or electronic components ☐ *Yes* ☒ *No* QB11) According to your knowledge, does your product (product / components / packaging) contain any of the following: B11a) Metals or derived metallic elements, classified as hazardous (such as regulated metals: lead, mercury, cadmium, chromium 6) ☒ *Yes or don't know* ☐ *No* B11b) Flame retardants classified as hazardous ☐ *Yes or don't know* ☒ *No* B11c) Halogenated materials ☐ *Yes or don't know* ☒ *No* B11d) Other hazardous regulated or at-risk substances on the market? ☐ *Yes or don't know* ☒ *No*	

Transport	
QB12) Give the geographic distribution of your direct suppliers of materials, parts and components, and of your subcontractors, as a percentage of their volume (number or mass of purchased products) (Total = 100%): ☐ *Regional : …%* ☐ *National : …%* ☒ *European : … %* ☐ *Worldwide : … %*	QC12) Give the geographic distribution of your shipments, as a percentage of their volume (number or mass of sold products; total = 100 %): ☐ *Regional : %* ☐ *National : …%* ☒ *European : … %* ☐ *Worldwide : … %*
Packaging	
QB13) Is the product delivered to the client in packaging? ☒ *Yes* ☐ *No* QB14) If the product is delivered in packaging, is this packaging recyclable? ☐ *Yes, 100%* ☒ *Yes, partly* ☐ *No*	QC13) Is your purchase packaging: C13a) reusable? ☐ *Yes, 100%* ☒ *Yes, partly* ☐ *No* C13b) recyclable? ☐ *Yes, 100%* ☒ *Yes, partly* ☐ *No* C13c) If the packaging is recyclable, is a sorting process for recycling carried out? ☒ *Yes* ☐ *No* QC14) Is packaging for grouping and transport (pallet, plastic film-wrap, shuttle boxes, etc.): C14a) Reusable? ☐ *Yes, 100%* ☒ *Yes, partly* ☐ *No* C14b) Recyclable? ☐ *Yes, 100%* ☒ *Yes, partly* ☐ *No*

	QC15) Specify other characteristics of the packaging ☐ *Number of packaging materials, biodegradable materials …* ☒ *Reusable components, …*
European legislation	
▪ WEEE Is your product covered by Directive 2012/19/EU governing waste electrical and electronic equipment (WEEE)? ☐ *Yes* ☒ *No* ▪ RoHS Is your product covered by Directive 2011/65/EU governing the restriction on the use of hazardous substances (including indirect use in the form of a component of a system covered by this directive)? ☐ *Yes* ☒ *No* ▪ End-of-life vehicles (ELV) Is your product covered by Directive 2000/53/EC governing end-of-life vehicles (including indirectly in the form of a component of a system covered by this directive)? ☐ *Yes* ☒ *No* ▪ ErP Is your product subject to any execution measure under Directive 2009/125/EC governing the eco-design of energy related products? ☒ *Yes (expected in 2013)* ☐ *No*	▪ Packaging Is your product delivered as a packaged product and covered by Directive 2004/12/EC governing packaging? ☐ *Yes* ☒ *No* ▪ Other regulations (in particular, regulations for placing "products" on the market) Is your product subject to any other regulation covering one or more environmental aspects? ☒ *Yes – Give details (REACH regulation)* ☐ *No*

Table D.3 — Inputs to the algorithm

Questions		**Answers**
Manufacture	QB1) Number of parts	**< 100**
Use	QB2) Energy consumption	**Yes**
	QB3) Integrated in a complex system	**Yes**
	QB4) Modifies efficiency	**Yes**
	QB5) Product lifetime compared with the larger assembly	**Shorter lifetime**
	QB6) Consumables or regular cleaning/maintenance	**Yes**
	QB7) Lifetime	**Long (>10)**
	QB8) Type of use	**Frequent**
Product end-of-life	QB9) Recyclability rate:	**≥ 90 %**
Hazardous substances	QB10) Electronic components	**No**
	QB11a) Heavy metals	**Yes**
	QB11b) Flame retardants	**No**
	QB11c) Halogenated materials	**No**
	QB11d) Other hazardous substances	**No**
Transport	QB12) Purchase logistics	**European**
Packaging	QB13) Packaging for end customer	**Yes**
	QB14) Recyclability of end customer packaging	**Partly**
Regulation	▪ WEEE	**No**
	▪ RoHS	**No**
	▪ End-of-life vehicles (ELV) directive	**No**
	▪ ErP directive	**Yes**
	▪ Directive 2004/12/EC governing packaging	**No**

D.2.4 Analysis algorithm

The application of the analysis algorithm is shown on Figures D.1 to D.5 and Table D.4. The resulting scoring of environmental profile is given in Figure D.6.

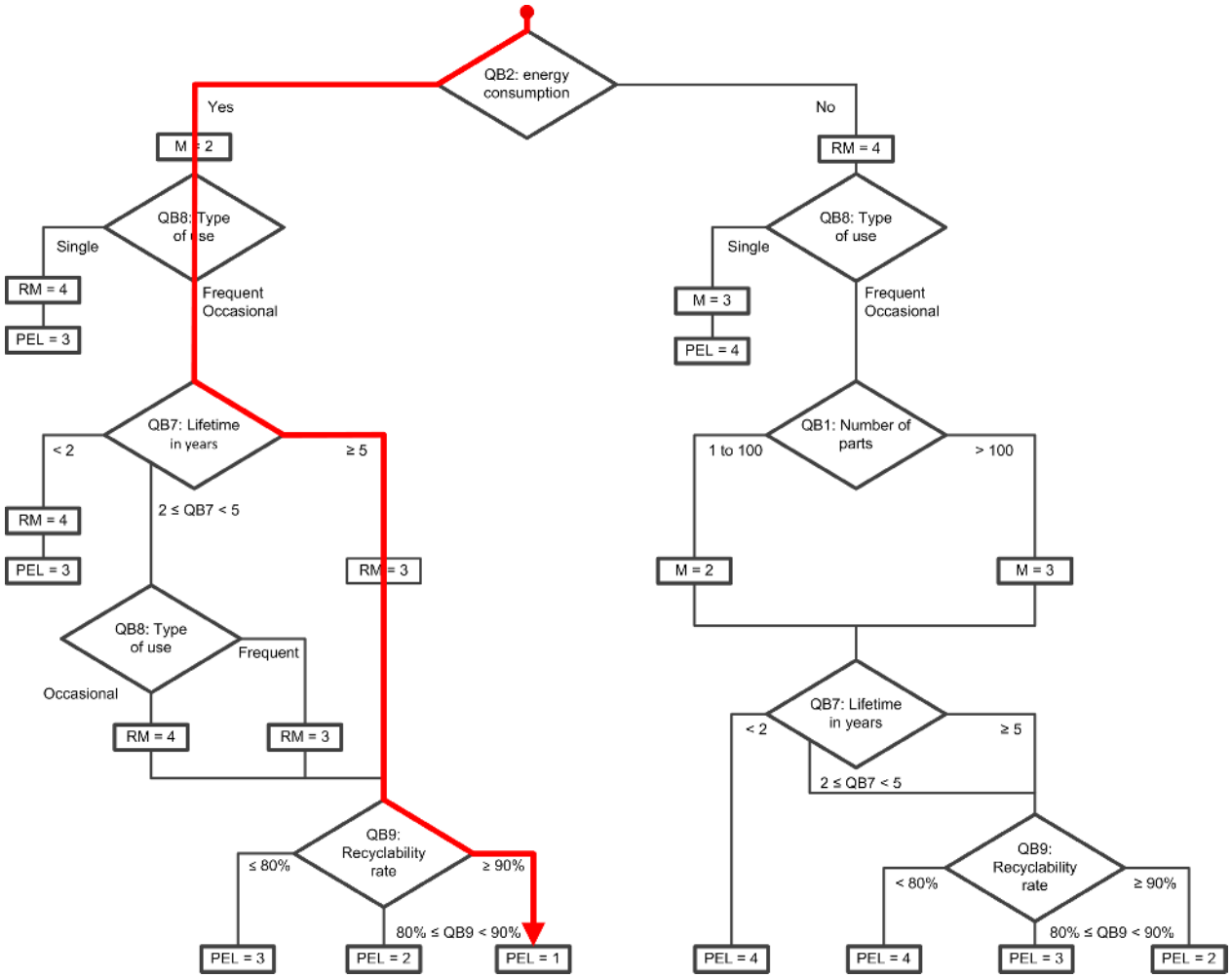


Figure D.1 — Environmental aspects M = 2, RM = 3 and PEL = 1

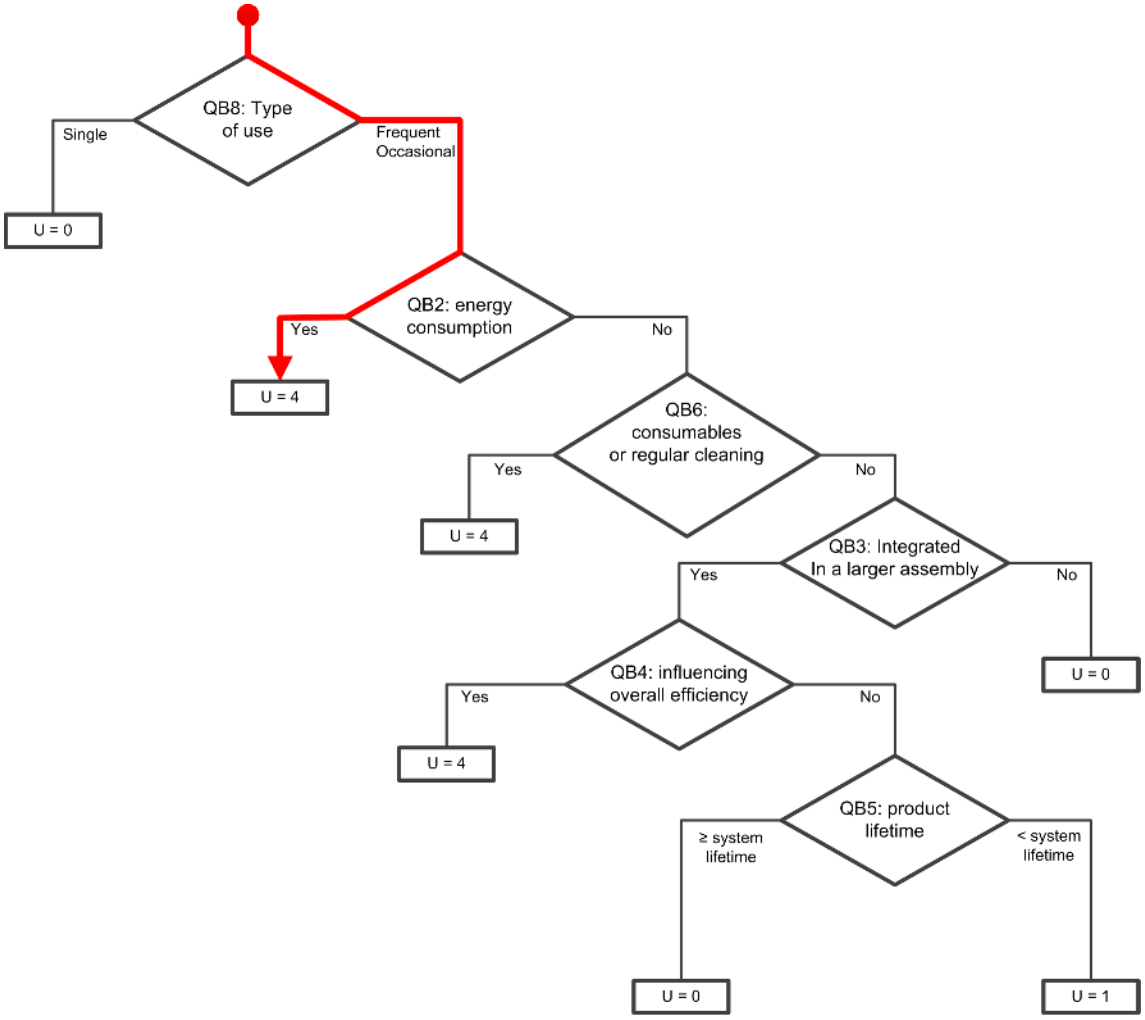


Figure D.2 — Environmental aspect U = 4

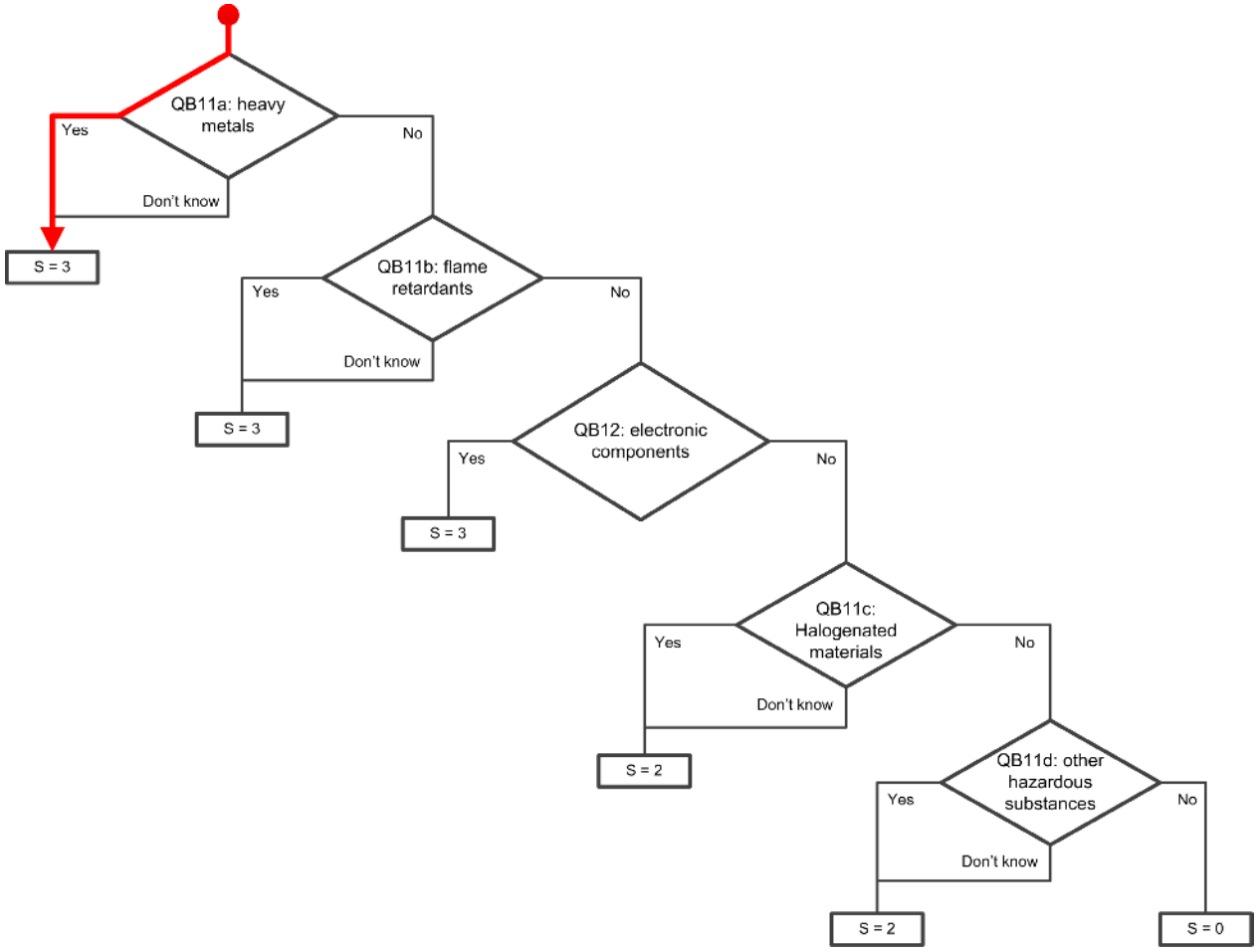


Figure D.3 — Environmental aspect S = 3

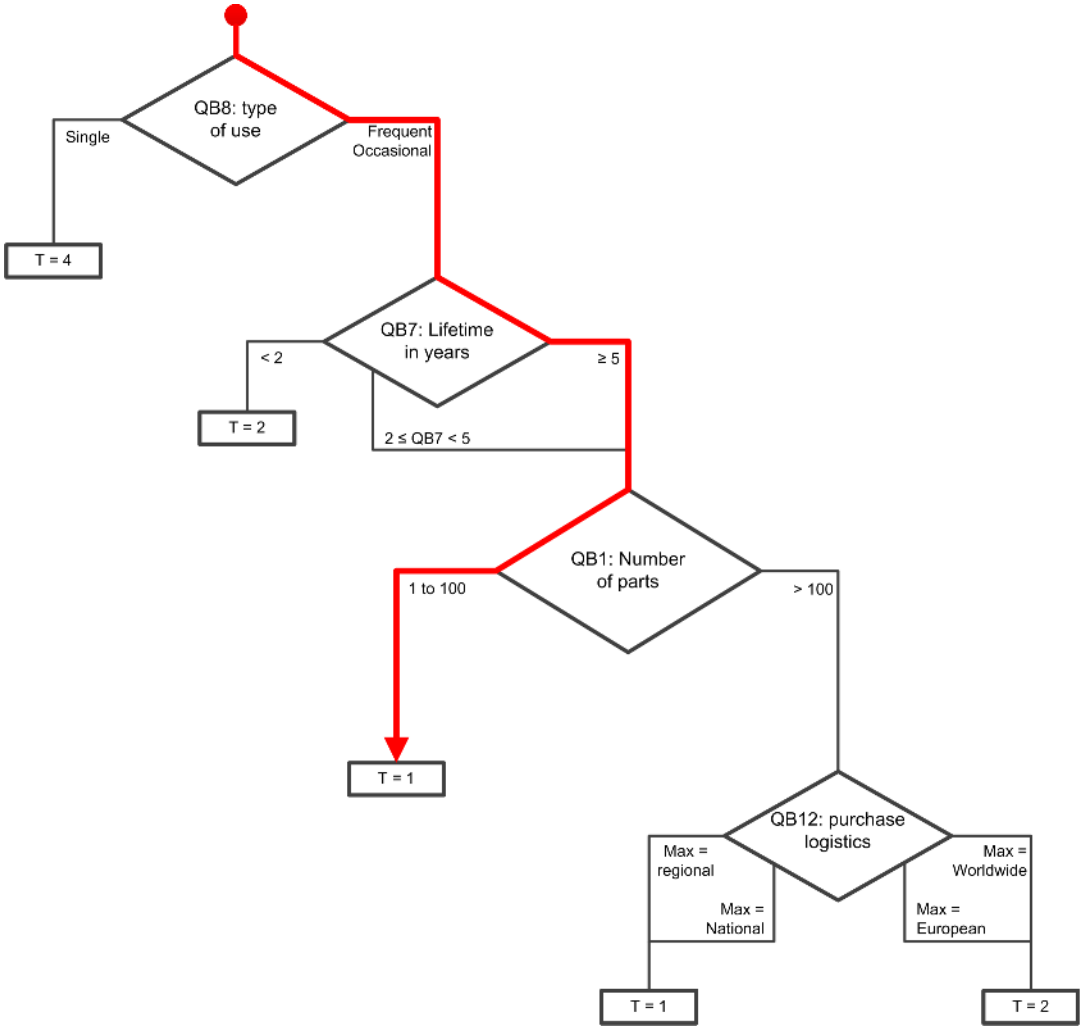


Figure D.4 — Environmental aspect T = 1

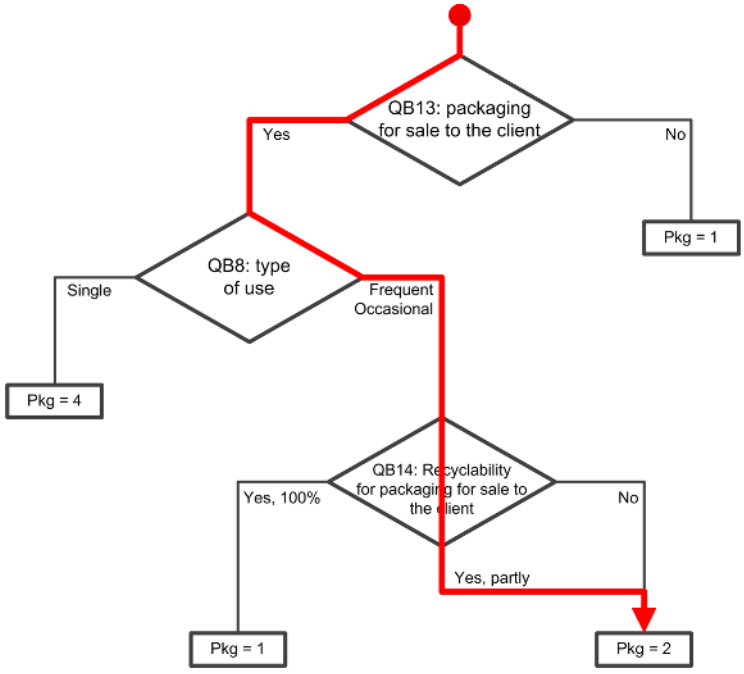


Figure D.5 — Environmental aspect Pkg = 2

Table D.4 — Adjustment of the scoring regarding specific rules linked to regulations

The product is covered by Directive 2002/96/EC governing waste electrical and electronic equipment (WEEE).	No adjustment
The product is covered by Directive 2011/65/EU governing the restriction on hazardous substances (including indirectly).	No adjustment
The product is covered by Directive 2000/53/EC governing the end-of-life vehicles (ELV) (including indirectly).	No adjustment
The product is subject to execution measure under Directive 2009/125/EC governing the eco-design of energy using products.	No adjustment

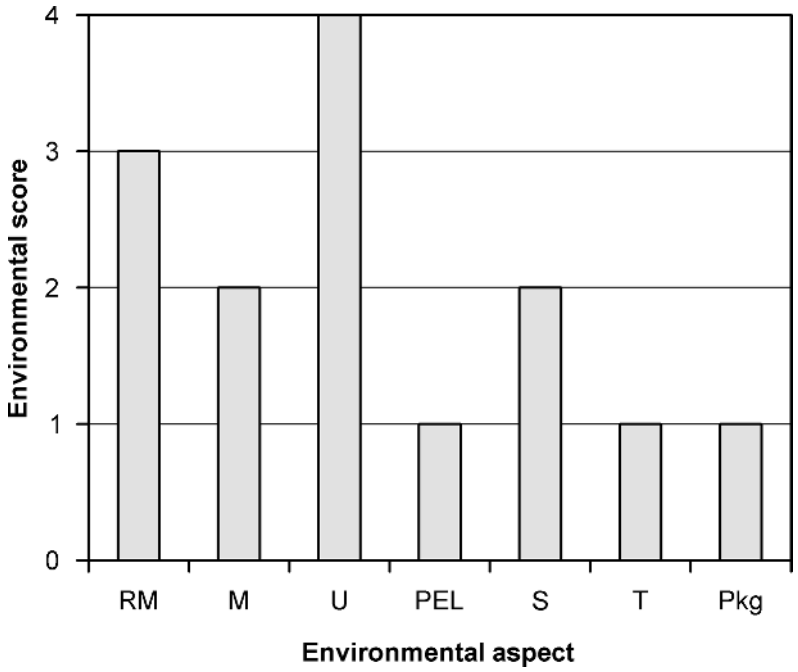


Figure D.6 — Resulting scoring of environmental aspects

D.3 Steps 2 and 3

Table D.5 gives the results of Steps 2 and 3: selection and ranking of design options, then choice of DO and EA indicators.

Table D.5 — Design options and indicators *(1 of 2)*

	STEP 2						STEP 3				STEP 4	
EA	**Design option (DO)**	**Env. score**	**Tech. score**	**Strategic score**	**Final score**	**Design option retained**	**Type of indicator**	**Indicator name**	**Related methods**	**Indicator value before redesign**	**Indicator value after redesign**	**Remarks**
U	Improve the energy efficeinecy	4	2	3	24	Yes	DO/EA	MEI (minimum efficiency index)	Measurement method given in the regulation and the draft standard associated	*To be measured*	*To be measured*	
U	Encourage the correct use of the product	4	3	3	36	Yes	DO	Number of specific instructions	Instruction manual of the product	*To be counted*	*To be counted*	
U	Improve product durability and reliability	4	2	2	16	No						
RM	Reduce the mass	3	2	3	18	Yes	DO	Product mass	Measurement of the mass	181 kg	*To be measured*	
RM	Use of material with less CO2 and energy content	3	2	2	12	No						
RM	Sell functionality instead of a product	3	2	1	6	No						
RM							EA	Carbon and energy content of materials	Eco-Invent database	*To be calculated*	*To be calculated*	
M	Minimise energy consumption for each product	2	2	2	8	No						
M	Modular design to optimise production	2	2	3	12	No						
M							EA	Production-related energy consumption	Measurement method defined by the enterprise	*To be measured*	*To be measured*	

Table D.5 — Design options and indicators *(2 of 2)*

	STEP 2						STEP 3				STEP 4	
EA	**Design option (DO)**	**Env. score**	**Tech. score**	**Strategic score**	**Final score**	**Design option retained**	**Type of indicator**	**Indicator name**	**Related methods**	**Indicator value before redesign**	**Indicator value after redesign**	**Remarks**
S	Eliminate and substitute hazardous substances	3	2	3	18	Yes	DO	Use a painting without lead	Check the painting technical specification	Painting with lead	*To be recorded*	
S							EA	Identification of hazardous substances in materials	Environmental questionnaire	Presence of lead	*To be recorded*	
T	Opt for less polluting means of transport	1	3	1	3	No						
T	Minimise product weight	1	2	2	4	No						
T							EA	Product + packaging mass	Measurement of the mass	189 kg	*To be measured*	
PEL	Facilitate disassembly	1	2	3	6	No						
PEL	Facilitate the reuse of parts or components	1	3	1	3	No						
PEL							EA	Recyclability rate	As for the bill	97 %	*To be calculated*	
Pkg	Use reusable packaging	2	2	3	12	No						
Pkg							EA	% of biodegradable packaging materials	Measured mass of biodegradable materials to the total measured mass of packaging materials	87,5 %	*To be measured and calculated*	

Annex E
(informative)

Background of the algorithm

NOTE The content of this annex is an extract of the PhD work [30]. Some adjustments have been made in this document to take account of the latest development.

E.1 Construction of the algorithm

E.1.1 Overview

The algorithm is the process that will make the product's environmental cluster analysis possible using the environmental questionnaire. It produces a ranking scoring of the seven environmental aspects that corresponds to the environmental "assessment" of the product:

– Raw Materials (RM);

– Manufacture (M);

– Use (U);

– End of Life Recyclability (EL-R);

– Hazardous Substances (S);

– Transportation (T);

– Packaging (Pkg).

It is based on a body of environmental rules that fall into two types:

– the rules for the environmental analysis of products, regardless of any regulatory considerations;

– the rules for the environmental regulation of products.

E.1.2 Rules for environmental analysis

These rules are constructed using environmental postulates combined with criteria and threshold values to allow them to be linked to the properties of the product that is being studied (see Figure E.1).

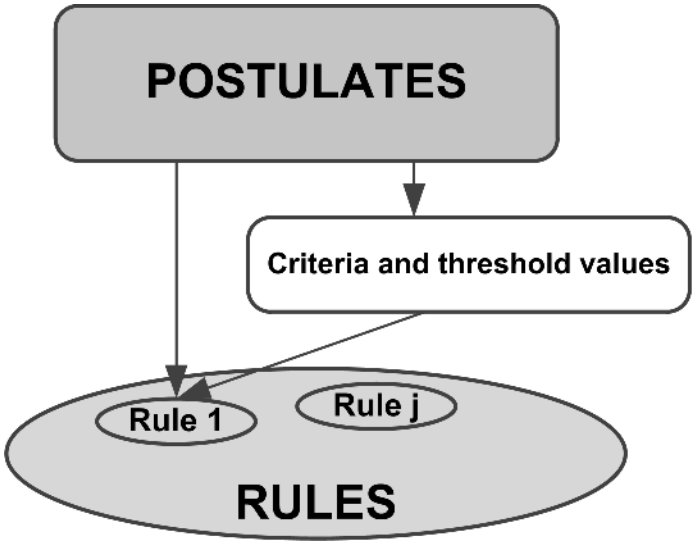


Figure E.1 —Algorithm background – Environmental rules

Table E.1 describes the 21 postulates considered, the combined criteria and the threshold values.

Each rule combines a relative value of the environmental aspects with a particular combination of criteria; that is a particular hierarchical structure of environmental aspects.

By combining the environmental postulates, the environmental rules take the form of logico-deductive relations:

If *proposed criterion Xi* **and/or if** *proposed criterion Yj …,* **then** *proposition AEk*

with

proposed criterion Xi: combination of the X criterion and the value i of the range of values of the criterion X;

proposition AEk: combination of the environmental aspect k (k ∈ [1, 7]) with a value on the hierarchy scale [0, 4].

EXAMPLE Analysis of the RM environmental aspect of a product compared to other aspects: if the product does not consume energy in the use phase, and if the product has a short service life (2-5 years), and if the product is for occasional use, then the materials' environmental aspect is predominant (RM = 4). The score attributed (RM = 4) allows to rank the RM aspect compared to the other aspects.

The body of rules is thus represented by a decision tree for each of the seven environmental aspects, as shown in Figures B.1 to B.5.

To make the link between the properties of the product studied and these rules, a questionnaire is proposed (Annex A) that matches a question to each criterion, for which the possible responses are the threshold values for the criterion identified.

Table E.1 — Postulates, criteria and threshold values *(1 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
1	All	Material intensity (mass / volume)	The lower the mass intensity of a product, the fewer environmental impacts it generates over its life cycle. Accordingly, reducing the mass and / or volume of the product leads to a reduction in the significance of all the phases of the life cycle (and of the seven environmental aspects).	Total mass of the product	- Mass decomposition of the product / material
2	All	Service life	The service life of a product has a direct consequence on the absolute environmental impact of the life cycle of the product. The shorter a product's service life, the greater its environmental impact.	Service life	- Very short: 0-2 years - Short: 2-5 years - Medium: 5-10 years - Long: > 10 years
3	All	Service life / larger assembly	Adjusting the service life of products or components (regarded here as products) to the service life of the assemblies (products) in which they are incorporated tends to minimise the overall environmental impact of the products or components.	Service life / larger assembly	- Included / Not included - Longer service life / Shorter service life
4	All	Type of use of a product	The type of use of a product (single, frequent, continuous, intermittent use, etc.) has a bearing on the relative significance of environmental aspects.	Type of use	- Single use - Occasional use - Frequent use - Intensive use - Intermittent use - Continuous use
5	M, T, Pkg	Number of product parts and components	The number of product parts and components has a direct impact on the manufacturing aspect (M), and generally speaking, because of the phenomena of outsourcing, on the transportation (T) and packaging (Pkg) aspects: the more parts and components there are, the greater the number of manufacturing operations and the more transportation and packaging.	Number of parts and components	- 1 to10 - 11 to 50 - 51 to 100 - > 100
6	EL-R, S	Electrical and electronic products	Electrical and electronic products present problems of waste management because it is difficult to recycle them and their recyclability rate is at present relatively low. Electrical and electronic products use a relatively large quantity of rare metals; this has a direct environmental impact on non-renewable resources.	Covered by the WEEE/ROHS directives	- Yes / No

Table E.1 — Postulates, criteria and threshold values *(2 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
7	EL-R, S	Electrical and electronic products	Electrical and electronic products contain hazardous substances (heavy metals and flame retardants) which present problems of toxicity (at end of life) for humans and the environment.	Contain electrical and electronic parts and components.	- Yes / No
8	EL-R, S	End of life vehicles(ELVs)	End of life vehicles (ELVs) present problems of waste management in terms of the quantity of waste (recyclable at present at 75 % at best) and the toxicity of the waste (numerous hazardous substances).	Covered by the ELV directive	- Yes / No
9	U	Energy consumption in use phase	If a product consumes energy during its use phase, then the use phase is, in the vast majority of cases, largely predominant (magnitude of significance: > 80 %). In most cases, the energy consumption is so great that the environmental impact of the life cycle of the product may be directly correlated to the energy consumption.	Energy consumption	- Yes / No
				Type of energy	- Electricity - Fossil energy - Renewable energy
10	U	Energy consumption in use phase	For all means of motor transport, the use phase generally represents more than 95 % of the total environmental impact. As far as mobile machinery are concerned, the environmental impact is directly related to the mass of the moving vehicle.	Energy consumption	- Yes / No
				Type of energy	- Electricity - Fossil energy - Renewable energy

Table E.1 — Postulates, criteria and threshold values *(3 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
11	U	Product / component interaction with larger assembly	A product or component (regarded here as a product) incorporated into a larger assembly (product) may influence or even determine the significance of the use phase (and, to a lesser degree, its end of life recyclability aspect) through certain parameters or properties: mass, pressure loss, energy efficiency, friction, etc	Interaction with larger assembly	- Yes / No
12	U	Use of consumables in use phase	If a product uses consumables during its use phase (e.g. batteries, oil, filters, water, detergents, etc.), then the use phase becomes more significant (irrespective of any energy consumption).	Use of consumables	- Yes / No
				Type of emission	- Polluting - Non polluting - None
				Type of waste	- Special industrial waste (SIW) - Ordinary industrial waste (OIW) - None
				Maintenance in use phase	- Yes / No

Table E.1 — Postulates, criteria and threshold values *(4 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
13	RM	Environmental impact of materials, in particular energy content and rarity	No direct correlation exists between the mechanical properties of a material (its density, Young's modulus, strength, etc.) and its environmental impact. By contrast, the materials may be classified according to several criteria: - according to their energy content, - according to their toxicity, - according to their rarity (estimated remaining worldwide reserves). Heavy metals (Cr, Ni, Cd, Pb, etc.), known for their potential high toxicity, are also rare metals in terms of resources (known worldwide reserves of less than 50 years). Many metals that are important for industry due to the properties that they grant to other materials (copper, nickel, zinc, etc.) may be described as rare given the state of known worldwide reserves. Copper (Cu) and nickel (Ni) are two metals that have a particularly heavy environmental impact.	Rare materials	- Yes (% mass / material) - No
				Recycled materials	- Yes (% mass / material) - No
				Renewable materials	- Yes (% mass / material) - No
14	RM	Environmental impact of materials, in particular energy content and rarity	The environmental burden of the constituent materials of a product is always very significant. When the environmental impact of the product is not dominated by the energy consumption in the use phase, the materials phase (RM: raw materials) is the predominant phase (more significant in particular than the manufacturing phase and / or transportation phase).	Rare materials	- Yes (% mass / material) - No
				Recycled materials	- Yes (% mass / material) - No
				Renewable materials	- Yes (% mass / material) - No

Table E.1 — Postulates, criteria and threshold values *(5 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
15	Pkg	Packaging	Packaging presents a problem of end of life waste management, as well due to the volume of waste as due to its toxicity.	Type of packaging	- Source of supply - Shipping - End customer
				Number of packages / end customer	- 0 - 1 - 2 - 3
				Reusable	- Yes 100% - Yes, in part - No
				Recyclable	- Yes 100% - Yes, in part - No
				Biodegradable	- Yes / No
16	F	Manufacturing phase	The significance of the manufacturing phase on the life cycle of a product depends on: - the number of product parts and components (the more parts and components there are, the more manufacturing processes there are); - the types of processes used: some processes that employ hazardous substances (solvents, heavy metals, chlorinated oils, etc.) or consume large amounts of energy pollute more than others (for example: treatment processes – ST: surface treatment or HTr: heat treatment – certain processes in the electrical and electronic industries, etc.).	Number of "polluting" operations over the entire life cycle	- < 1/3 of the total number - 1/3 to 2/3 - > 2/3
				Number of internal "polluting" operations	- < 1/3 of the total number - 1/3 to 2/3 - > 2/3

Table E.1 — Postulates, criteria and threshold values *(6 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
17	T, Pkg	Transportation	The significance of the transportation phase (T) is generally of the same order of magnitude as that of the manufacturing phase (M); both phases are considered as relatively less significant than the use (U) and raw materials (MP) phases.	Geographic distribution of suppliers and sub-contractors	- Regional - National - European - Worldwide
				Geographic distribution of product shipments	- Regional - National - European - Worldwide
18	T, Pkg	Transportation	Means of transportation are more or less polluting. The means of transportation may be classed in the following order, from most polluting to least polluting: - plane - truck - train - ship	Geographic distribution of suppliers and sub-contractors	- Regional - National - European - Worldwide
				Geographic distribution of product shipments	- Regional - National - European - Worldwide
19	EL-R	Recyclability of materials, in particular metals and plastics	All metals have a very good real recyclability rate - higher than 90 % and up to 98 % for steel. However, this recyclability rate does not resolve the problem of the consumption of resources (even if it lessens it). Accordingly, a product consisting mainly of metal will have an end of life (EL-R) recyclability aspect that is relatively insignificant but a raw materials (MP) aspect that is as significant (at first approximation) as all the products.	Recyclability rate	- < 80 % - 80 % to 90 % - > 90 %

Table E.1 — Postulates, criteria and threshold values *(7 of 7)*

No.	EA	Title	Postulates	Criteria	Threshold values
20	EL-R	Recyclability of materials, in particular metals and plastics	Although in theory plastics are all perfectly recyclable, in practice the recyclability of plastics is generally very low – almost non-existent (because the recycling systems does not exist). Products consisting mainly of plastic have a very low recyclability rate in practice and it is all the lower when different plastics are combined in the same product.	Recyclability rate	- < 80 % - 80 % to 90 % - > 90 %
21	S, F, U	Hazardous substances	The number of hazardous substances is extremely large. Problems of toxicity linked to hazardous substances concern all phases of the life cycle. However, certain molecules contained in the mass of materials present problems for eliminating these substances at end of life, and they make the toxic aspect of the substances predominant. These are: - - heavy metals – especially Cd, Cr6, Pb and Hg; - - halogenated molecules containing Br, F and Cl atoms and especially the flame retardants PBDE and PBB.	Heavy metals	- Yes / No
				Flame retardants	- Yes / No
				Halogenated substances	- Yes / No
				Others	- Yes / No

E.1.3 Consideration of legislation

It was decided to give the greatest significance, when appropriate, to the “recyclability” and “substances” environmental aspects related to the requirements of the legislation (directives and regulations).

EXAMPLE If a product falls within the scope of one of the existing directive (ELV, WEEE and ROHS), the environmental aspects “EL-R” and “S” have a score of 4 on the hierarchical scale. No adjustment is needed fir Directive ErP, which is already taken into account by the postulates 9 and 11.

E.2 Validation of the algorithm

A pilot phase was conducted to test the proposed approach.

The experimental protocol consisted of comparing the results obtained on the one hand with the environmental analysis methodology proposed in this document (algorithm) and, on the other, with a unique LCA methodology (EDIP) according to the schema in Figure E.2.

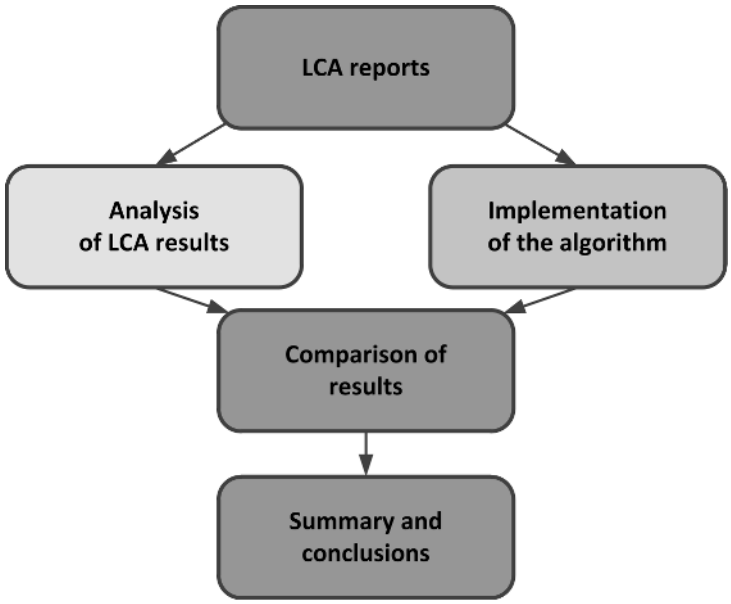


Figure E.2 — Algorithm validation

Case studies have been carried out on products of various kinds (office chair, lift pump, HP cleaner, hydraulic cylinder, check valve, etc). From that, the convergence of the results was validated [see 30].

In summary, it has been shown that in every case, at least:

- either the three first environmental aspects obtained after establishing a hierarchy with each of the two methodologies are the same; or

- only the two first environmental aspects are the same and in the same order.

This convergence has been judged to be sufficient to allow the manufacturer to know the environmental aspects to consider as priorities in guiding his eco-design project.

Bibliography

Standards and regulations

[1] EN 13430, *Packaging — Requirements for packaging recoverable by material recycling*

[2] EN ISO 14001, *Environmental management systems — Requirements with guidance for use (ISO 14001)*

[3] EN ISO 14020, *Environmental labels and declarations — General principles (ISO 14020)*

[4] EN ISO 14006, *Environmental management systems -- Guidelines for incorporating ecodesign (ISO14006)*

[5] EN ISO 14021, *Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling)* (ISO 14021)

[6] EN ISO 14025, *Environmental labels and declarations — Type III environmental declarations — Principles and procedures (ISO 14025)*

[7] EN ISO 14040, *Environmental management — Life cycle assessment — Principles and framework (ISO 14040)*

[8] EN ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines (ISO 14044)*

[9] ISO 14046, *Environmental management — Water footprint — Principles, requirements and guidelines*[1)]

[10] ISO/TR 14062, *Environmental management — Integrating environmental aspects into product design and development*

[11] ISO/TS 14067, *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification and communication*

[12] ISO 22628, *Road vehicles — Recyclability and recoverability — Calculation method*

[13] NF E 01-005, *Mechanical products – Eco-design methodology*

[14] Decision 94/3/EC, Commission Decision of 20 December 1993 establishing a list of wastes pursuant to Article 1a of Council Directive 75/442/EEC on waste

[15] Directive 94/62/EC, Directive of European Parliament and Council of 20 December 1994 on packaging and packaging waste

[16] Directive 1999/13/EC, Council Directive of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

[17] Directive 2000/53/EC, Directive of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles

[18] Directive 2004/12/EC, Directive of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste

1) In preparation.

[19] Regulation EC/1907/2006, Regulation of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directive 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

[20] Regulation 1272/2008, Regulation of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

[21] Directive 2009/125/EC, Directive of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products

[22] Directive 2011/65/EU, Directive of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

[23] Directive 2012/19/EU, Directive of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

Possible source of information

[24] http://echa.europa.eu

[25] http://ec.europa.eu/enterprise/policies/rawmaterials/critical/index_en.htm

[26] http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm

[27] http://lca.jrc.ec.europa.eu/lcainfohub/directory.vm

[28] http://lct.jrc.ec.europa.eu/assessment/publications

[29] http://lca.jrc.ec.europa.eu/lcainfohub/index.vm

Background

[30] Le Pochat, Stéphane (2005), *Integration of eco-design in SMEs: proposal for a know-how appropriation method for environmental design of products*, Doctoral degree, Industrial Engineering, ENSAM 2005ENAM0021

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