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General methods for assessing the recyclability and recoverability of energy related products

Méthodes générales pour l'évaluation de la recyclabilité et de la valorisabilité des produits liés à l'énergie

Allgemeines Verfahren zur Bewertung der Rezyklierbarkeit und Wiederverwertbarkeit energieverbrauchsrelevanter Produkte

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/CLC/JTC 10.

If this draft becomes a European Standard, CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European foreword

This document (prEN 45555:2018) has been prepared by Technical Committee CEN/CLC/JTC 10 "Energy-related products – Material Efficiency Aspects for Ecodesign", the secretariat of which is held by NEC.

This document is currently submitted to the CEN Enquiry.

The dual logo CEN-CENELEC standardization deliverables, in the numerical range of 45550 – 45559, have been developed under standardization request M/543 of the European Commission and are intended to potentially apply to any product within the scope of the Directive 2009/125/EC concerning energy-related products (ErP).

Topics covered in the above standardization request are linked to the following material efficiency aspects:

a) Extending product lifetime

b) Ability to re-use components or recycle materials from products at end-of-life

c) Use of re-used components and/or recycled materials in products

These standards are general in nature and describe or define fundamental principles, concepts, terminology or technical characteristics. They can be cited together with other product or product-group standards, e.g. developed by product technical committees.

This document is intended to be used by technical committees when producing horizontal, generic, and product-specific or product-group standards.

Introduction

To close the loop to a circular economy, amongst other measures, an efficient handling of waste is paramount. Recovering materials and energy can reduce environmental impacts over the lifecycle, including reduced extraction of natural resources and associated emissions of primary material production. To judge the recycling potential of an ErP in terms of how easy it is to recycle/recover materials from the product or to what degree a product can undergo recycling/recovery, the concepts of recyclability and recoverability are introduced/used.

NOTE The waste hierarchy, introduced in Directive 2008/98/EC, ranks different waste management principles (from highest to lowest priority): prevention, preparing for re-use, recycling, recovery, disposal.

Once an ErP has reached its end-of-life (EoL) and has become waste, the ErP can be either prepared for re-use, recycled and/or recovered. This document elaborates on the product characteristics which are relevant for recyclability and recoverability of a whole ErP. Focus is therefore on abilities of the product itself and not on recycling and recovery processes. However, the availability and efficiencies of state-of-the art recycling and recovery processes are taken into account to determine the recyclability/recoverability rate of an ErP. The outcome of the recyclability and recoverability assessment may be affected by for instance technological changes over time or from the location, where the actual end-of-life process is operated. For the assessment of the recyclability/recoverability of an ErP, it is assumed that the whole ErP undergoes the respective EoL treatment process. It is assumed that no re-use takes place in this assessment. In order to be able to compare recyclability and recoverability rates of different products, one EoL treatment scenario needs to be used. Selection of the EoL treatment scenarios should be done by the user of this document.

This document describes how an end-of-life (EoL) treatment scenario has to be chosen (Clause 5) by the user of this document. Based on this scenario, the recyclability/recoverability rate of an ErP can be assessed. While Clause 6 describes design related considerations to set criteria for the recyclability and recoverability assessment of an ErP, subclause 7.1 presents the general considerations for quantifying the recyclability/recoverability. A detailed recyclability/recoverability assessment (see subclause 7.2) and a simplified recyclability/recoverability assessment (see subclause 7.3) are described in Clause 7. Further considerations on the assessment of the recyclability and recoverability of critical raw materials are given in Clause 8. Provisions on the communication of the result of the recyclability/recoverability assessment are shown in Clause 9.

1 Scope

This document provides a general methodology for:

- Assessing the recyclability of energy-related products;
- Assessing the recoverability of energy-related products;
- Assessing the ability to access or remove certain components, assemblies, materials or substances from products to facilitate their extraction at the end-of-life for ease of treatment, recycling and other recovery operations;
- Assessing the recyclability of critical raw materials from energy-related products.

This document defines generic methods and parameters which are applicable for the development of product-specific standards in order to calculate product-specific recyclability and recoverability rates. This document cannot be applied directly to a product-group because a correct assessment can only be done in a product-specific way. This document defines a series of parameters which may be considered to calculate product-specific recyclability and recoverability indices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 45558:—,[1] *General method to declare the use of critical raw materials in energy-related products*

EN 45559:—[2], *Methods for providing information relating to material efficiency aspects of energy-related products*

3 Terms and definitions

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

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

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

NOTE See CLC/prTR 455501 for additional definitions.

3.1
end-of-life treatment
operation of any kind by which an end-of-life product that has become waste is recovered or disposed

3.2
end-of-life treatment scenario
description of a process flow resulting from end-of-life treatment including the data needed to calculate recyclability and recoverability rates

[1] Under preparation. Stage at time of publication: prEN 45558
[2] Under preparation. Stage at time of publication: prEN 45559

3.3
energy recovery
production of useful energy through direct and controlled combustion or other processing of waste

[SOURCE: IEC 62635:2012, modified Note 1 to entry deleted]

3.4
material recovery
recovery operation of any kind, excluding energy recovery and the reprocessing into materials which are to be used as fuel

[SOURCE: EN 50625-1:2014, 3.23, modified formatting and sentence structure]

3.5
recovery
operation of any kind, the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

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

[SOURCE: Directive 2008/98/EC, modified: addition of Note 1 to entry]

3.6
recoverability
ability of a waste product to be recovered

[SOURCE: IEC 62635:2012, modified "based on actual practices" deleted]

3.7
recoverability rate
ratio of the sum of recoverable products, product parts, materials mass to total waste product mass reprocessed

[SOURCE: IEC 62635:2012, modified "the sum of" added]

3.8
recycling
recovery operation of any kind, by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes

Note 2 to entry: It includes organic recycling but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations

[SOURCE: Directive 2008/98/EC, modified: moved second sentence of definition to Note 1 to entry]

3.9
recyclability
ability of a product to be recycled at end-of-life

[SOURCE: IEC 62635:2012, modified "based on actual practices" replaced by "at end-of-life"]

3.10
waste
substance or object of any kind, which the holder discards or intends or is required to discard

[SOURCE: Directive 2008/98/EC]

3.11
hazardous waste
waste which displays one or more of the hazardous properties listed in Annex III of Directive 2008/98/EC

[SOURCE: Directive 2008/98/EC]

3.12
removal
manual, mechanical, chemical or metallurgic handling with the result that hazardous substances, mixtures and components are contained in an identifiable stream or are an identifiable part of a stream within the treatment process

Note 3 to entry: A substance, mixture or component is identifiable if it can be monitored to verify environmentally safe treatment.

[SOURCE: Directive 2012/19/EU, modified: moved second sentence of definition to Note 1 to entry]

3.13
disposal
operation of any kind, which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy

[SOURCE: Directive 2008/98/EC, modified: second sentence deleted]

3.14
collection
gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a treatment facility

[SOURCE: Directive 2008/98/EC]

3.15
part
hardware or software constituent of a product

[SOURCE: EN 45554[3] definition 3.2]

[3] Under preparation. Stage at time of publication: prEN 45554

4 General assessment procedure

Recyclability and recoverability of a product is a combination of:

- the design characteristics of the product such as the structure, material composition, size, weight;
- the techniques, combination or sequence of techniques used to recycle or recover a given waste stream.

The recyclability and recoverability assessment of an ErP shall thus be based on an end-of-life treatment scenario defined according to Clause 5 on a product or product-group specific basis.

While recycling of ErPs aims at closing the circular economy loop, trade-offs might arise between different material efficiency related topics. In general, different material efficiency aspects like for instance weight, durability, reparability, re-usability, need to be balanced in order to optimize the environmental benefit (balancing between different material efficiency choices is quoted in: DIN SPEC 59, CEN Guide 4, ISO Guide 64). Further explanation on the relationship with environmental impacts of recycling and recovery, including environmental benefits, are displayed in the informative Annex A.

Based on product structure and material content, a generic end-of-life treatment scenario for the product-group shall be specified. The end-of-life treatment scenario shall consider state of the art treatment and recycling methods. Based on input limitations of the specified treatment and recycling methods, criteria at product or product-group level shall be defined in order to assess a products compatibility with the specified treatment and recycling methods. Criteria could for example include the ability to remove parts from a product due to the treatment relating reasons or due to the legal requirement. Against these criteria, recyclability/recoverability of individual products can be assessed. Figure 1 describes this process as well as the connection of the steps and different parts of this document.

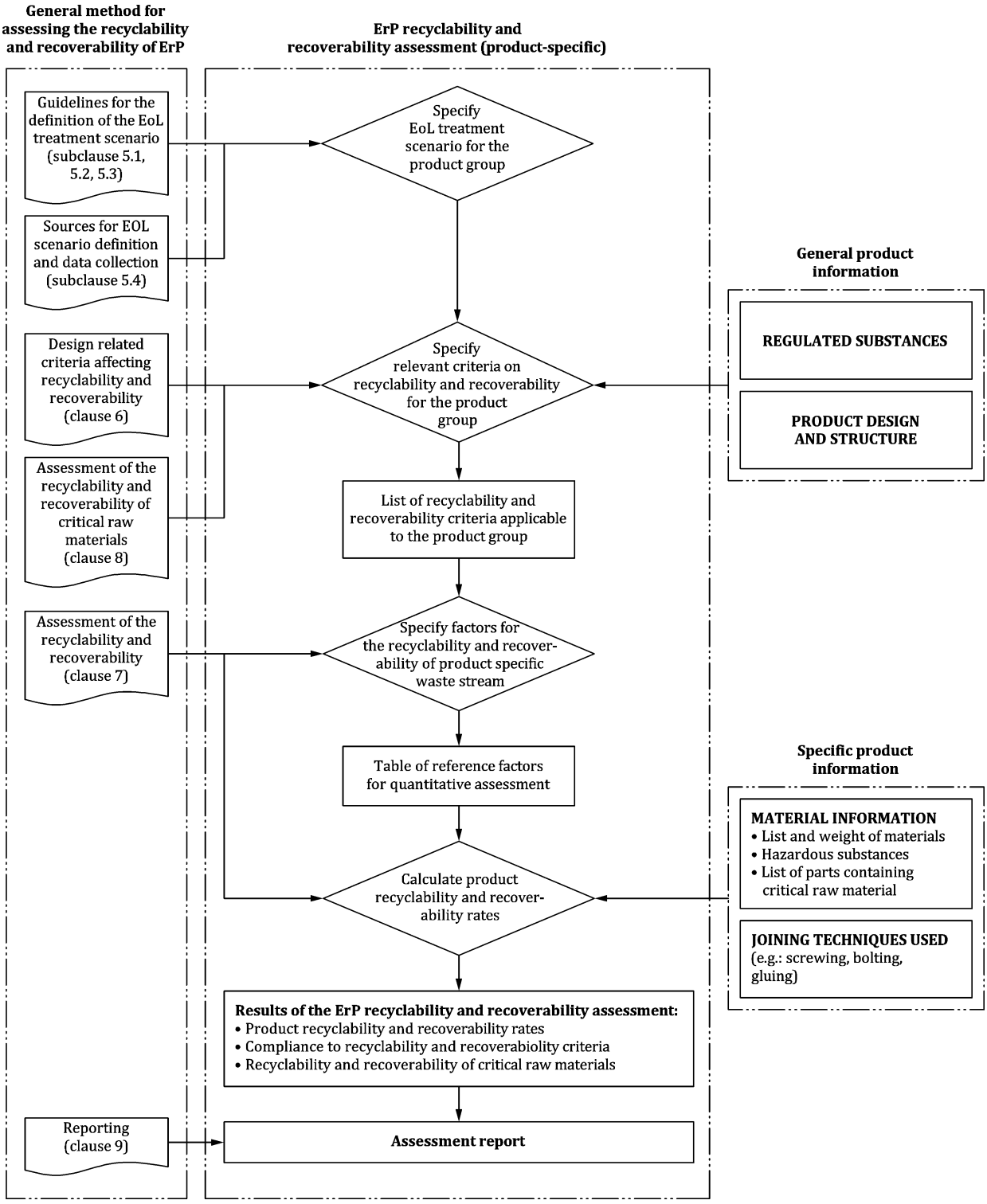


Figure 1 — Flowchart on assessing the recyclability/recoverability of an ErP

5 End-of-life treatment scenario

5.1 General considerations

An end-of-life treatment scenario is a description of the combination and sequence of processes and steps required for the EoL treatment of a product.

End-of-life treatment needs to comply with applicable regulations and in general observes relevant industry practices and standards, allowing efficient recycling and recovery, while at the same time addressing health, safety and environmental concerns.

The treatment operations may include:

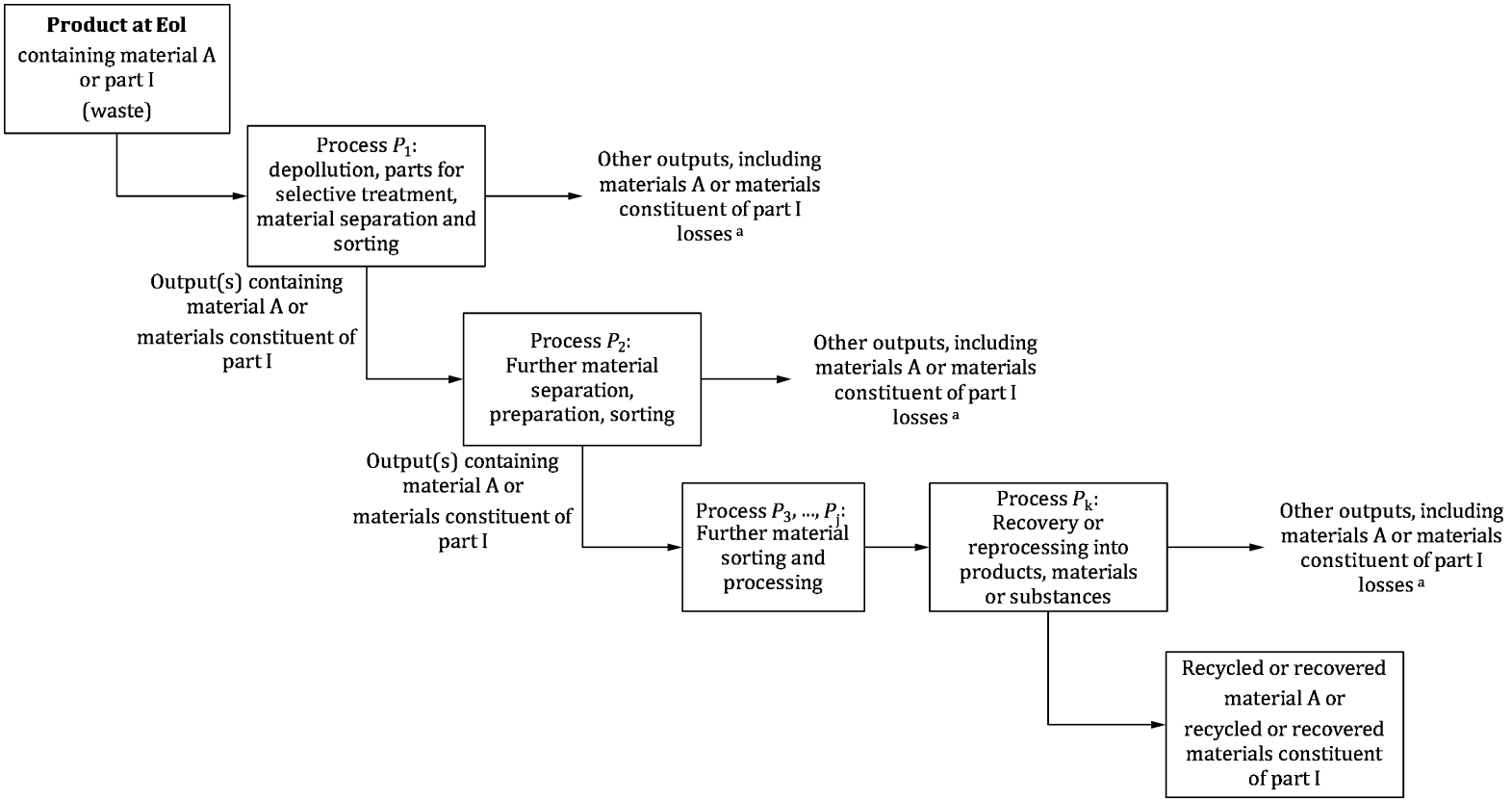
- operations to mitigate hazards and remove parts for selective treatment, when it's required (e.g. regulations applicable to the recycling facility), or allows a better efficiency of the end-of-life treatment;
- Recovery operations including material separation, which can be achieved through several techniques, such as mechanical, chemical or thermal separation material ;
- Recycling operations which are recovery operations whereby waste materials are actually reprocessed into products, materials or substances;
- Energy recovery operations and operations for treating waste for incineration or landfill;
- Disposal operations and operations for treating waste for landfill.

The end-of-life treatment scenario should be assessed up to the point where waste material has been reprocessed into products, materials or substances whether for the original or other purposes and as from which the recycled content can be calculated.

5.2 Definition of the end-of-life treatment scenario

The reference end-of-life treatment scenario shall be established in product-group specific standards.

For full transparency, a flow diagram shall be developed to illustrate the materials' flows through the EoL treatment chain. The diagram shall include all the steps of the EoL treatments in sequential order and specify from the starting point (waste product) all the outputs of each step and its destination (e.g. material recovered, landfilled or input to another process). To the extent possible the material output shall indicate the efficiency of the materials recovery in the process steps, as well as the losses of the same material in other outputs. The process steps shall describe briefly the operations that take place in them. A simplified example is shown in Figure 2.



Key

a Other outputs from which material A or materials constituent of part I, if present, could be considered if they are eventually recycled or recovered.

Figure 2 — Schematic example of flow diagram of an EoL treatment chain

The end-of-life treatment scenario shall define and document the full chain of treatment technologies for a material or a part (e.g. Printed Circuit Board). The EoL treatment scenario shall be taken as a reference to specify the applicable recyclability and recoverability criteria according to the requirements set in Clause 6, and to calculate the parameters required in the formulas set in Clause 7.

5.3 Representativeness of the end-of-life treatment scenario

Users of this document shall define on a product- or product-group specific basis the applicable end-of-life treatment scenario considering the criteria of representativeness listed in the table below:

Table 1 —Representativeness criteria for end-of-life treatment scenario definition

Criteria	Guidelines
Product-related representativeness	The EoL reference scenario shall be appropriate for the category and market of the product studied, in particular when treatment technologies are product- or product-group specific due to applicable regulations, industry practices, collection flows (e.g. per individual or collective producers' responsibility schemes) or health, safety and environmental concerns. The EoL reference scenario shall be representative for the corresponding waste collection flow.
Technological representativeness	State of the art treatment technologies shall form the baseline of the end-of-life treatment scenario for each process. For materials or components newly introduced on the market, treatment processes under development may be studied and documented. NOTE The end-of-life treatment scenario will include state of the art technologies, meaning that the latest, most up-to-date, methods for each technology/process are included, provided that they are already used by the industry, and economically viable, in a business as usual setting. The geographical representativeness of the latest technologies is also taken into account in the scenario definition.
Temporal representativeness	Due to the variations of the waste composition, recycling strategies and treatment technologies available, the end-of-life treatment scenario should be defined to be influenced as little as possible by short-term fluctuations that do not reflect fundamental changes of the recyclability and recoverability of the products
Geographical representativeness	Harmonized data from different countries (e.g. countries of the EU) should be used. The use of data generated by selecting operators representing BAT out of a pool of operators complying with the requirements of European treatment standards (e.g. in the case of WEEE: EN 50625 series) may be considered as representative for Europe.

For the recyclability assessment only one European recycling scenario can be set up per product-/ or product-group. A combination of different options resulting from the criteria and guidelines listed above can result in an average EU scenario.

5.4 Sources for EoL scenario definition and data collection

Representative data such as data from public sources (e.g. authority, industry, academia, etc.) may be used to define the EoL scenario for a specified product-group.

The most recent and appropriate data sources should be used. It is recognized that data gaps can challenge the applicability and the actual implementation of quantitative assessment methodologies.

NOTE 1 See JRC report "Feasibility study for setting-up reference values to support the calculation of recyclability / recoverability rates of electr(on)ic products"

The end-of-life treatment scenario should be set on the basis of studies of the suitable end-of-life treatments and complemented by information from manufacturers and recyclers.

NOTE 2 See "Refined methods and Guidance documents for the calculation of indices concerning Reusability/Recyclability/Recoverability, Recycled content, Use of Priority Resources, Use of Hazardous substances, Durability." Joint Research Centre (JRC) Technical Report, 2013

EXAMPLE: Sources of data for users of the document to define the EoL scenario are:

- Data on recovery and recycling rates of different waste categories, stated with reporting tools commonly used within the corresponding industry (e.g.: WF-RepTool for WEEE);
- Treatment standards applicable to the category of product (e.g.: EN 50625 standards on WEEE management)
- Case studies described in the scientific literature;
- Database of reference values, if developed, provided by national or European authorities;
- Parameters produced by treatment processes modelling with simulation tools.

NOTE 3 See M. A. Reuter and A. van Schaik, "Product-Centric Simulation-Based Design for Recycling: Case of LED Lamp Recycling," J. Sustain. Metall., vol. 1, pp. 4–28, 2015.

6 Design related criteria affecting recyclability and recoverability

The following horizontal guidelines shall be considered by the users of this document by taking into account the specificities of ErPs. They shall constitute a starting point and provide general guidance for product-specific standards or specific assessment methods.

Depollution and selective treatment of certain materials or parts at end-of-life (EoL) are prerequisites for recycling and recovery operations. A product complying with the chemicals or product legislation at a certain point in time shall not be considered as recyclable without depollution by default.

NOTE 1 The product may contain substances benefiting from a time-limited exemption under the chemicals or product specific legislation.

The following criteria are addressing the design characteristics of ErPs affecting the identification and removal of regulated substances or materials requiring selective treatment and their recycling or recovery.

NOTE 2 Examples of materials requiring selective treatment are specified in Annex VII of the WEEE Directive 2012/19/EU for products falling under its scope

Identification of regulated substances that have to be removed during depollution:

- Assess the ability to identify the parts of the product containing substances that shall be removed during depollution. This identification can be facilitated by e.g. a reference in the dismantling instructions, labels or coloured marking provided by the manufacturer and visible on the product.

Product design and structure:

- Assess the ability to access and remove (e.g. depending on joining techniques used) the parts that require selective treatment according to the end-of-life treatment scenario.
- Assess the ability to liberate joints (including screws, glue, snaps, etc.), to separate and to sort materials compatible with recycling processes.
- In case of non-separable material combinations, assess the use of materials which are compatible with existing recycling processes.
- Assess the ability to access and remove parts containing critical raw material from the product.
- Assess the ability to access and remove plastics parts (e.g. plastic using certain fillers or certain flame retardants) that reduce the recyclability according to the end-of-life treatment scenario.

Users of this document should implement these criteria under the form of a checklist and should consider these criteria within the definition of the factors used in the quantitative assessment described in Clause 7.

7 Assessment of the recyclability and recoverability of an energy-related product

7.1 General considerations for quantifying recyclability and recoverability

The recyclability rate, R_{cyc}, and recoverability rate, R_{cov}, of an ErP, shall be calculated as percentages by mass (mass fraction in percent) using the following formulas:

$$R_{cyc} = \frac{\sum_{k=1}^{n}\left(m_k \cdot R_{cyc,k}\right)}{m_{tot}} \cdot 100\ \% \quad (1)$$

$$R_{cov} = \frac{\sum_{k=1}^{n}\left(m_k \cdot R_{cov,k}\right)}{m_{tot}} \cdot 100\ \% \quad (2)$$

Where:

R_{cyc} is the recyclability of the product;

R_{cov} is the recoverability of the product;

n is the number of parts/materials;

m_{k} is the mass of the k^{th} material/part;

$R_{\mathrm{cyc,k}}$ is the recyclability of the part/material;

$R_{\mathrm{cov,k}}$ is the recoverability of the part/material;

m_{tot} is the mass of the complete product.

The calculation of the recyclability and recoverability rates of an ErP requires to determine the recyclability and recoverability factors of all its materials or parts ($R_{cyc,k}$ and $R_{cov,k}$).

NOTE 1 The calculation rates are subjected to uncertainties on several aspects as representativeness of the treatment scenario of reference, determination of the recyclability and recoverability factors, geometrical tolerancing of product, etc.

These factors shall be assessed taking into account, on the complete treatment chain defined in the end-of-life scenario (see Clause 5) and the criteria set on product characteristics according to the horizontal guidelines (see Clause 6).

NOTE 2 A product mass approach is not the only method to assess recyclability and recoverability. One of the limitations of a mass-based approach, is that the environmental benefits and impact of recovering different materials are not taken into account, including the quality of the recycled materials being generated and associated resource efficiency benefits that can result from recycling. However, the approach considering the environmental impacts also has its limitations. Further details on how these additional aspects can be considered is provided in Annex A.

In particular, the following rules shall be applied:

- When substances prevent recycling or recovery material stream in reference EoL treatment scenario are used, respectively $R_{cyc,k}$ and $R_{cov,k}$ of the material or part containing it shall be 0.

- When joining techniques do not allow separation of part or material combinations into recyclable or recoverable material stream in reference EoL treatment scenario, respectively $R_{cyc,k}$ and $R_{cov,k}$ of the part or material shall be 0.

- When the combinations of fillers or coatings and material they are intrinsically connected incompatible with recycling or recovery material stream in reference EoL treatment scenario are used, respectively $R_{cyc,k}$ and $R_{cov,k}$ of the material concerned shall be 0.

- R_{cyc} and R_{cov} of the surface proportion and related weight not able to be disjoined in the EoL scenario shall be 0

These factors should include the efficiency yields of the treatment processes (e.g. to depollute, separate, sort and recycle or recover the corresponding materials and parts) and shall define and document the full chain of treatment technologies, as described in subclause 7.2.

Alternatively, if no data are available on such yields, a simplified assessment may be done, as described in subclause 7.3. A simplified assessment could be done for the entire treatment scenario of reference or only on treatment processes on which no data are available.

NOTE 3 Recyclability and recoverability rates can be calculated either for the product as a whole or for specific parts or materials.4 The recyclability and recoverability rate for an individual material in the entire product or in a part of interest can be obtained as the ratio of the material(s) that can be recycled/recovered, divided by the total mass of that material contained in the product or part.

[4] "Integration of resource efficiency and waste management criteria in European product policies – Second phase". Application of the project's methods to three product groups (final). Joint Research Centre (JRC) Technical Report, 2012.

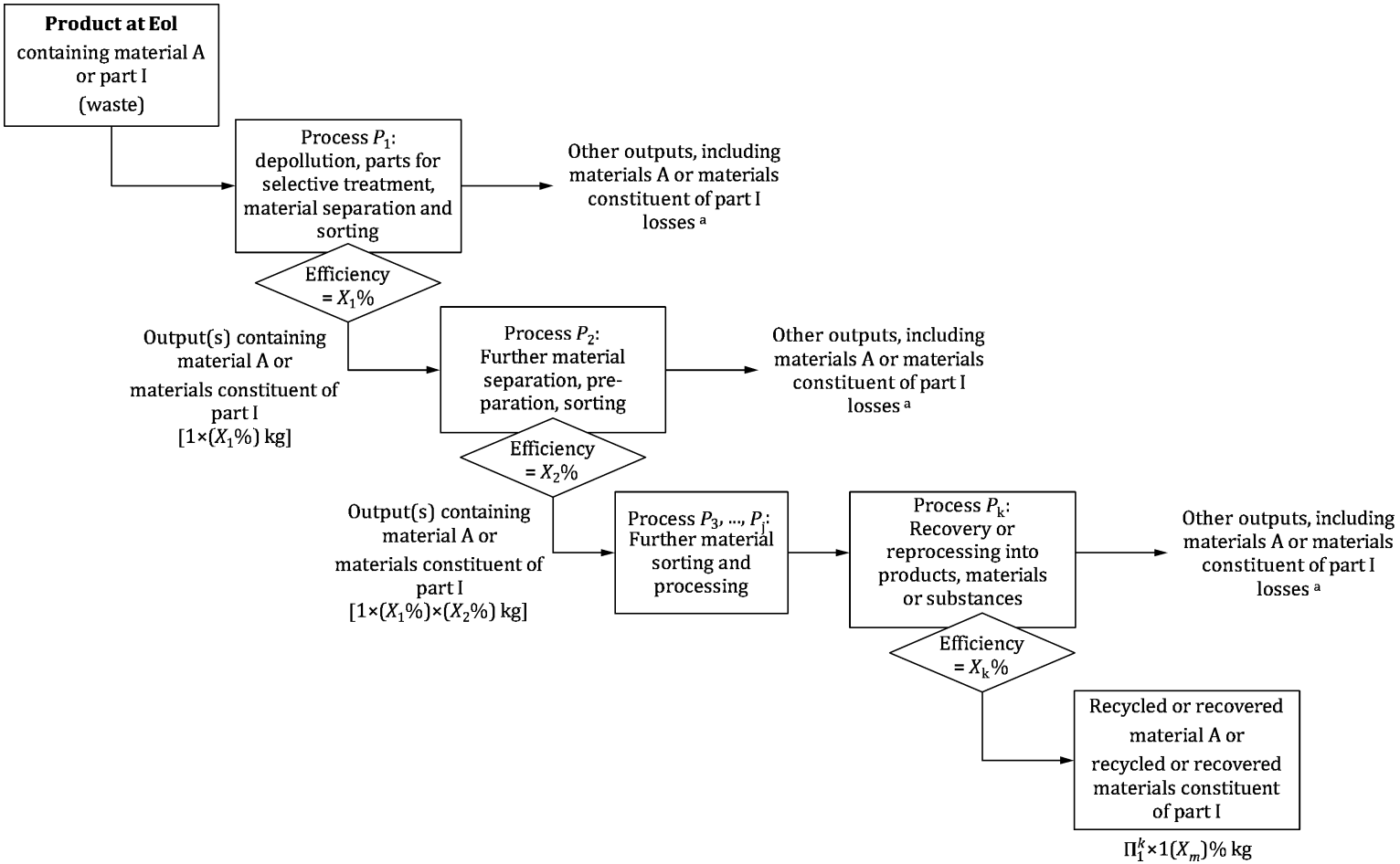
7.2 Detailed assessment of recyclability and recoverability

Recyclability ($R_{cyc,k}$) and recoverability ($R_{cov,k}$) factors for each material or part shall be comprised between 0 and 1, depending if and how the ability to recycle or recover the material is affected by one or several criteria set on product characteristics according to the guidelines provided in Clause 6.

The material-specific yields of the treatment processes shall be assessed on their efficiency to bring the input materials to output fractions that will be fed into the adequate recycling and recovery technologies, as illustrated in Figure 3. The material-specific yield of the complete treatment chain for material A, is equal to $\prod_{1}^{k} 1 \cdot (X_m)\%$, with X_m the yield of process m.

EXAMPLE: A part containing copper is processed in three subsequent processes. The efficiency for the first process is 100 %, for the second process 50 % and for the last step of the process 80 %. RCR_{copper} of the entire chain of processes is 40 % (100 %·50 %·80 %).

NOTE In the process of performing this assessment one can also gain insight into the quality and/or purity of the recycled material output relative to the waste input, but the Formula (1) and (2) in subclause 7.1 cannot quantify material quality or purity.



Key

a Other outputs from which material A or materials constituent of part I, if present, could be considered if they are eventually recycled or recovered.

Figure 3 — Schematic example of full assessment of recyclability and recoverability factors for a material A along the treatment chain

7.3 Simplified assessment of recyclability and recoverability

Recyclability ($R_{cyc,k}$) and recoverability ($R_{cov,k}$) factors for each part or material shall be equal to 0 or 1, depending if the ability to recycle or recover the material is affected by one or several criteria set on product characteristics according to the guidelines provided in Clause 6.

In the simplified assessment, process yields are not taken into account: the ability of the treatment process to bring the input materials to output fractions that will be fed into the adequate recycling and recovery technologies is assessed in a binary way, as illustrated in Figure 4.

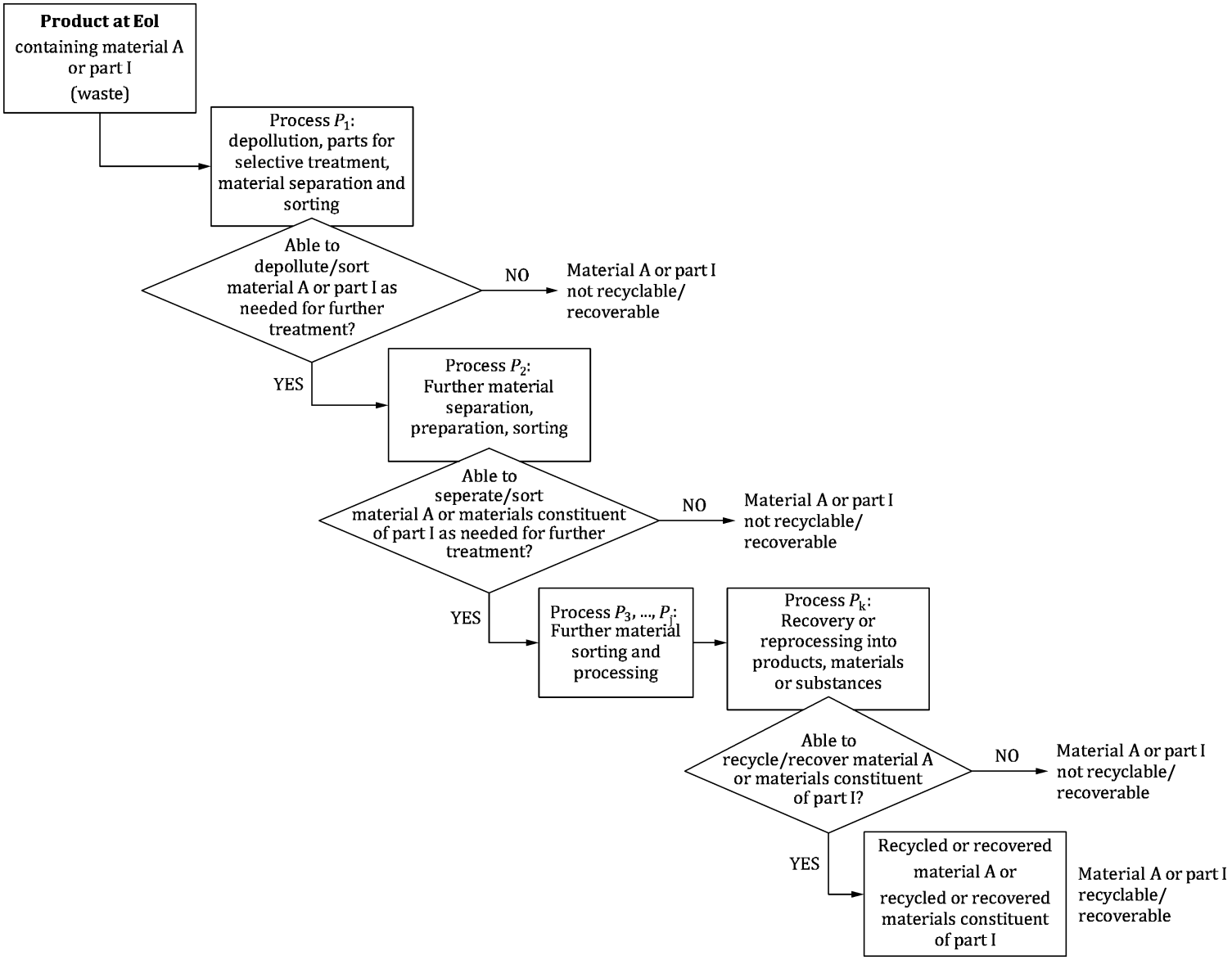


Figure 4 — Schematic example of simplified assessment of recyclability and recoverability factors for a material A along a treatment chain

8 Assessment of the recyclability and recoverability of critical raw materials

8.1 General considerations

Due to their low weight share, Critical Raw Materials (CRMs) have generally a negligible effect on the mass-based recyclability rate of the product, but may contribute to avoid supply, economic and environmental risks and impacts. Therefore, the recyclability of critical raw materials shall be determined in accordance with a product-specific assessment, which supports particular implementing measures.

The recyclability of one (or more) CRM(s) may be assessed by the recyclability formula (see subclause 7.1.), calculated for those parts that contain the target substance(s). Representative EoL scenarios and associated data for recycling and recovery rates for CRMs have to be defined analogously as for other materials or parts (see Clause 5).

8.2 Assessment method

Assessment method for target substances like CRMs shall be created by the user of this document if applicable. The following aspects shall be considered when setting up assessment criteria:

- The likely presence of target CRM(s) in a specific ErP;
- Distribution of target CRM(s) over different parts (with particular care to CRMs declared according to EN 45558 [5]);
- Varying thresholds for different CRM(s);
- Ability to access and liberate parts containing CRM(s)
- Miscellaneous matters affecting possibilities to recycle target CRM(s);

9 Reporting recyclability and recoverability aspects

9.1 General

The product or product-group standard writers shall ensure that their standard(s) include requirements for reporting recyclability and recoverability as follows:

- The assessment of recyclability and recoverability of products shall be documented in a report.
- The assessment report itself is likely to be considered as data sensitivity level <3> in accordance to EN 45559.[6]
- The assessment report shall also include data and information of importance for any results published in data sensitivity levels < 2 and / or 1 > , for the different stakeholders.
- Special care shall be taken to demonstrate transparency and the correlation between information on the results of the assessment and the input data and assumptions used

[5] Under preparation. Stage at time of publication: prEN 45558
[6] Under preparation. Stage at time of publication: prEN 45559

9.2 .Elements of the assessment report

The product or product-group standard writers shall ensure that their standard(s) sufficiently cover that when reporting recyclability and recoverability results, data, methods, assumptions, limitations and conclusions shall be completely and accurately reported.

The report shall follow the following structure:

A. General aspects

1. Instigator of the assessment
2. Date of report, place, etc.
3. List of standards applicable to the assessment

B. Scope of assessment

1. Description of product assessed
2. Description of cut-off rules applied

C. Input data and approach for the assessment of recyclability and recoverability

1. Description of data and other information used/needed for the assessment
2. Calculations or scoring when relevant
3. Methods or tools used in the assessment

D. Output of the assessment

1. Result of the assessment covering a list of qualitative and quantitative recyclability and recoverability content that could be reported for different stakeholders
2. List of applicable references (incl. standards, requirements and policies)

9.3 Documentation

The assessment report shall include any documentation or reference to the documentation used for the assessment.

If generic data are used for the assessment, these shall be referenced and the use shall be justified.

Annex A
(informative)

Relationship with environmental impacts of recycling and recovery

Assessing recyclability based on the amount (mass) of material able to be recycled, does not consider the specific net environmental benefits of recycling different materials. These benefits depend on the ability to substitute primary production impacts, while taking into account the environmental burdens of operating the recycling processes. Whilst recycling and recovery of materials in general is considered to be environmentally beneficial, the differences between materials and recycling technologies are large. For example, recycling 'material A' that is contained only in small amounts in the product, would have little effect on the recyclability rate (mass) compared to 'material B', that is present in large amounts. However, the net environmental benefit of recycling the small amount of material A (e.g. a precious metal, rare earth in electronic components) can be much higher than of the large amount of material B (e.g. a structural material in a casing). Materials may also be downcycled, avoiding even less environmental primary production impacts, meaning the recycling outcome is of lower 'value' or 'quality' from an environmental perspective. Additional information on the environmental benefits of recycling can therefore complement the mass-based recyclability rate, by providing information on what specific materials are worth recycling, and where additional recycling efforts and associated emissions may exceed the environmental benefits.

The net recyclability and recoverability environmental benefits of a representative end-of-life treatment scenario for the considered product, can be calculated by converting the amounts of individual recycled and recovered materials or substances into avoided environmental impacts from the primary production of these materials and substances using Life-Cycle Analysis (LCA) methods, which principles are set out in ISO 14040 and ISO 14044. This calculation also should consider the environmental impacts of the recycling, recovery and disposal processes, as well as the changes in the inherent properties of the materials or substances ("upcycling" or "downcycling") by considering the qualities and quantities of materials on both input and output side.

NOTE 1 Other relevant standards for reference are ISO 14067 "Carbon footprint of products — Requirements and guidelines for quantification and communication", and EN 15804 "Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products".

Recyclability and recoverability benefit rates may then be calculated, in analogy with the mass-based recyclability and recoverability rates, by putting for the individual materials the net recyclability and recoverability benefits in relationship to the theoretical benefit potential of the product at EoL, before summing up the rates. The benefit rates express hence the share of the environmental value of the embodied materials in a product that can be recycled or recovered in the end-of-life treatment of that product.

The relevance of calculating the environmental benefits for specific materials for the defined EoL scenario and specify data sources and assumptions should be considered, where needed, to ensure consistent calculations. Default values for recycled contents, recycling rates and the environmental benefits of various materials and recycling processes (e.g. as normalized and aggregated environmental index or as Climate Change impact or other indicators) can be considered to be provided to avoid additional producer-specific data collection is needed. More information on how the environmental benefit could be integrated, possible data sources, and an illustrative example can be found in a White paper.

NOTE http://maki-consulting.com/wp-content/uploads/2018/03/Environmental-benefits-recycling_White-paper_clean.pdf

Bibliography

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

[3] ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

[4] ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

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

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[7] EN 50625 (series), *Collection, logistics & Treatment requirements for WEEE*

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[9] IEC 62474, *Material Declaration for Products of and for the Electrotechnical Industry*

[10] Directive 2008/98/EC

[11] IEC/TR 62635:2012, *Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment*