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Technical recommendations on possible elements and parameters of a methodology to assess recyclability of packaging in the framework of the Packaging and Packaging Waste Regulation Proposal

Listing the essential elements and parameters of a methodology to assess recyclability of packaging

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Contents

Abstract

The aim of this study is to develop technical recommendations for possible elements and parameters of a methodology to assess recyclability of packaging, referred to in Article 6 of the EC proposal for a Packaging and Packaging Waste Regulation, to support the co-decision process.

The main objective is to identify relevant functionalities of the packaging materials (listed in Table 1 of Annex II of the proposal) that could be considered in a design-for-recycling (DfR) methodology.

A mapping exercise of available DfR guidelines was carried out to build up an extensive database for each packaging material. The outcomes of this study are based on data and evidence provided by experts in the written stakeholder consultation.

The proposal consists of a list of elements and parameters, a detailed description of each parameter and the relevance for recyclability.

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Organisations (in alphabetical order):

ACE (Alliance for Beverage Cartons and the Environment)	DSM Engineering Materials BV	FEICA (Association of the European Adhesive and Sealant Industry)	PAPREC
Ahlstrom	DUH (Deutsche Umwelthilfe e.V.)	FERVER (European Federation of Glass Recyclers)	PCEP
APA (Advanced Packaging Alliance)	EAFA (European Aluminium Foil Association)	FEVE (European Container Glass Federation)	Petcore Europe
ATT Polymers GmbH	Eastman Chemical Germany	FH Campus Wien	Plastics Europe
BDE (Bundesverband der Deutschen Entsorgungs-, Wasser- und Kreislaufwirtschaft e. V.)	ECMA (European Carton Makers Association)	FINAT (Association for the European label industry)	PRE (Plastics Recyclers Europe)
Borealis	ECTA (European Core and Tube Association)	FPE (Flexible Packaging Europe)	Pro Carton
CEFIC (European Chemical Industry Council)	EKO-KOM	Heineken	R-Cycle
CEFLEX (Circular Economy for Flexible Packaging Initiative)	EPBP (European PET Bottle Platform)	Huhtamaki	RECOUP
CEPI (Confederation of European Paper Industries)	ESA (European Snacks Association)	Ingevity	SCS (Styrenics Circular Solutions)
Cerame-Unie (European Ceramic Industry Association)	EUMEPS (European Manufacturers of Expanded Polystyrene)	IPV (Industrieverband Papier- und Folienverpackung e.V.)	Smurfit Kappa
Circular Analytics	EUPIA (European Printing Ink Association)	KIDV (Kennisinstituut Duurzaam Verpakken)	Stora Enso
CITEO	European Bioplastics e.V.	L'Oréal	Suez
Coca-Cola Europe	EUROPEN (European Organisation for Packaging and the Environment)	Lucense	Sulapac

COMIECO (Consorzio Nazionale Recupero e Riciclo degli Imballaggi a base Cellulosica)	EUROSAC (European Federation of paper sack industries)	Mosaico	TEC (Total Energies Corbion)
CONAI (Consorzio Nazionale Imballaggi)	EXPRA (Extended Producer Responsibility Alliance)	MPE (Metal Packaging Europe)	UBA (Umweltbundesamt Deutschland)
CTP (Centre Technique du Papier)	ExxonMobil Chemical Europe Inc.	Novamont	Utilitalia (Federazione Utilities)
Cyclos HTP Institute	FEA (European Aerosolo Federation)	Novelis	WPV (Wirtschaftsverband Papierverarbeitung e.V.)
Delfort Group	FEAD (European Waste Management Association)	NW	ZSVR (Stiftung Zentrale Stelle Verpackungsregister)
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Executive summary

Within this study we identified relevant parameters and elements that can be used as basis for the development of a methodology to assess recyclability of packaging. The recommendations are based on a mapping exercise of Design-for-Recycling (DfR) guidelines for the different packaging materials, complemented by data provided by the involved stakeholders.

Policy context

Article 6 of the EC proposal for a Packaging and Packaging Waste Regulation (PPWR) lays down obligations for all packaging placed on the market to be recyclable and sets out criteria for recyclability.

A DfR assessment based on DfR criteria is proposed as a method to assess recyclability of packaging. In order to create regulatory certainty for economic operators and economies of scale, the Commission proposes to harmonise DfR criteria as mandatory requirements at Union level. It is foreseen to establish DfR criteria via delegated acts, which will have to be complied with by 2030. The methodology for assessing recyclability at scale will also be developed at a later stage and will have to be complied with by 2035.

The development of the methodology, based on DfR criteria and recyclability at scale requirements, is not part of the present study.

Key conclusions

Based on the JRC in-house research and the feedback received by stakeholders a list of 4 elements and 19 parameters is proposed as starting point for a methodology to assess recyclability of packaging materials (see Table 1).

Table 1: Proposal of possible elements and parameters for a methodology to assess recyclability of packaging

Element	**Parameter**
Predominant packaging material	Materials
	Colours / Optical transmittance
	Additives / Fillers
	Barriers / Coatings
Decoration, information, branding	Coding
	Inks / Lacquers / Varnishes
	Labels / Sleeves - Materials
	Labels / Sleeves - Packaging coverage
Closing and opening systems	Tamper evident elements (shrink wrap / rings)
	Closures / Openings
	Liners / Seals / Valves
Other	Adhesives (packaging body, labels and components, closure)
	Dimension of packaging
	Separability of packaging parts (ease of dismantling)
	Product residues
	Recycled content
	Content of biodegradable materials
	Integrated and separate components
	Others

Related JRC work

This work is part of a preparatory study carried out by DG ENV and the JRC to support the co-decision process of the PPWR proposal. The preparatory study aims also at giving technical recommendations on a possible aggregation of selected packaging categories, listed in Table 1 of Annex II of the proposal (see Annex 1 of this document), presented in a separate JRC science for policy report (see (Pierri et al., 2024)).

Quick guide

The report is structured as follows: in chapter 1 the policy context is given and the rationale and objectives of the study are presented; in chapter 2 the methodology used to build up the database and to come up with the technical proposal is described; in chapter 3 the results are presented; finally in chapter 4 concluding remarks and final recommendations are drawn.

1 Introduction

1.1 Policy context

Article 6 of the **EC proposal for a Packaging and Packaging Waste Regulation** amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (hereafter: PPWR) sets out recyclability requirements for packaging as conditions for placing packaging on the market.

In this context, the Design-for-Recycling (DfR) approach is proposed for assessing packaging recyclability and is considered to be one of the most effective measures to improve packaging circularity. DfR criteria have been established already for several packaging formats by industry or by some Member States. However, in order to create a regulatory certainty for economic operators and economies of scale, the Commission proposes to harmonise such criteria as mandatory requirements at Union level. It is foreseen to establish DfR criteria via delegated acts, which will have to be complied with by 2030. The methodology for assessing recyclability at scale will also be developed at a later stage and will have to be complied with by 2035.

1.2 Rationale and objectives of the current study

The current preparatory study carried out by DG ENV and the JRC aims at:

(i) assessing the feasibility of **aggregating the packaging categories** listed in Table 1 of Annex II of the PPWR proposal (EC, 2022) (Table 4, Annex 1). This task is described in Pierri et al. (2024).

(ii) developing technical recommendations on possible **parameters and elements of the methodology to assess recyclability** of packaging. This task is described within this report.

It has to be noted that the development of the detailed methodology and criteria for DfR and recyclability at scale, is not part of this study. The technical proposals by the JRC are based on data and evidence submitted by the stakeholders during the consultation phase.

The outcome of this study will be used as a basis for the development of a recyclability methodology and will support the co-decision process of the Packaging and Packaging Waste Regulation (PPWR).

This report focuses on task (ii) developing technical recommendations on possible elements of the methodology to assess recyclability of packaging but also to provide a solid base for task (i). The database developed within this study fed the statistical analysis carried out in Pierri et al. (2024) to identify similarities across selected packaging categories.

2 Methodology

2.1 Mapping of Design-for-Recycling guidelines

As a first step, a mapping exercise of available DfR guidelines for packaging materials was carried out by the JRC. Academic papers were not included in this exercise, the focus was exclusively on technical reports, factsheets by brand owners or associations and existing design for recycling guidelines. The geographical coverage of the reports analysed spans national, EU-wide and global areas. The 28 guidelines that were screened are either general, i.e. are applicable to all packaging materials, or are material specific (see Table 5 in Annex 2 of this document).

2.2 Development of a packaging database

The aim of the mapping exercise was to develop a database for each packaging category (Table 4, Annex 1) with the essential **elements**[1] and **parameters**[2] that could be used as starting point for the development of a methodology to assess recyclability of packaging (see Table 6). The packaging materials covered are glass, paper and cardboard, metal, plastic, wood and cork, textile, ceramics and porcelain stoneware, the main packaging materials listed in Table 1 of Annex II of the PPWR proposal (see also Annex 1 of this document).

In order to assess the feasibility of aggregating packaging categories (task i of the preparatory study), it is crucial to know which criteria can affect recyclability. Therefore, it was necessary to increase the granularity of the database by providing details of so-called **sub-parameters**[3] for each parameter.

2.3 Stakeholder consultation for data validation and extension of the database

Within the written stakeholder consultation, experts were asked to validate the findings and to complement the database. A stakeholder workshop was held on 29 June 2023 to present the initial findings by JRC and the process for the written consultation. This consultation consisted in an extensive data validation exercise, in the format of an excel spreadsheet. Stakeholders had the possibility to complement or comment on the essential components, to indicate if specific elements, parameters or sub-parameters were irrelevant and to provide open comments (e.g. on aggregation or amendment of packaging categories).

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[1] The term **element** refers in the current exercise to the overarching classification of possible building blocks of the recyclability assessment that encompass a specific part of the packaging (e.g. main packaging body, closure system) or present a specific feature. Each element can contain a set of parameters.

[2] The term **parameters** refers to factors that can influence recyclability of packaging (e.g. additives). Each parameter can contain a set of sub-parameters.

[3] The term **sub-parameters** refers to specific features of a parameter (e.g. wet strength agents are classified under the parameter 'additives').

3 Results

3.1 JRC packaging database

The following sections presents an overview of the available data on DfR guidelines for the different packaging materials (Section 3.1.1) and the initial proposal for essential components of a methodology to assess recyclability (Section 3.1.2).

3.1.1 Data availability for the different packaging materials

The availability of data to elaborate the list of parameters and sub-parameters in the screened DfR guidelines differs for the various packaging categories (see Figure 1).

For **glass packaging**, several guidelines have been proposed by the industry, allowing the development of a solid database for category 1. However, none of those guidelines cover or specifically refer to composite glass (category 2).

For **paper/cardboard packaging** different guidelines or recommendations on DfR were developed by different organisations at national, EU-wide or even global level. The database is thus extensive for category 3 and category 4.

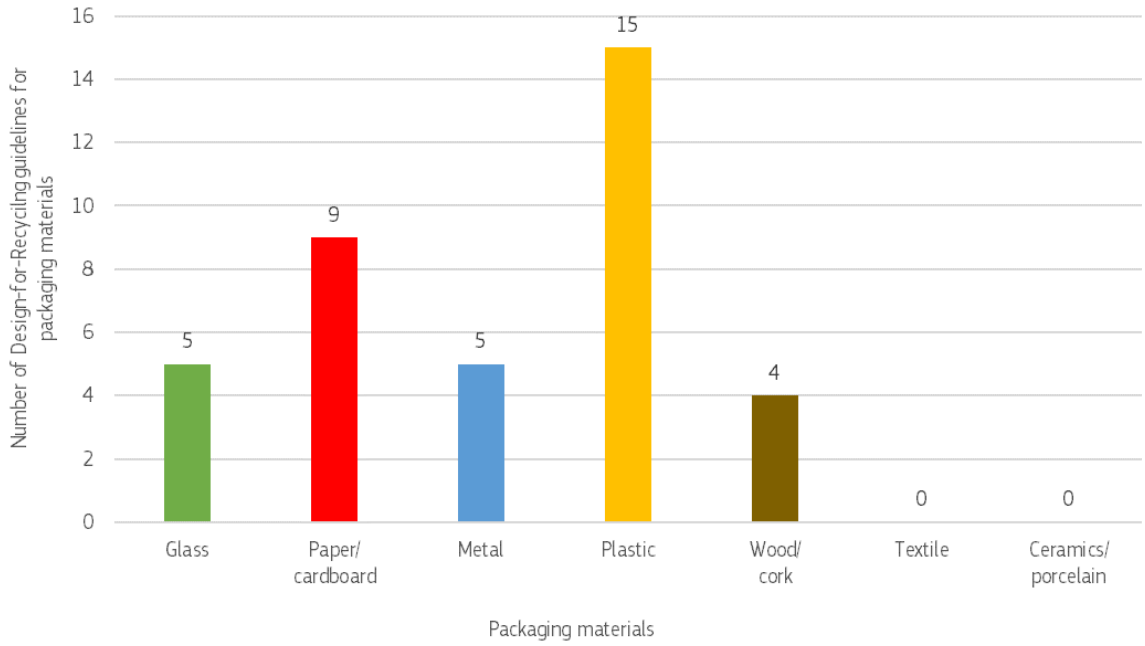
For **metal packaging**, far fewer DfR guidelines were found, but nevertheless a comprehensive and robust database could be established on the basis of the available data for category 5 (metal – steel), category 7 (metal – aluminium rigid) and category 8 (metal – aluminium semi rigid or flexible). The database is generally more comprehensive for mono-material and rigid packaging.

For **plastic,** DfR criteria have already been developed by different organisations and even proposals for recyclability assessment have been published. Therefore, the database is the most complete. However, the database is not comprehensive and lacks some information for specific categories that are either not covered in the screened guidelines or are not covered at the desired level of detail for this study, as it is the case for XPS/EPS rigid (category 24/25) and other flexible plastics (category 27). The most comprehensive data for plastic packaging is available for those plastic categories that are already being recycled on a large scale (categories 10-23).

For **wood/cork packaging** (category 28) no specific DfR guidelines were found. The reports that were used as basis are related to wood waste and recycling of wood in general. Hence it was not possible to establish an extensive database.

No DfR guidelines were found for **textile packaging** and **ceramics or porcelain stoneware** (categories 29 and 30, respectively).

Figure 1. Number of DfR guidelines or other relevant reports for the different packaging materials listed in Table 1 of Annex II of the PPWR proposal (EC, 2022)



Source: JRC in-house mapping of Design-for-Recycling guidelines.

3.1.2 Initial proposal for essential components of a methodology to assess recyclability

Based on the information extracted from the DfR guidelines, the JRC developed an extensive database, including detailed tables for each of the 30 packaging categories listed in Table 1 of Annex II of the initial PPWR proposal from 22 November 2022. The tables of the JRC packaging database consist of **elements, parameters** and **sub-parameters** of a possible methodology to assess **recyclability of packaging.**

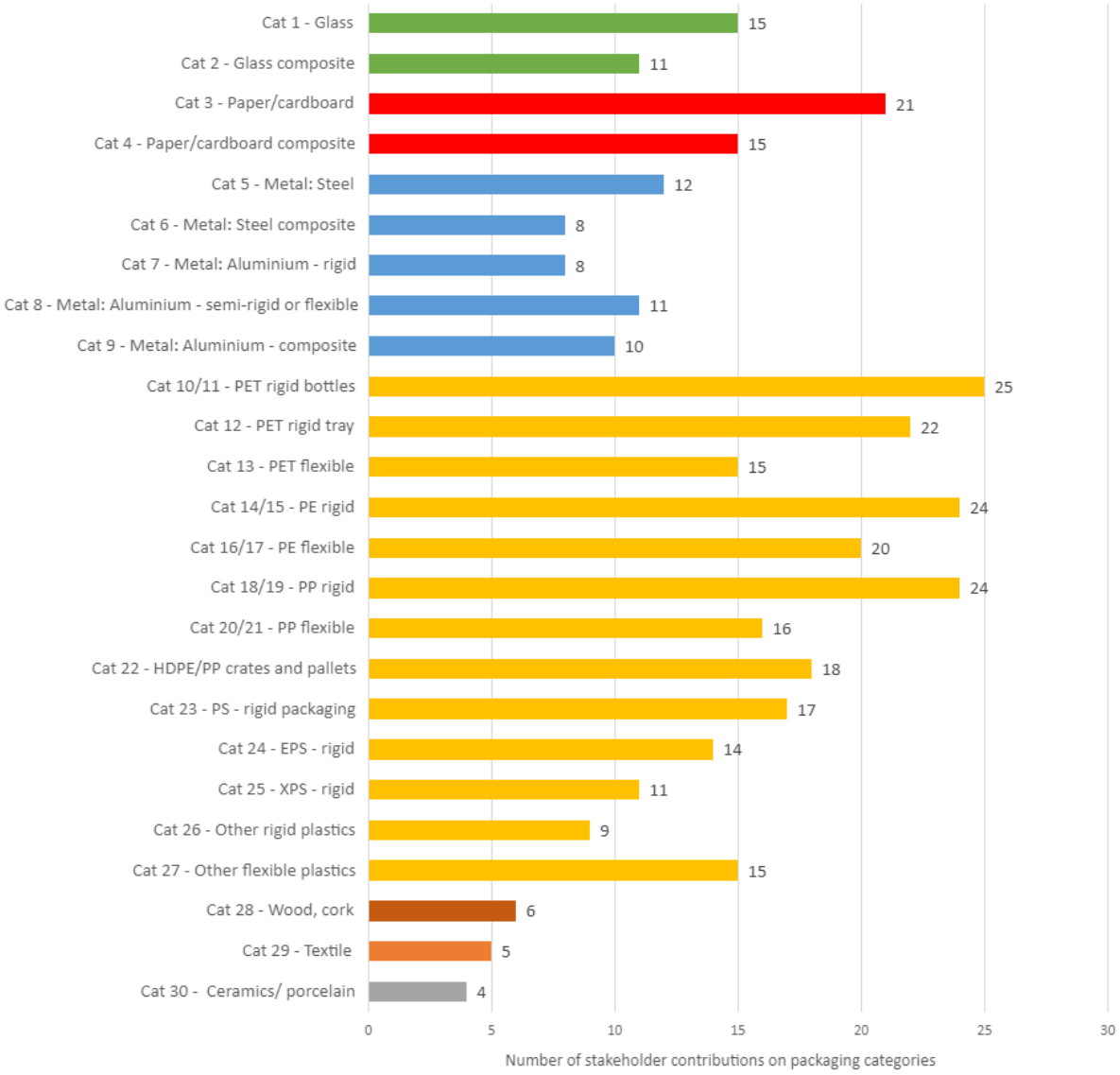
As part of the mapping exercise, 20 parameters were identified upfront to the stakeholder consultation that are most relevant for the recycling of packaging. These parameters were then clustered into 4 elements (see Table 6 in Annex 3). The **sub-parameters** are very specific to each packaging material and are not presented in detail in Table 6, as this level of detail goes beyond the scope of this work.

3.2 Outcome of the stakeholder consultation

The JRC received feedback from nearly 100 organisations and the contributions to the different packaging materials were distributed as shown in Figure 2. Most responses were received for the packaging materials for which the JRC database was already more comprehensive, on the basis of the mapping exercise (i.e. paper/cardboard, plastic). Within plastic, most contributions were received for rigid plastics, so again for those categories for which the database was already the most detailed. The comments allowed a proper data validation.

Data provided by stakeholders were used to improve and consolidate the database for the composite materials (e.g. glass composite, metal – steel composite, metal - aluminum composite) and for flexible packaging (e.g. PET flexible, other flexible plastics). For the packaging categories wood/cork, textile, and ceramics/porcelain, only a few comments were received and the database for those materials could not be improved significantly. Nevertheless, the JRC internal mapping and feedback from the stakeholders were sufficient to fulfil the objectives of the current study, i.e. to come up with a list of elements and parameters.

Figure 2. Number of contributions of stakeholders on the different packaging categories.



Source: JRC stakeholder consultation from 27 June 2023.

3.2.1 Update on Design-for-Recycling guidelines and additional information

Besides the direct input on the existing tables on elements, parameters and sub-parameters, for each packaging category, stakeholders provided further DfR guidelines, position papers and general input that were screened and taken into account. Furthermore, the JRC has been informed that CEN (CEN/TC 261/SC 4/Working group 10) is currently developing 15 standards on DfR for plastic packaging (CEN, 2023). It is expected that by 2025, CEN will publish guidelines for DfR and recyclability evaluation processes for PET bottles, PET rigid packaging (except bottles), PE and PP rigid packaging, PE and PP flexible packaging, PS/XPS packaging, and EPS packaging. An updated list of DfR guidelines and the on-going CEN work on standards is given in Table 5 in Annex 2. The information from the on-going CEN work on plastics was also considered for the potential merging of plastic packaging categories described in Pierri et al. (2024).

The comments and additional evidence received from stakeholders were taken into account for the consolidation of the JRC database including elements, parameters and sub-parameters (see supplementary Excel-document for this report, as described in Annex 4).

3.2.2 Feedback on elements

According to stakeholders, no major elements were missing from JRC's initial proposal and only suggestions to rename individual elements were made. The following changes have been adopted (see Table 2):

- 'Packaging material / Main packaging body' changed to 'Predominant packaging material'
- 'Information / Branding' changed to 'Decoration, information, branding'
- 'Closure system' changed to 'Closing and opening systems'

3.2.3 Feedback on parameters

Overall, stakeholders endorsed the list of parameters initially proposed by the JRC. In the following paragraphs the most relevant changes on the parameters are presented and discussed (not exhaustive).

- **Changes in designations:** To be in line with specific terms used in the packaging industry, certain designations were changed (e.g. 'Inks / Lacquers (on packaging, labels, sleeves and tamper evident)' to 'Inks / Lacquers / Varnishes). In the case of 'Closure (rigid and flexible)' the designation was changed to 'Closures / Openings', as the closure fulfils at the same time an opening function. 'Colourants (pigment / dyes)' was changed to 'Colours / Optical transmittance'. The reasoning behind this is that colourants was an inaccurate and incomplete description. To properly detect the material the optical transmittance[4] and colour (e.g. carbon black) are key properties and the colour of the packaging can affect the recyclability of packaging.
- **Merging of parameters**: To reduce and simplify, certain parameters were merged as for example '*Labels – Materials'* and '*Sleeve Materials'* to '*Labels / Sleeves – Materials*' or '*Labels – Product coverage*' and '*Sleeves – Product coverage'* to '*Labels / Sleeves - Packaging coverage*'.
- **Inclusion of new parameters:** Multiple stakeholders suggested to include new parameters, in particular '*recycled content*' and '*content of biodegradable materials*'. The recycled content could affect transparent plastic packaging, but also paper to a certain extent. Studies on PET bottles reveal that an increasing percentage of recycled content can have negative effects on for example haziness, colour (lightness, yellowing), intrinsic viscosity, and molecular weight (Chacon & Brouwer, 2020). Biodegradable materials were mentioned in view of their increasing quantities in packaging. In addition, Pierri et al. (2024) proposed to include biodegradable plastics as a new category in Table 1 of Annex II of the PPWR proposal.
- **Reallocation of parameters to other elements**: In the first draft presented to the stakeholders, *'Adhesives / glue'* were only considered for labels. However, adhesives are also essential for the packaging body in case of multi-layer materials (laminating) and reinforcing the packaging. Adhesives are used to apply labels and other components or can also be used to seal the packaging. As adhesives are an integral part of different elements of a packaging, the adhesives were reallocated from the element '*information / branding*' to the element '*other*' (new designation: *'Adhesives (packaging body, labels and components, closure'*)).

3.2.4 Feedback on sub-parameters

The feedback on sub-parameters was extensive. The JRC thoroughly analysed the received input and proceeded to deleting, adding, reallocating or changing a sub-parameter based on the number of stakeholders' comments and their relevance. As mentioned above, the extensive list of sub-parameters served also as basis for assessing the feasibility of aggregating the packaging categories (see (Pierri et al., 2024)).

3.3 Proposal for essential components of a methodology to assess recyclability

The objective of this section is to provide technical recommendations on possible elements and parameters of a methodology to assess recyclability of packaging. Based on the information extracted from the DfR guidelines and the input provided by the stakeholders, **4 elements and 19 parameters** are proposed as essential components that could be accounted for in DfR criteria (see Table 2). It has to be noted that the parameters

[4] The optical transmittance measures the amount of light able to pass through a material, without the material reflecting or absorbing it.

below are not necessarily relevant for all packaging categories. For example '*Additives / Fillers*' or '*Barriers / Coatings*' are mostly relevant for paper/cardboard and plastic packaging, but are likely not relevant for other packaging categories, such as e.g. glass or metal.

Table 2. Proposal for elements and parameters of a methodology to assess recyclability of all packaging materials, including a more detailed description of the parameters.

Element	**Parameter**	**Description**
Predominant packaging material	Materials	The material of which the predominant packaging material is made of (origin of the material) and the way it is assembled in the final packaging product (finishing). It includes the main material as well as other materials used in composites.
	Colours / Optical transmittance	Colour: the substance that imparts colour to the packaging material. Optical transmittance: measures the amount of light able to pass through a material, without the material reflecting or absorbing it. A fully transparent packaging material theoretically transmits 100% of the light.
	Additives / Fillers	The substance added to the material to confer specific physico-chemical properties (e.g. antistatic, preserve soft/hard properties, fire resistant, UV resistant).
	Barriers / Coatings	The material or substance added to confer barrier properties (barrier), or a variety of materials applied to coat a packaging, e.g. wax, silicone (coating).
Decoration, information, branding	Coding	Code applied on the main packaging body or on a packaging component (e.g. on a label), including for instance batch coding and best-before-date.
	Inks / Lacquers / Varnishes	Ink: mixture of colourants with other substances applied onto the packaging material or other packaging components (labels, sleeves) by a printing or coating process. Lacquer: a protective coating made of resin and/or cellulose ester dissolved in a volatile solvent. Varnish: resin dissolved in a liquid for applying on wood, metal, or other materials to form a hard, clear, shiny surface when dry.
	Labels / Sleeves - Materials	The material which a label or sleeve is made of. Labels are glued to the packaging body with adhesives; sleeves are attached to the packaging body without using adhesives.
	Labels / Sleeves - Packaging coverage	The coverage rate in % of a label or a sleeve on the main packaging body.
Closing and opening systems	Tamper evident elements (shrink wrap / rings)	A shrink film or ring applied on the closure to seal the packaging, used mostly to provide guarantee to the consumers that the product is unopened.
	Closures / Openings	Rigid or flexible closures or openings (e.g. caps) used to close and open the packaging.
	Liners / Seals / Valves	Specific closure systems that protect the content of the package until it is opened by the consumer. Valves allow the release of gases from a packaging but prevent other gases like e.g. oxygen from entering.
Other	Adhesives (packaging body, labels and components, closure)	Substances used to: - attach components to the main packaging body (e.g. label);

		- laminate one or more layers of flexible packaging material; - close the packaging; - reinforce the packaging; - create a certain shape (e.g. a box).
	Dimension of packaging	Size of a packaging.
	Separability of packaging parts (ease of dismantling)	Ability to dismantle the packaging components and/or ability to separate different packaging materials by consumers, during collection or at sorting plants.
	Product residues	Amount of product residues in the packaging body (share in %) and also content of recycling-disrupting residues or content of hazardous residues.
	Recycled content	Share of recycled material on the overall weight of packaging (%).
	Content of biodegradable materials	Share of biodegradable material on the overall weight of packaging (%).
	Integrated and separated components	Other components that are specific to the individual packaging categories, e.g. straws on beverage cartons or carrying handles.
	Others	Contains any other sub-parameters which cannot be assigned to the parameters above.

4 Conclusions and recommendations

The JRC performed a mapping exercise to identify relevant DfR guidelines for the packaging materials referred to in Table 1, Annex II of the PPWR proposal (see also Annex 1 of this document).

An extensive database was elaborated for each packaging category with the data extracted from the screened guidelines. The database was consolidated following a written stakeholder consultation. The database includes elements, parameters and sub-parameters (see supplementary Excel file for this report, as described in Annex 4).

With regard to the packaging categories, the comments received by stakeholders did not allow to elaborate a comprehensive database for glass composite, EPS, XPS, wood/cork, textile and ceramic/porcelain. However, this did not impede the development of the present proposal listing the elements and parameters relevant for assessing the recyclability of packaging in general.

Based on the outcomes of the mapping exercise and the validation process, **4 elements and 19 parameters** are proposed as essential components of a methodology for assessing the recyclability of all packaging materials (see Table 3).

Table 3. Proposal of possible elements and parameters for a methodology to assess recyclability of packaging (consolidated version).

Element	**Parameter**
Predominant packaging material	Materials
	Colours / Optical transmittance
	Additives / Fillers
	Barriers / Coatings
Decoration, information, branding	Coding
	Inks / Lacquers / Varnishes
	Labels / Sleeves - Materials
	Labels / Sleeves - Packaging coverage
Closing and opening systems	Tamper evident elements (shrink wrap / rings)
	Closures / Openings
	Liners / Seals / Valves
Other	Adhesives (packaging body, labels and components, closure)
	Dimension of packaging
	Separability of packaging parts (ease of dismantling)
	Product residues
	Recycled content
	Content of biodegradable materials
	Integrated and separate components
	Others

As mentioned above, the stakeholder consultation allowed the consolidation of the database for each packaging material at sub-parameter level. The results on sub-parameter level are the basis for the statistical analysis carried out by Pierri et al. (2024) with the aim of identifying similarities across the different packaging categories.

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List of abbreviations and definitions

CEN	European Committee for Standardization
DfR	Design-for-recycling
DG ENV	Directorate General for the Environment
(DG) JRC	(Directorate General of the) Joint Research Centre
EC	European Commission
EPS	Expanded Polystyrene
EU	European Union
HDPE	High Density Polyethylene
PC	Polycarbonate
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PPWR	Packaging and Packaging Waste Regulation
PS	Polystyrene
PVC	Polyvinyl Chloride
XPS	Extruded Polystyrene

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Annexes

Annex 1. Categories and parameters listed in Table 1 of Annex II of the PPWR proposal of 30.11.2022

Table 4. Indicative list of packaging materials, types and categories referred to in Article 6.

Cat. No	Predominant packaging material	Packaging type	Format (illustrative)	Colour
1	Glass	Glass	Bottles, jars, flacons, cosmetics pots, tubs etc. made of glass (soda lime silica)	
2	Glass	Composite packaging, of which the majority is glass	Bottles, jars, flacons, cosmetics pots, tubs	
3	Paper/cardboard	Paper/cardboard packaging	Boxes, trays, grouped packaging	
4	Paper/cardboard	Composite packaging of which the majority is paper/cardboard	Including beverage cartons, plates and cups, i.e., metallised or plastic laminated paper/ card, liquid paperboard, paper/cardboard with plastic liners/ windows	
5	Metal	Steel	Boxes, trays, grouped packaging Rigid packaging formats (aerosols, cans, paint tins, boxes, etc.) made of steel, including tinplate	
6	Metal	Composite packaging of which the majority is steel	Drums, tubes, cans, boxes, trays, etc.	
7	Metal	Aluminium	Rigid formats (food and beverage cans, bottles, aerosols)	
8	Metal	Aluminium	Semi rigid or flexible formats (containers and trays, tubes, foils)	
9	Metal	Composite packaging of which the majority is Aluminium	Drums, tubes, cans, boxes, trays, etc.	
10	Plastic	PET - rigid	Bottles and Flasks	Transparent clear/ light blue
11	Plastic	PET - rigid	Bottles and Flasks	Transparent other colours
12	Plastic	PET - rigid	Rigid packaging other than bottles and flasks (Includes pots, tubs and trays)	Transparent
13	Plastic	PET - flexible	Films	
14	Plastic	HDPE - rigid	Containers and Tubes	natural /clear
15	Plastic	HDPE - rigid	Containers and Tubes	coloured
16	Plastic	PE - flexible	Films	natural /clear
17	Plastic	PE - flexible	Films	coloured
18	Plastic	PP - rigid	Containers and Tubes	natural /clear
19	Plastic	PP - rigid	Containers and Tubes	coloured
20	Plastic	PP - flexible	Films	natural /clear
21	Plastic	PP - flexible	Films	coloured
22	Plastic	HDPE and PP - rigid	crates and pallets	
23	Plastic	PS - rigid	Rigid packaging (except EPS and XPS)	
24	Plastic	EPS - rigid	Fish boxes/ white goods	
25	Plastic	XPS - rigid		
26	Plastic	Other rigid plastics including. PVC, PC - rigid	Rigid	

27	Plastic	Other flexible plastics including multilayer plastic films and multi-material materials - flexible	Pouches	
28	Wood, cork	Wooden packaging, including cork	Pallets, boxes	
29	Textile	Natural and synthetic textile fibres	Bags	
30	Ceramics or porcelain stoneware	Clay, stone	Pots, containers, bottles	

Annex 2. Overview of the DfR guidelines analysed within the mapping exercise and additional DfR guidelines and CEN standard provided by stakeholders (grey)

Table 5. Overview of DfR guidelines or other relevant reports screened and packaging materials covered.

Reference	**Title**	**Geo-graphical area covered**	**Packaging material covered**						
			Glass	Paper / Cardboard	Metal	Plastic	Wood / cork	Textile	Ceramic / porcelain
(WPO, 2021)	Packaging Design for Recycling. A global recommendation for circular packaging design	Global	x	x	x	x	x		
(CIRCPACK, 2022)	Design for recycling guidelines for packaging	Global	x	x	x	x			
(FH Campus Vienna, 2021)	Circular Packaging Design Guideline	AT	x	x	x	x			
(ZSVR, 2021)	Minimum standard for determining the recyclability of packaging	DE	x	x	x	x	x	x	x
(APCO, 2019)	Design for recyclability. Quickstart guide for glass packaging	Australia	x						
(CPI, 2022)	Design for recyclability guidelines. Helping retailers and brands specify and design cellulose-fibre based packaging that can be reprocessed in standard paper mills	UK		x					
(CEPI, 2023)	Paper-based packaging recyclability guidelines. How to specify and design paper-based packaging in a way to ensure high quality recycling by the paper industry	EU		x					
(CONAI, 2023b)	Guidelines for facilitating the recycling of packaging made predominantly from paper	IT		x					
(ACE, 2022)	Beverage cartons. Design for recyclability guidelines	Global		x					
(4evergreen, 2023)	Circularity by design guideline for fibre-based packaging	EU		x					

(APEAL, 2022)	Why steel recycles forever. How to collect, sort and recycle steel for packaging	EU			x				
(CONAI, 2023a)	Guidelines to facilitate the recycling of aluminium packaging	IT			x				
(GIZ, 2021)	Design-for-recycling. State of play	EU				x			
(Eco Design, 2022)	Instruction Design for Recycling	DE				x			
(Der Grüne Punkt, 2022)	Design for recycling	DE				x			
(Briedis & Syversen, 2019)	Plastic packaging recyclability in a nordic context	Nordic countries				x			
(RECOUP, 2023)	Plastic packaging recyclability by design	UK				x			
(Recyclass, 2022)	Recyclass recyclability methodology	EU				x			
(Recyclass, 2023)	Recylass factsheets for different plastic packaging formats	EU				x			
(CONAI, 2023c)	Guidelines to facilitate the recycling of plastic packaging	IT				x			
(CEFLEX, 2023)	Recyclability of polyolefin-based flexible packaging	EU				x			
(APR, 2023)	APR Design Guidance for Plastic Packaging	Global				x			
(Watkins et al., 2020)	Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for- recycling of plastic products	EU				x			

(GROW International, 2023)	The Lightwood Packaging Industry	EU					x		
(UBA, 2019)	Waste wood	DE					x		
(Rilegno, 2014)	The wood packaging supply chain. Sustainability and environmental virtuosity (Original title: *La filiera degli imballaggi di legno. Sostenibilitá e virtuositá ambientale*)	IT					x		
(EPBP, 2023)	Design Guidelines for PET bottles	EU				x			
(CEN, 2023)	Standards on Design-for-Recycling of plastic packaging (work in progress)	EU				x			

Annex 3. Possible elements and parameters of a methodology to assess recyclability of packaging

Table 6: Possible elements and parameters of a methodology to assess recyclability of packaging (initial version shared with stakeholders for validation or commenting).

Element	**Parameter**
Packaging material / Main packaging body	Materials
	Colourants (pigment / dyes)
	Additives
	Barriers / Coatings
Information / Branding	Coding
	Inks / Lacquers
	Labels – Materials
	Labels – Adhesives / Glue
	Labels – Product coverage
	Sleeves – Materials
	Sleeves – Product coverage
Closing systems	Tamper evident shrink wrap
	Closures (rigid and flexible)
	Liners
	Seals and valves
Other	Size of packaging
	Separability of packaging (ease of dismantling)
	Product residues (ease of emptying)
	Other components
	Others

Annex 4. Supplementary data

The results presented in this report are based on an extensive mapping exercise of elements, parameters and sub-parameters for each packaging category. The data are available in the supplementary excel spreadsheet, accompanying this report. The sole purpose of this file is to list the data collected via literature research and stakeholder consultation.

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