



Technical recommendations on packaging categories to support the design for recycling assessment of the Packaging and Packaging Waste Regulation Proposal

Assessing the feasibility of clustering packaging categories based on stakeholders' feedback and statistical analysis of similarities

Pierri, E., Egle, L., Gaudillat, P., Gallo, F., Manfredi, S., Saveyn, H.

2024

This document is a publication by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The contents of this publication do not necessarily reflect the position or opinion of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication. For information on the methodology and quality underlying the data used in this publication for which the source is neither Eurostat nor other Commission services, users should contact the referenced source. The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contact information

Name: European Commission – Joint Research Centre, Fair and Sustainable Economy, Circular Economy and Sustainable Industry

Address: Edificio EXPO, Calle Inca Garcilaso 3, 41092 Seville, Spain

Email: JRC-PACKAGING-RECYCLABILITY@ec.europa.eu

EU Science Hub

<https://joint-research-centre.ec.europa.eu>

JRC136783

EUR 31908 EN

PDF ISBN 978-92-68-14373-5 ISSN 1831-9424 doi:10.2760/296502 KJ-NA-31-908-EN-N

Luxembourg: Publications Office of the European Union, 2024

© European Union, 2024



The reuse policy of the European Commission documents is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Unless otherwise noted, the reuse of this document is authorised under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated.

For any use or reproduction of photos or other material that is not owned by the European Union permission must be sought directly from the copyright holders.

How to cite this report: European Commission, Joint Research Centre, Pierri, E., Egle, L., Gaudillat, P., Gallo, F., Manfredi, S. and Saveyn, H., *Technical recommendations on packaging categories to support the design for recycling assessment of the Packaging and Packaging Waste Regulation Proposal*, Publications Office of the European Union, Luxembourg, 2024, <https://data.europa.eu/doi/10.2760/296502>, JRC136783.

Contents

Abstract.....	1
Acknowledgements	2
Executive summary.....	4
1 Introduction.....	5
1.1 Policy context.....	5
1.2 Rationale and objectives of the current study	5
2 Methodology	6
2.1 Background and starting point for the feasibility assessment.....	6
2.2 Feasibility assessment.....	6
2.2.1 Statistical analysis of similarities	6
2.2.2 Qualitative assessment of similarities.....	9
2.2.3 Identification of missing packaging categories, formats and further amendments	10
3 Stakeholders' feedback on Table 1 of Annex II of the PPWR proposal.....	11
3.1 Glass.....	11
3.2 Paper and cardboard.....	11
3.3 Metal.....	12
3.4 Plastic.....	12
3.5 Wood and cork.....	13
3.6 Textile.....	13
3.7 Ceramics or porcelain stoneware.....	13
4 Results of the statistical analysis and qualitative assessment.....	14
4.1 Glass.....	14
4.1.1 Results of statistical analysis for combination g1.....	14
4.1.2 Qualitative assessment for glass packaging.....	14
4.2 Paper and cardboard.....	15
4.2.1 Results of statistical analysis for combination p1.....	15
4.2.2 Qualitative assessment for paper and cardboard packaging.....	15
4.3 Metal.....	16
4.3.1 Results of statistical analysis for combination m1.....	16
4.3.2 Results of statistical analysis for combination m2.....	17
4.3.3 Qualitative assessment for metal packaging.....	17
4.4 Plastics (rigid).....	18
4.4.1 Results of statistical analysis for combination r1.....	18
4.4.2 Results of statistical analysis for combination r2.....	19
4.4.3 Results of statistical analysis for combination r3.....	20
4.4.4 Qualitative assessment for plastic packaging (rigid).....	20
4.5 Plastics (flexible).....	22
4.5.1 Results of statistical analysis for combination f1.....	22

4.5.2	Qualitative assessment for plastic packaging (flexible).....	22
4.6	Other packaging categories.....	22
4.6.1	Qualitative assessment for wood and cork packaging.....	23
4.6.2	Qualitative assessment for textile packaging.....	23
4.6.3	Qualitative assessment for ceramics or porcelain stoneware	23
5	Conclusions and recommendations.....	24
	References	27
	List of abbreviations	29
	List of boxes.....	30
	List of figures	31
	List of tables.....	32
	Annexes	33
	Annex 1. Categories and parameters listed in Annex II of the PPWR proposal of 30.11.2022.....	33
	Annex 2. Available DfR guidelines identified by JRC (non-exhaustive list)	34
	Annex 3. Input files for statistical analysis using the software RStudio	36

Abstract

The aim of this study is to develop technical recommendations for a possible amendment of Table 1 – Annex II of the EC proposal for a Packaging and Packaging Waste Regulation, to support the co-decision process.

The main objective is to consider reducing the number of packaging categories referred to in Article 6 of the Regulation. To this end, the feasibility of aggregating some of the packaging categories has been assessed. The methodological approach followed was based on a statistical analysis to quantify similarities across selected categories. The data used as basis for the analysis have been retrieved from available design for recycling guidelines and from evidence submitted by experts in a written stakeholder consultation. The analysis was complemented by a critical appraisal of results, thereby also accounting for evidence received by stakeholders. The proposal also includes recommendations on possible integration of missing packaging categories or formats in Table 1 of Annex II.

The study led to the recommendation to reduce the number of packaging categories from 30 to 22, by merging mono-material and composite packaging for glass, steel and aluminium (distinguishing between rigid and semi-rigid or flexible aluminium packaging); plastic packaging categories that differed only by colour; and PS and XPS plastic packaging. A new category for biodegradable plastic packaging is proposed to be added to the table.

Acknowledgements

The authors would like to acknowledge the support offered by the stakeholders who participated in the workshop and written consultation (see below a partial list of organisations).

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 Glass Container 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 (Consortio Nazionale Recupero e Riciclo degli Imballaggi a base Cellulosica)	EUROSAC (European Federation of paper sack industries)	Mosaico	TEC (Total Energies Corbion)
CONAI (Consortio 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)
Domo Caproleuna GmbH	FEFCO (European Federation of Corrugated Board Manufacturers)	Pakkaus	ZWE (Zero Waste Europe)

Additionally, we thank our colleague Jorge Cristóbal García for reviewing the document and the colleagues in DG Environment for their support and feedback throughout the project, in particular: Maja Desgrées du Loû, Ioannis Antonopoulos and Wolfgang Trunk.

Authors

Pierri, Erika¹

Egle, Lukas¹

Gaudillat, Pierre¹

Gallo, Federico²

Manfredi, Simone²

Saveyn, Hans¹

¹ European Commission, Joint Research Centre, Directorate B Fair and Sustainable Economy - Circular Economy and Sustainable Industry Unit (B5)

² European Commission, Joint Research Centre, Directorate D Sustainable Resources - Land Resources and Supply Chain Assessments Unit (D3)

Executive summary

Within this study we assessed the feasibility of clustering the packaging categories referred to in Article 6 of the Commission proposal for a new Packaging and Packaging Waste Regulation (PPWR), amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC. The packaging categories are listed in Table 1 of Annex II of the PPWR proposal.

The assessment consists of a statistical analysis of similarities across selected combinations of packaging categories, based on their potential to be merged. The data used as basis for the analysis have been retrieved from available design for recycling guidelines and from evidence submitted by experts in a written stakeholder consultation. The analysis was complemented by a critical appraisal of results, thereby also accounting for evidence received by stakeholders.

Policy context

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

A design-for-recycling (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 design-for-recycling criteria and recyclability at scale requirements, is not part of the present study.

Key conclusions

Based on the results of the feasibility assessment, it is proposed to reduce the number of packaging categories from 30 to 22. Merging is proposed for mono-material and composite glass packaging categories, for steel packaging and for aluminium packaging (keeping the distinction between rigid and semi-rigid or flexible). Besides, it is proposed to depart from a differentiation by colour for plastic packaging. It is suggested to aggregate PS and XPS plastic packaging and to add a separate category for biodegradable plastics.

It is to be noted that packaging formats merged under a given category could still follow separate design for recycling guidelines. Merging does not imply a unique design for recycling assessment for all the formats under a given category.

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 possible elements for the methodology to assess recyclability of packaging, presented in a separate JRC science for policy report (see (Egle 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 assess the feasibility of clustering packaging categories is described; chapter 3 includes a summary of the feedback received by stakeholders; in chapter 4 the results of the statistical analysis and qualitative assessment are presented; in chapter 5 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) (see Annex 1 of this document). This task is described within this report.
- (ii) developing technical recommendations on possible **elements for the methodology to assess recyclability** of packaging. This task is described in (Egle et al., 2024).

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 two goals of the present study are strongly interwoven. The technical proposals by the JRC for clustering packaging categories are based on identifying commonalities in possible DfR criteria across the packaging categories listed in Annex II of the PPWR proposal. The outcome of this study will be used as a basis for the development of a recyclability methodology and will also support the co-decision process of the Packaging and Packaging Waste Regulation (PPWR).

This report focuses on task (i) assessing the feasibility of aggregating the packaging categories listed in Table 1 of Annex II of the EC proposal. It also includes recommendations on possible integration of missing packaging categories or formats.

2 Methodology

2.1 Background and starting point for the feasibility assessment

Annex II of the EC proposal on PPWR includes a list of 30 packaging categories referred to in Article 6 (see Annex 1 of this document). The seven packaging materials covered are **glass, paper and cardboard, metal, plastic, wood and cork, textile, ceramics and porcelain stoneware**. The packaging materials are disaggregated by the materials used and type (e.g. mono-material / composite, rigid / flexible), by format (e.g. bottles / films / trays / boxes) and in the case of some plastic by colour (e.g. clear / coloured).

A database for the 30 packaging categories was developed in-house by the JRC, on the basis of available DfR guidelines (see Annex 2). The JRC database contains possible components of a methodology to assess recyclability of packaging. Components are structured in elements¹, parameters² and sub-parameters³. For further details, please refer to the JRC report (Egle et al., 2024). The database was complemented by information and data provided by the stakeholders during the consultation phase.

2.2 Feasibility assessment

2.2.1 Statistical analysis of similarities

In order to assess the feasibility of aggregating packaging categories listed in Annex II of the PPWR proposal, as a first step a statistical analysis was conducted, using as starting point the consolidated database on the packaging categories, in particular the list of sub-parameters.

Different combinations of packaging categories were pre-selected, based on their potential for merging and considering suggestions from stakeholders (see Table 1). In all cases, combinations were restricted to categories containing the same predominant packaging material.

For the packaging materials **glass** and **paper/cardboard** the categories of mono-material packaging were combined with the categories of composite packaging. This results in two combinations, **g1** for glass (Cat. No 1, 2) and **p1** for paper/cardboard (Cat. No 3, 4).

In the case of **metal**, the same approach is used and additionally a distinction is made between **steel packaging** and **aluminium packaging**, resulting in two combinations: **m1** containing mono-material steel and composite steel (Cat. No 5, 6) and **m2** containing mono-material aluminium rigid, mono-material aluminium semi-rigid and flexible and composite aluminium (Cat. No 7, 8, 9).

In the case of **plastic** packaging, the categories in Annex II are differentiated by **rigid** (combinations r1, r2, r3) and **flexible** (combination f1).

Combination **r1** contains all the categories of rigid PET (Cat. No 10, 11, 12). Combination **r2** contains HDPE rigid (Cat. No 14, 15) and PP rigid (Cat. No 18, 19), with a similar polymer structure and recycling behaviour. Combination **r3** includes polystyrene packaging PS, EPS and XPS (Cat. No 23, 24, 25).

Combination **f1** contains PE flexible (Cat. No 16, 17) and PP flexible (Cat. No 20, 21), with a similar polymer structure and recycling behaviour.

Cat. No 13 was not included in one of the packaging combinations, as it consists of PET films, which present very specific properties and merging with other categories has already been ruled out *a priori*.

Cat. No 22 covers specific packaging formats (crates and pallets) with specific physical properties that are not comparable to the other packaging formats.

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').

Due to the fact that Cat. Nos 26 and 27 cover a broad field of different plastic polymers (e.g. PC, PVC), these categories were not considered for analysing similarities with other plastic categories covering only specific polymers (e.g. PET).

For Cat. Nos 28, 29 and 30, no similarity was analysed, as only one packaging category is listed for each packaging material.

Table 1. Selected combinations of packaging categories to be used for the statistical analysis of similarities

Predominant packaging material	Combination acronym	Category No	Packaging type
Glass	g1	1	Glass
		2	Composite packaging, of which the majority is glass
Paper and cardboard	p1	3	Paper/cardboard packaging
		4	Composite packaging of which the majority is paper/cardboard
Metal	m1	5	Steel
		6	Composite packaging of which the majority is steel
	m2	7	Aluminium (rigid formats)
		8	Aluminium (semi-rigid or flexible formats)
		9	Composite packaging of which the majority is Aluminium
Plastic (rigid)	r1	10	PET – rigid (bottles and flasks; transparent clear / light blue)
		11	PET – rigid (bottles and flasks; transparent other colours)
		12	PET – rigid (other than bottles and flasks; transparent)
	r2	14	HDPE – rigid (natural / clear)
		15	HDPE – rigid (coloured)
		18	PP – rigid (natural / clear)
		19	PP – rigid (coloured)
	r3	23	PS – rigid
		24	EPS – rigid
		25	XPS – rigid
Plastic (flexible)	f1	16	PE flexible (natural / clear)

		17	PE flexible (coloured)
		20	PP flexible (natural / clear)
		21	PP flexible (coloured)

Different clustering methods can be used to group heterogeneous datasets into homogeneous data points, based on certain criteria. Those include connectivity-based (hierarchical) clustering, centroid-based clustering, density-based clustering and distribution-based clustering.

Hierarchical clustering produces a visual representation of the clustering structure in the form of a dendrogram, i.e. a tree diagram that displays the arrangement of the clusters, based on their similarity.

The statistical analysis was carried out with RStudio, an integrated development environment for R, commonly used for statistical computing. The function **heatmap** was used to generate the plots. A heatmap is a data visualisation tool that shows different values or factors of a number of samples or dataset in a matrix form using a colour code. In R, the heatmap function is combined with a **dendrogram** (hierarchical clustering). This combined visualisation facilitates the interpretation of the results.

For the purposes of the current study, heatmaps were used to show the presence or absence of a sub-parameter in the packaging categories of each selected combination. Dendrograms were used to show the distance (or dissimilarity) between the categories in the given combination.

The plots were complemented by a third element, a similarity coefficient, to quantify the distance between clusters. The Rand similarity coefficient, also called Rand index or simple matching coefficient (hereafter: **similarity coefficient**), measures the similarity between two sample sets. It can be described as the ratio between the total number of attributes that are present or absent in both sets (mutual values) and the total number of attributes in the two sample sets.

For the purposes of the current study, the similarity coefficient (S) was used to quantify similarities across packaging categories, as follows:

$$S = \frac{a + d}{a + b + c + d} \quad (1)$$

where:

a = total number of sub-parameters where packaging category x and y both have a value of 1

b = total number of sub-parameters where sub-parameter of packaging category x is 1 and sub-parameter of packaging category y is 0

c = total number of sub-parameters where sub-parameter of packaging category x is 0 and sub-parameter of packaging category y is 1

d = total number of sub-parameters where packaging category x and y both have a value of 0

For the 8 combinations of packaging categories listed in Table 1, heatmaps with dendrograms were plotted, along with the similarity coefficient calculated for each pair of packaging categories (see section 4). The similarity coefficient, which can have a value between 0 and 1 (the closer to 1, the higher the similarity between two categories), was converted to a **similarity rate** (percentage).

Figure 1. Exemplary heatmap with dendrogram plotted in RStudio

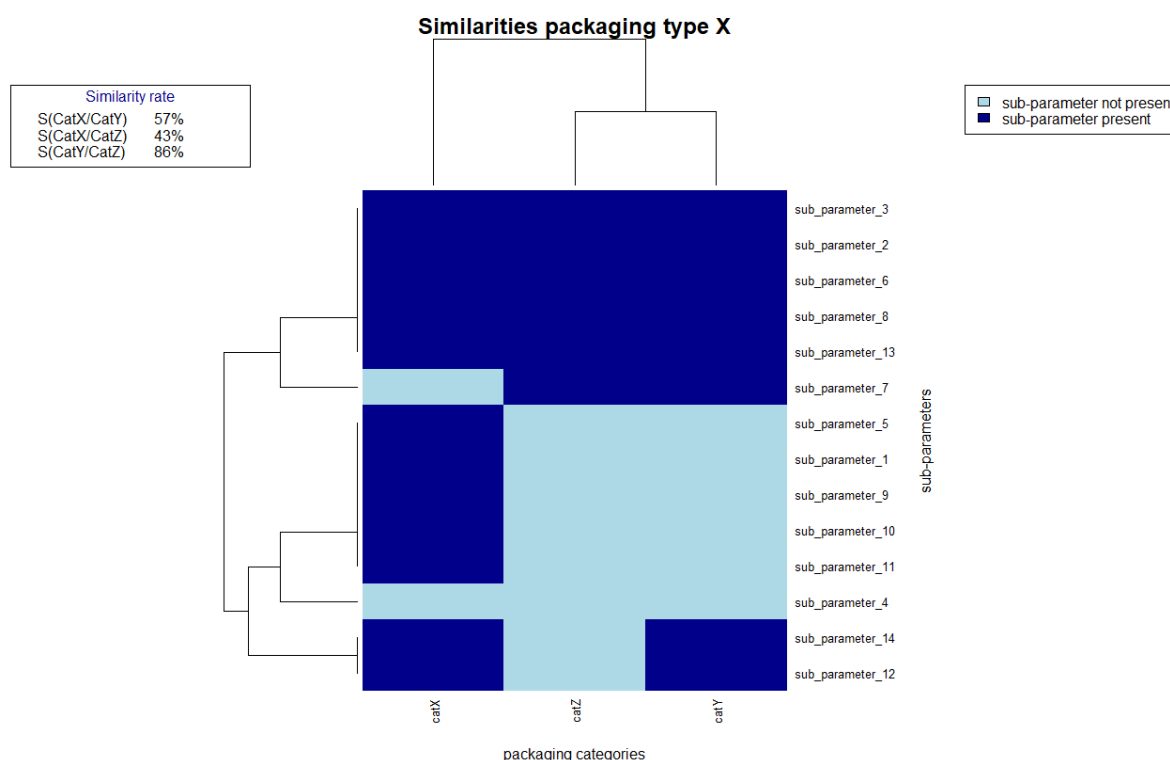


Figure 1 shows an illustrative example of a heatmap with dendrogram, to help the reader understand the methodology. In the heatmap the packaging categories are on the horizontal axis, whereas the sub-parameters are on the vertical axis. The heatmap colour code refers to the binary values of the sub-parameters: 0 = sub-parameter is not present in the packaging category (light blue), 1 = sub-parameter is present in the packaging category (dark blue).

The distribution of the horizontal axis is given by the dendrogram at the top of the diagram, representing the suggested clustering of packaging categories, according to their distance (the lower the distance, the higher the similarity). Sub-parameters in the vertical axis are also redistributed according to their values.

The dendrogram at the left of the diagram contains as many branches as the obtained number of configurations of values in the whole dataset. In the illustrative example there are 5 configurations of binary values: from top to bottom (1, 1, 1); (0, 1, 1); (1, 0, 0); (0, 0, 0); (1, 0, 1). This means that for instance the sub-parameters of the first configuration at the top (1, 1, 1) are present in all categories (X, Y and Z).

The input files computed in RStudio are available in Annex 3 of this document. Each input file contains the full list of sub-parameters of the given combination, the binary values (0, 1) and the coefficients a , b , c , d .

One of the limitations of the statistical method used is that it relies on a database that is partly incomplete, due to lack of data in the initial JRC database or to a lack of input from the stakeholders. Hence the absence of a sub-parameter (value 0 in the input file) does not necessarily mean that this sub-parameter is in practice not applicable to the packaging category. It could be simply due to the lack of data for that specific packaging category.

In addition, the statistical method gives equal weighting to all sub-parameters, whereas certain sub-parameters may have a more pronounced influence on the requirements of the recycling process and material recyclability than others.

As a consequence, it is not possible to set *a priori* a threshold of similarity (e.g. 90%) for clustering the packaging categories selected in the different combinations.

2.2.2 Qualitative assessment of similarities

To overcome the limitations of the statistical analysis and come up with sound recommendations on clustering, the results of the statistical analysis were also qualitatively assessed, thereby taking into account the feedback received by stakeholders, presented in section 3.

2.2.3 Identification of missing packaging categories, formats and further amendments

As mentioned above, recommendations on missing categories, formats and colours were also provided by stakeholders in the written consultation. Those recommendations (summarised in section 3) were accounted for in the JRC proposal to amend Table 1 of Annex II of the PPWR proposal, presented in section 5.

3 Stakeholders' feedback on Table 1 of Annex II of the PPWR proposal

In the following sections, the input received by stakeholders on the packaging categories, as well as on the list of formats and colours is summarised for each main packaging material. As mentioned above, the feedback served as a complementary source of information for the qualitative assessment as well as for the proposed amendment of Table 1 of Annex II of the Regulation proposal.

3.1 Glass

Categorisation of packaging materials

Stakeholders argued that there are no composite glass packaging materials on the market, under the condition that other packaging parts (e.g. non glass closure or plastic sleeve) are considered integral part of the packaging and not as separate components. Based on this assumption, stakeholders suggested that categories 1 and 2 could be merged.

Illustrative formats

Stakeholders also indicated that formats as e.g. ampoules and vials (used for cosmetics and pharmaceutical products) are missing and should be considered.

3.2 Paper and cardboard

Categorisation of packaging materials

There was not a common opinion on the categorisation of paper/cardboard packaging. Stakeholders provided different and partly inconsistent suggestions.

Some stakeholders suggested to keep only two categories but to change the classification as follows:

Option 1:

- Category 3: Non-coated/non-laminated paper/cardboard packaging
- Category 4: Coated/laminated paper/cardboard packaging.

Option 2:

- Category 3: Paper/cardboard and composite paper/cardboard (that can be recycled in standard paper mills)
- Category 4: Composite packaging of which the majority is paper/cardboard (that can be recycled in specialised paper mills).

Other stakeholders recommended to split category 4 in two categories and have a total of three categories for the packaging material paper/cardboard:

- Category 3: Paper/cardboard packaging (boxes, trays, grouped packaging, etc.)
- Category 4a: Composite packaging of which the majority is liquid paper board (beverage cartons, paper cups and boxes made of liquid paper boards i.e. laminated with polyolefins and with or without aluminium, etc.)
- Category 4b: Composite packaging of which the majority is cardboard (trays, plates and cups, metallised or plastic laminated paper/cardboard, paper/cardboard with plastic liners, windows, etc.).

No suggestions for merging were made.

As regards plastic-cardboard combinations, stakeholders proposed they could be included either in category 4 or alternatively in a plastic category, if they are not considered a composite material.

It was suggested that specific packaging formats made of plastics that have integrated cardboard components to support the stability of the plastic packaging part (e.g. yogurt pots with a cardboard sleeve) should be classified under a plastic category, even if the majority by weight is cardboard. Following the same rationale, it was also suggested that the Bag-in-Box packaging (e.g. for wine) should equally be classified under a plastic category.

Illustrative formats

According to stakeholders, in Annex II of the PPWR proposal it was unclear under which category flexible paper packaging should be classified. It was therefore suggested to add flexible paper packaging (e.g. films, sheets, pouches, lidding, cones, and wrappers) as format in category 3. Further suggestions were to include sachets in category 3 and 4 as formats.

3.3 Metal

Illustrative formats

For metal packaging, stakeholders provided comments related to missing formats:

- Category 5: Stainless steel packaging should be added.
- Categories 8 and 9: Flexible aluminium foil and pouches should be added.

3.4 Plastic

Categorisation of packaging materials and colours specifications

Stakeholders highlighted that in the case of plastics, Annex II is not always consistent in terms of colours. It would be more meaningful to list only the packaging type and waive extra categories based on the colour.

Other comments on specific categories are summarised below:

- **Categories 10/11 – PET rigid (bottles and flasks):** opaque coloured PET bottles are not covered and should be added to the table.
- **Category 12 – PET rigid (other than bottles and flasks):** two separate categories should be added covering the colour 'transparent / clear' and 'transparent coloured'.
- **Categories 14/15 – HDPE rigid:** should be renamed to 'PE – rigid', as rigid packaging is also produced out of LDPE (which is recycled at present). Furthermore, the colour should be changed from 'natural / clear' to 'natural / white'.
- **Category 22 – HDPE and PP rigid:** PP and PE crates and pallets need separate categories and corrugated board plastic should be added.
- **Category 23 – PS rigid:** this category should be divided into two categories, namely PS rigid (colour natural / white) and PS rigid (coloured).
- **Category 25 – XPS rigid:** In standardisation XPS with a density $d > 0.8$ is grouped with PS and XPS with $d < 0.8$ in a separate category due to very different sorting centres and recycling behaviour.

Numerous stakeholders commented that separate categories for **biodegradable plastics** are missing. For biodegradable plastics, it was suggested that rigid (e.g. PLA, PHB) and flexible (e.g. PLA films) packaging should be added either as two separate categories or under category 26 (other rigid plastic) and 27 (other flexible plastic), respectively.

Illustrative formats

Stakeholders provided an extensive list of missing formats:

- All rigid plastics: Multi-layer.
- **PET:** PET caps, PET jars, PET tubes, PET canisters, plasma treated PET bottles, PET tubs, multilayer PET bottles, PET aerosol can, PET lids, PET cups, PET pail, PET vials, LDPE vials, PET pill packers, PET droppers.
- **PE:** PE caps, HDPE jars, HDPE tubes, HDPE canisters, HDPE white bottles, HDPE sticks, labelled containers in HDPE and PET, multilayer HDPE bottles, plasma treated HDPE bottles, HDPE bottles, HDPE bucket, HDPE tubs, HDPE lids, HDPE cups, HDPE pail, HDPE vials, HDPE pill packers, LDPE pill packers, HDPE droppers, LDPE droppers, HDPE cartridges, woven PE.
- **PP:** PP caps, PP sticks, IML labelled containers in PE and PET, PP bucket, PP tubs, PP lids, PP cups, PP pail, PP vials, PP pill packers, PP droppers, woven PE, PP trays.
- **Category 12:** Monolayer- and multi-layer trays.

- **Categories 16/17 and 20/21 - PE and PP flexibles:** multi-layer and multi-material (e.g. EVOH) polyolefin.
- **Category 24 - EPS rigid:** EPS trays.
- **Categories 26/27 - other rigid/flexible plastics:** rigid plastics drums and intermediate bulk containers (IBC) for rigid plastics and flexible intermediate bulk container (FIBC), bags, stretch films, pouches, thermoformed packages, vacuum packaging, modified atmosphere/modified humidity packaging.

3.5 Wood and cork

Categorisation of packaging materials

Stakeholders suggested to split category 28 in two categories: refurbishable wood (e.g. pallets) and non-refurbishable wood (e.g. wine crates).

3.6 Textile

Categorisation of packaging materials

Stakeholders suggested to consider the synthetic polymers separately (e.g. PP woven big bags and PE liners) to drive mono material solutions.

3.7 Ceramics or porcelain stoneware

Stakeholders commented that this waste stream is very minor in the EU (ceramic ware accounts only for 0.013% of the total packaging waste generated in the EU) and is, in most cases, not separately collected.

In the following, the results of the statistical analysis are presented. As mentioned in section 2.2.1, only the eight pre-selected combinations of packaging categories were plotted (g1, p1, m1, m2, r1, r2, r3, f1) to assess their clustering potential (see Table 1). The results are then critically appraised, taking into account stakeholders' comments summarised in section 3.

4.1.1 Results of statistical analysis for combination q1

[illegible]

Categories 1 and 2 have a similarity of 97%. The dissimilarity is given exclusively by the materials (mono-material vs composite). Given the high similarity rate, it would seem appropriate to cluster categories 1 and 2.

The opinion of the stakeholders is in line with the results of the statistical analysis (possible merging of category 1 and category 2), as described in section 3.1.

One single option is proposed:

Option 1: **categories 1 and 2** are clustered into one single category (glass and glass composites).

4.3 Metal

4.3.1 Results of statistical analysis for combination m1

Figure 4. Heatmap metal packaging – steel (combination m1: categories 5 and 6)

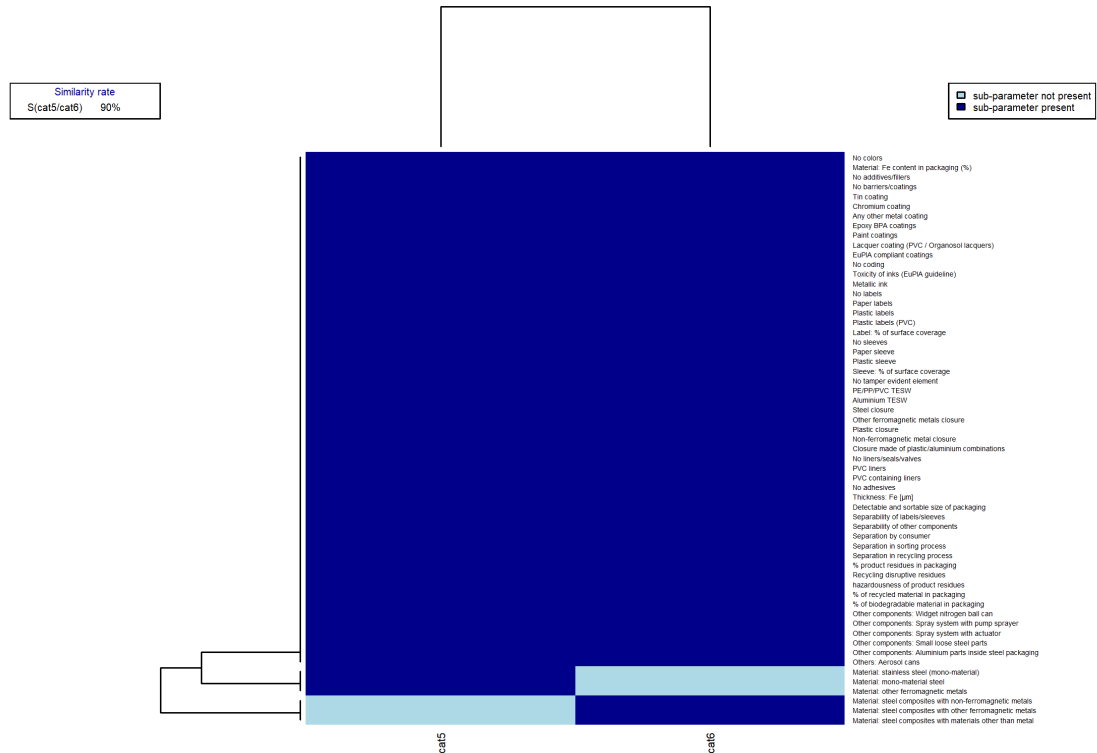


Figure 4 displays the results for combination m1 (metal packaging – steel). Categories 5 and 6 have a high similarity rate (90%). The difference between the two categories is due to the presence of sub-parameters on composite materials in category 6. Given the high similarity, it would seem appropriate to cluster the two categories.

4.3.2 Results of statistical analysis for combination m2

Figure 5. Heatmap metal packaging – aluminium (combination m2: categories 7, 8 and 9)

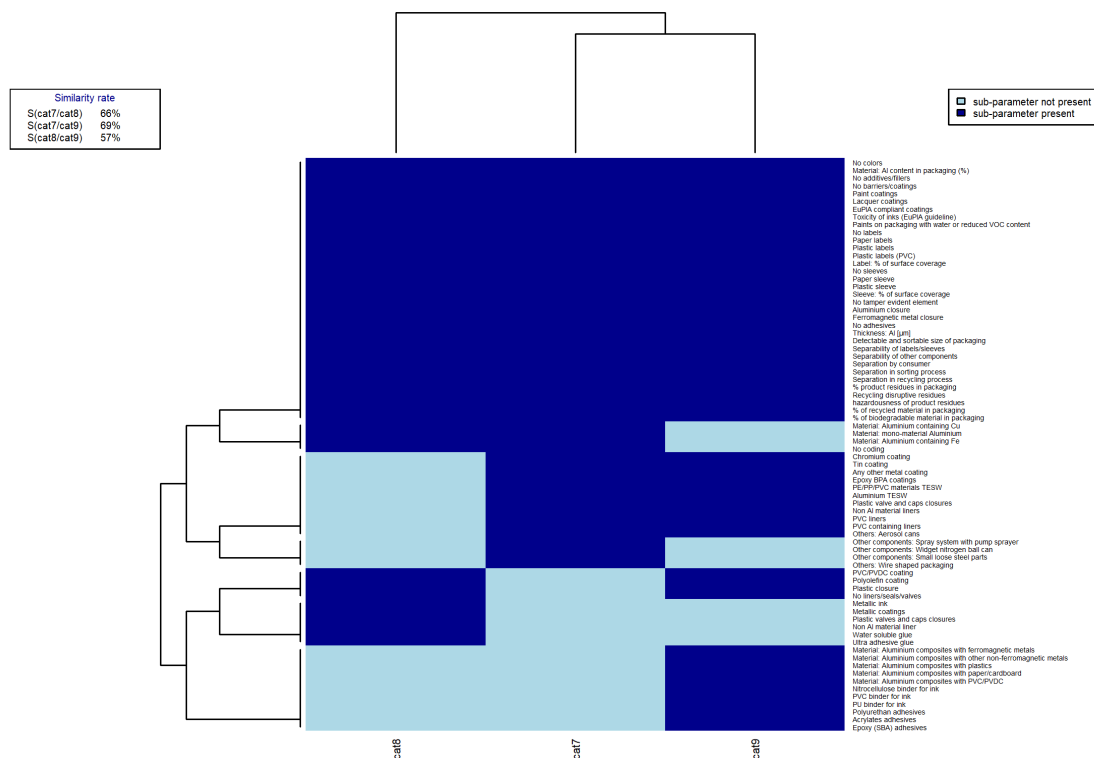


Figure 5 displays the results for combination m2 (metal packaging – aluminium).

Category 7 (Aluminium –rigid) has a similarity of 66% with category 8 (Aluminium – semi-rigid or flexible) and 69% with category 9 (Aluminium composite). Categories 8 and 9 have a similarity of 57%. Analysing the results, it does not seem appropriate to cluster any of the three categories.

4.3.3 Qualitative assessment for metal packaging

Stakeholders only provided comments on missing formats for this material (see section 3.3), hence the qualitative assessment is based on JRC considerations, as described in the following paragraph.

In the case of metal packaging, a clustering of mono-materials with composite materials could be meaningful. For steel packaging the statistical analysis suggests possible merging, however for aluminium packaging the results are against clustering (similarity rates below 70%). An option could be to merge category 7 with specific formats of category 9 (only rigid formats) and category 8 with other formats of category 9 (only semi-rigid and flexible formats).

Box 3. JRC proposal for metal packaging

Two options are given, in order of preference:

Option 1: categories 5 and 6 are merged (steel and steel composites); category 7 is merged with category 9 (aluminium and aluminium composites – rigid), category 8 is merged with category 9 (aluminium and aluminium composites – semi-rigid and flexible).

Option 2: categories 5 and 6 are merged (steel and steel composites); categories 7, 8 and 9 are not merged.

4.4 Plastics (rigid)

4.4.1 Results of statistical analysis for combination r1

Figure 6. Heatmap plastic packaging – rigid (combination r1: categories 10, 11 and 12)

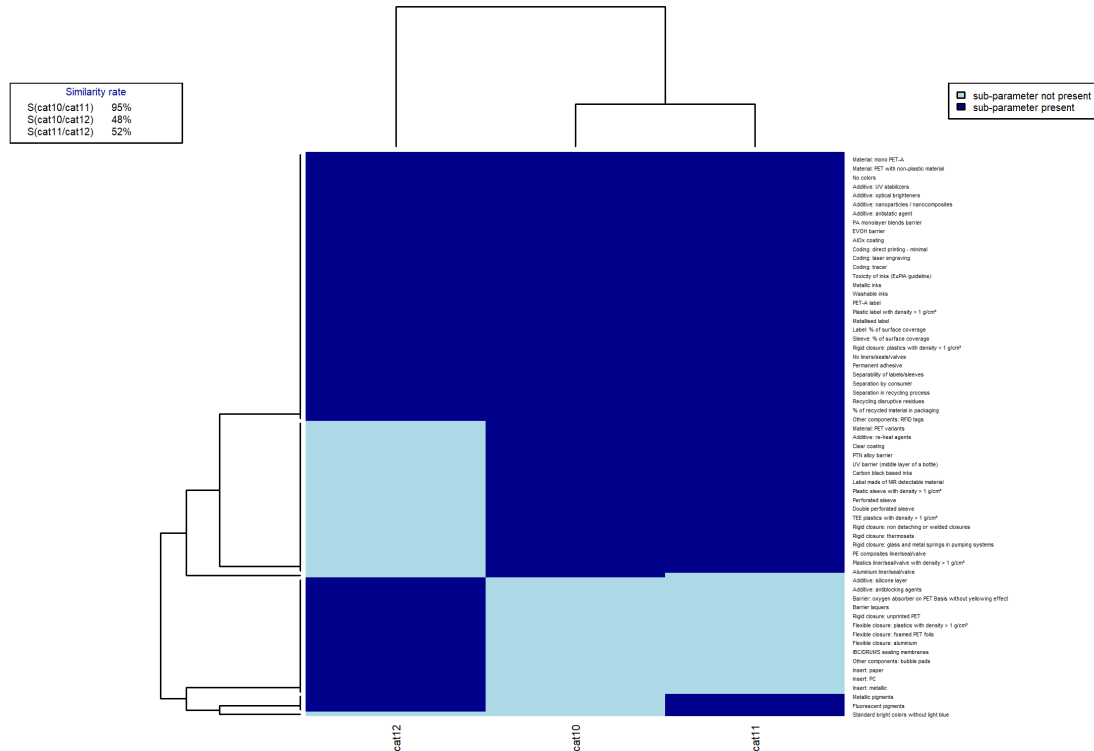


Figure 6 displays the results for combination r1 (plastic packaging – rigid).

Categories 10 and 11 have a very high similarity rate (95%). This is due to the fact that the only difference between the two categories is the colour. For example, category 10 includes bottles and flasks that are transparent clear / light blue, whereas category 11 includes bottles and flasks that are transparent other colours. Hence, categories 10 and 11 could be merged.

Categories 10 and 12 present a very low similarity (48%), as category 12 encompasses different formats and specific PET polymers (e.g. C-PET) are used for example for PET trays. A clustering of these two categories does not seem appropriate. Similar conclusions are drawn for clustering category 11 and 12 (with a similarity of 52%).

4.4.2 Results of statistical analysis for combination r2

Figure 7. Heatmap plastic packaging – rigid (combination r2: categories 14, 15, 18 and 19)

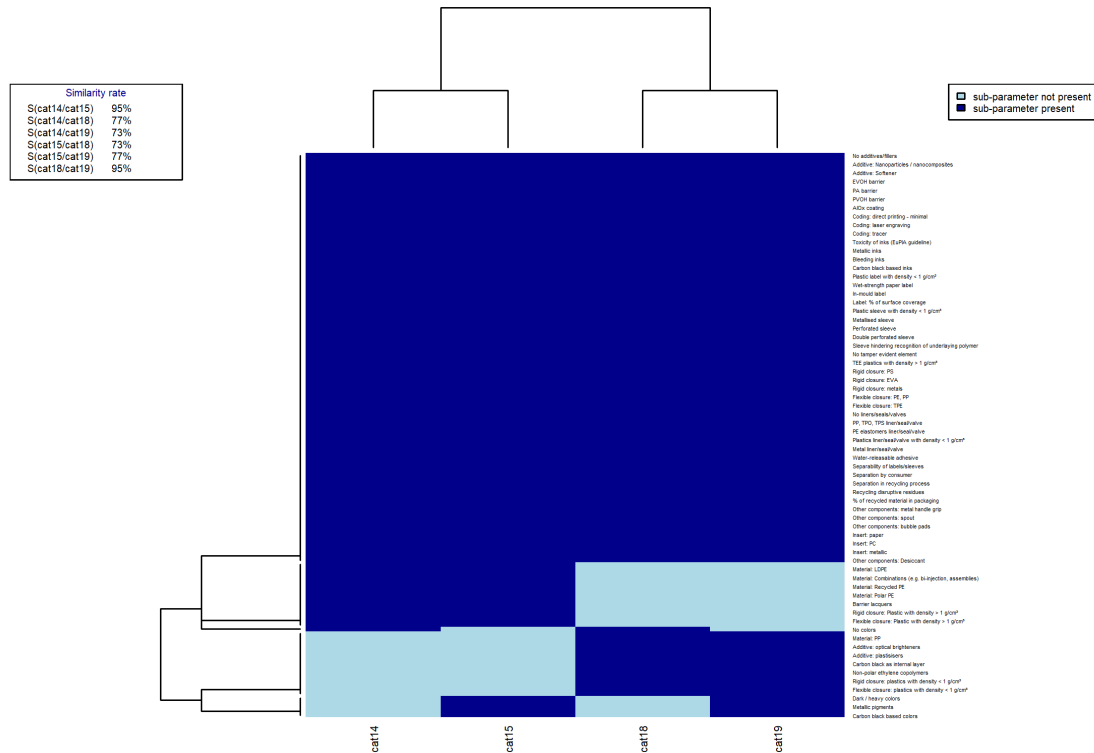


Figure 7 displays the results for combination r2 (plastic packaging – rigid).

The two pairs of categories 14/15 and 18/19 only differ by colour (natural / clear, coloured) and both pairs show a similarity of 95%.

If one compares the pairs of categories 14/18 and 15/19, having different polymer grades (HDPE, LDPE), but same colour (natural / clear in the first pair, coloured in the second pair) a similarity of 77% is given.

The remaining pairs of categories 14/19 and 15/18 show a slightly lower similarity (73%), due to the different colours in addition to the different polymer grades.

As a result of the statistical analysis, it would seem appropriate to merge at least category 14 and 15 as well as category 18 and 19. A clustering of all four categories (14, 15, 18, and 19) could also be meaningful.

4.4.3 Results of statistical analysis for combination r3

Figure 8. Heatmap plastic packaging – rigid (combination r3: categories 23, 24 and 25)

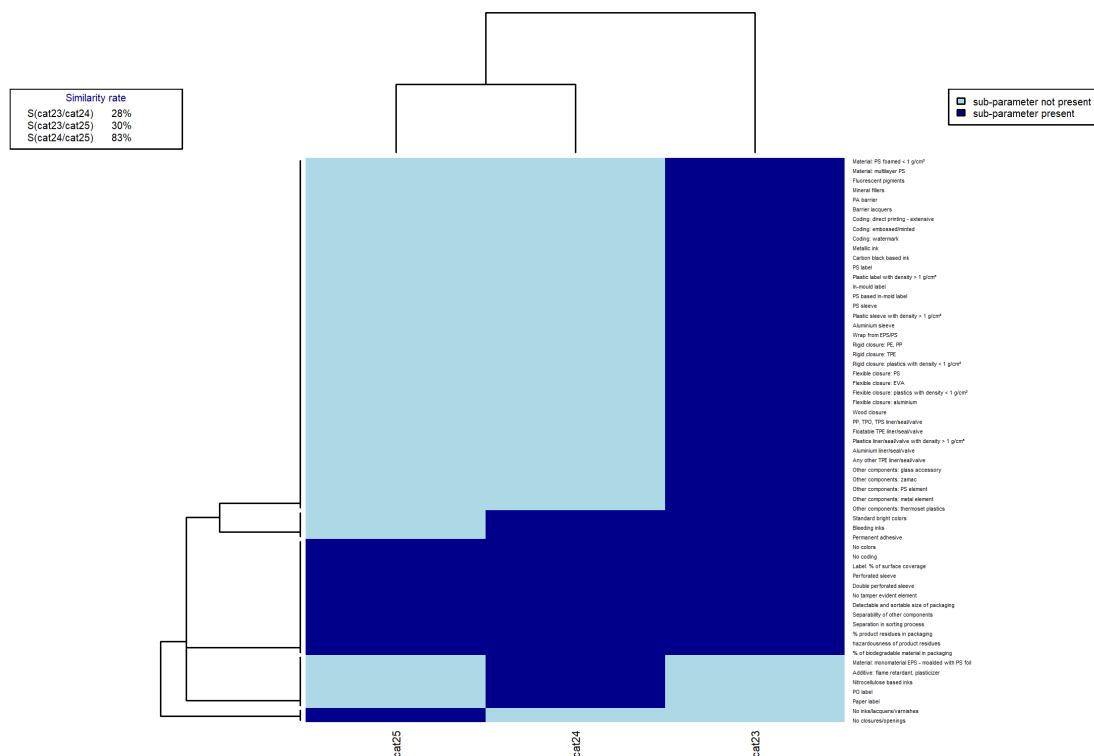


Figure 8 displays the results for combination r3 (plastic packaging – rigid).

Category 23 has a very low similarity both with category 24 (28%) and 25 (30%). Thus, a clustering would not be appropriate.

Categories 24 and 25 present a similarity rate of 83%.

It must be noted that the JRC database is much less extensive for category 24 than for category 23. For category 25 (XPS rigid) the initial database did not contain any information at sub-parameter level. The database was consolidated with supplementary data submitted by stakeholders, however the list of sub-parameters in category 25 is still far from exhaustive.

Hence on the one hand the low similarity rate between category 23 and 25 is due to the lack of data in category 25. On the other hand, the high similarity rate between category 24 and 25 is due to the fact that both datasets are not comprehensive, resulting in having a value of 0 for many sub-parameters that are present in category 23 and not present in both 24 and 25.

4.4.4 Qualitative assessment for plastic packaging (rigid)

Stakeholders provided diverging opinions for the rigid plastics (see section 3.4). Some stakeholders suggested to merge the categories that differ only by colour, others suggested to add new categories for opaque packaging for instance. Nonetheless, a common opinion was that the methodology should be consistent, i.e. for all plastic categories there should be (or not be) a differentiation by colour.

Considering that the JRC has received a mandate to assess the feasibility of clustering the packaging categories to reduce the burden of performing a recyclability assessment, the preferred approach by the JRC is to exclude a distinction by colour for all plastic packaging.

Based on this approach, the pairs consisting of categories 10/11, 14/15 and 18/19 could be merged.

Categories 14, 15, 18 and 19 (rigid polyolefins) could also be clustered in a less conservative approach, due to the similar characteristics of the polyolefin polymers HDPE and PP and the same format.

As regards PS, EPS and XPS (categories 23, 24 and 25, respectively), the results of the statistical analysis were not conclusive. At the time of drafting this report, the CEN technical committee⁴, in charge of developing DfR standards for plastic packaging, is considering including PS and XPS in the same guideline and to have a separate one for EPS. To be noted that the proposed categorisation is based on the current collection schemes and available recycling technologies in the EU, that could be subject to changes in the future.

PS and XPS packaging consists mostly of food packaging (e.g. dairy packaging and food containers). EPS packaging consists of protective packaging (for e.g. white goods, electronics) and also food packaging for specific applications (e.g. fish boxes, meat trays), which present different properties compared to PS. Besides fish boxes have a dedicated collection and recycling system in some Member States.

The density has a major impact on the ability to sort and recycle plastic packaging. Even within the same category the density and consequently other packaging properties can differ significantly. For example XPS is available on the EU market with densities between 0.03 and 1 g/cm³. In comparison, PS typically has a density of 1.04 g/cm³ and EPS of around 0.03 g/cm³.

However a distinction based on density is not feasible at this stage for the purposes of this project.

Box 4. JRC proposal for plastic packaging (rigid)

Two options are given, in order of preference:

Option 1: **categories 10/11, 14/15 and 18/19** are merged; **category 12** is not merged with **categories 10/11**; **category 23** is merged with **category 25**, **category 24** remains a stand-alone category.

Option 2: **categories 10/11** are merged; **category 12** is not merged with **categories 10/11**; **categories 14, 15, 18 and 19** are merged; **category 23** is merged with **category 25**, **category 24** remains a stand-alone category.

⁴ Working group 10 of the CEN technical committee is developing DfR guidelines and recyclability evaluation protocols under a standardization request issued by the European Commission and the European Free Trade Association.

4.5 Plastics (flexible)

4.5.1 Results of statistical analysis for combination f1

Figure 9. Heatmap plastic packaging – flexible (combination f1: categories 16, 17, 20 and 21)

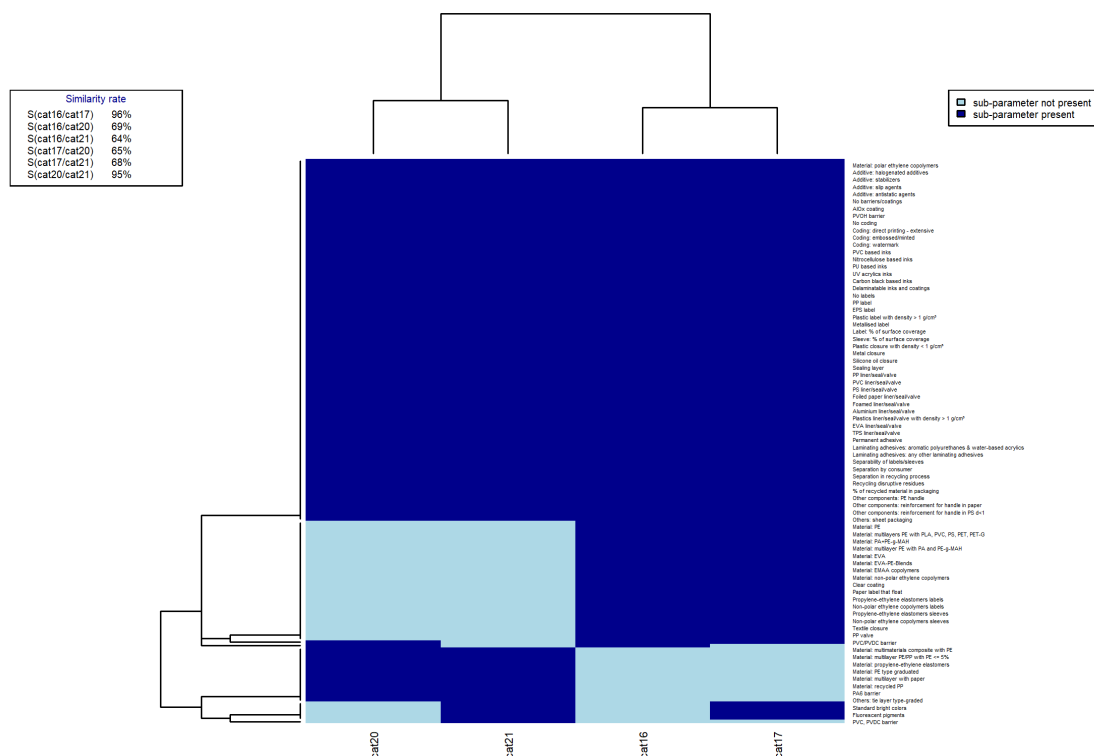


Figure 9 displays the results for combination f1 (plastic packaging – flexible).

Categories 16 and 17 show a similarity of 96%. This is due to the fact that the categories only differ in terms of colour of the main packaging material (natural / clear, coloured). The same is valid for the pair 20/21, which shows a similarity of 95%. When comparing different polymers (PE and PP) with the same colour as for the pairs 16/20 (natural / clear) and 17/21 (coloured) the similarity rate is equal to 69% and 68%, respectively. The other combinations have lower similarity rates, due to divergences in both materials and colours.

4.5.2 Qualitative assessment for plastic packaging (flexible)

Following the same approach proposed for rigid plastics, the pairs of categories that differ by colour can be merged, i.e. 16/17 and 20/21. It could also be possible to merge categories 16, 17, 20 and 21 (flexible polyolefins).

Box 5. JRC proposal for plastic packaging (flexible)

Two options are given, in order of preference:

Option 1: **categories 16/17** and **categories 20/21** are merged.

Option 2: **categories 16, 17, 20 and 21** are merged.

4.6 Other packaging categories

No statistical analysis was performed for categories 28, 29 and 30 as only one category exists for each of the constituting packaging materials. Hence the recommendations to amend specific items of Table 1 of Annex II of the PPWR proposal are based exclusively on comments received by stakeholders and critical appraisal by the JRC

4.6.1 Qualitative assessment for wood and cork packaging

One stakeholder organisation suggested to split this category into refurbishable and non-refurbishable wood (see section 3.5). However, considering that the JRC database for this category is not very comprehensive, the relevance of wood and cork packaging is low compared to other packaging under scope. Besides considering that the aim of this study is to reduce the number of categories, it does not seem appropriate at this stage to split this category.

Box 6. JRC proposal for wood/cork packaging

One single option is given:

Option 1: no changes to **category 28**.

4.6.2 Qualitative assessment for textile packaging

One stakeholder organisation suggested to consider synthetic polymer fibres in a separate category. Following the same argument as for wood/cork, at this stage we would refrain from disaggregating this packaging category.

Box 7. JRC proposal for textile packaging

One single option is given:

Option 1: no changes to **category 29**.

4.6.3 Qualitative assessment for ceramics or porcelain stoneware

For this category the comment received is not relevant for the categorisation. Hence no changes are proposed at this stage.

Box 8. JRC proposal for ceramics/porcelain packaging

One single option is given:

Option 1: no changes to **category 30**.

5 Conclusions and recommendations

The JRC performed statistical analyses to identify similarities between different packaging categories, with the aim of possibly reducing the number of packaging categories presented in Table 1, Annex II of the PPWR proposal (see Annex 1 of this document).

Eight combinations of packaging categories were selected for the analysis, based on their potential to merge, namely glass mono-material and composite (combination g1); paper/cardboard mono-material and composite (combination p1); steel mono-material and composite (combination m1); rigid aluminium mono-material, semi-rigid/flexible aluminium mono-material and aluminium composite (combination m2); PET bottles, flasks and other rigid formats (combination r1); HDPE and PP rigid formats, other than crates and pallets (combination r2); PS, EPS and XPS (combination r3); PE and PP flexible formats (combination f1).

It has to be noted that for categories 13 (Plastic, PET – flexible), 22 (Plastic, HDPE and PP – rigid; crates and pallets), 26 (Plastic, other rigid plastics) and 27 (Plastic, other flexible plastics) a clustering was not deemed appropriate *a priori*. Category 13 presents very specific features and should remain a category of its own. Category 22 includes very specific packaging formats (crates and pallets) that cannot be merged with other formats. Categories 26 and 27 include all other rigid and flexible packaging, not included in the other plastic categories, thus it is not meaningful to consider them in the analysis. For categories 28 (Wood and cork), 29 (Textile) and 30 (Ceramics or porcelain stoneware) a clustering was not contemplated, as they consist of only one specific packaging material per packaging category.

The results of the statistical analyses were assessed critically and complemented by a qualitative assessment, considering comments received from experts within the written consultation. Feedback related to further proposed changes as regards formats and colours (described in section 3) was used for formulating the proposed amendment of Table 1 – Annex II of the PPWR proposal we are presenting in Table 2.

The findings of the feasibility assessment of clustering selected packaging categories are given in the following paragraphs and summarised in Table 2.

For **glass packaging** it seems meaningful to cluster the two categories (mono-materials and composites) into the new category 1.

For **paper/cardboard packaging** the best option would be to keep two categories, one for mono-materials and one for composites, resulting in the **new category 2** and the **new category 3**, respectively.

For **metal packaging** it is proposed to merge mono-material steel and steel composites into the **new category 4**. For aluminium we propose to merge all the rigid aluminium packaging (mono-material and composite) into the **new category 5** and all semi-rigid and flexible aluminium packaging (mono-material and composite) into the **new category 6**.

As regards **plastic packaging**, it is suggested to merge all those categories that in the PPWR proposal differ only by colour. This is the case for PET – rigid (e.g. bottles and flasks) which were initially split into ‘transparent clear/light blue’ and ‘transparent/other colours’ and are suggested to be merged into the **new category 7**, whereas PET rigid (other than bottles and flasks) should be rather kept as a separate category (**new category 8**). The **new category 9** corresponds to PET flexible films, which, as mentioned above, were not included in the assessment. The same considerations based on colour differentiation were made for HDPE – rigid (e.g. containers and tubes), which were split into ‘natural/clear’ and ‘coloured’ and are suggested to be merged into the **new category 10**; PE – flexible (e.g. films), which were split into ‘natural/clear’ and ‘coloured’ and are proposed to be merged into the **new category 11**; PP – rigid (e.g. containers and tubes), which were split into ‘natural/clear’ and ‘coloured’ and are proposed to be merged into the **new category 12**; PP – flexible (e.g. films), which were split into ‘natural/clear’ and ‘coloured’ and are proposed to be merged into the **new category 13**. The **new category 14** covers HDPE and PP rigid formats (e.g. crates and pallets) that were not appraised for clustering. Following the on-going work led by the CEN technical committee on the standardization of DfR guidelines for plastic packaging, we propose to merge PS and XPS into the new **category 15**, whereas EPS should remain a separate category (**new category 16**). The **new category 17** and **new category 18** include other plastic packaging not covered in the categories above with rigid and flexible formats, respectively. Those categories can encompass innovative plastic packaging materials.

An additional category for biodegradable plastics is proposed to be included as a stand-alone entry (**new category 19**), including both rigid (e.g. PLA, PHB) and flexible formats (e.g. PLA).

Finally the **new categories 20, 21 and 22** include wood & cork, textile and ceramics or porcelain packaging, respectively.

Hence the total number of packaging categories **is reduced from 30 to 22**. It is to be noted that the packaging formats merged under a given category do not have to necessarily follow a unique design for recycling assessment.

Table 2. Proposed amendment of Table 1 of Annex II of the PPWR proposal (text highlighted in cyan represents new additions or amendments compared to Annex II of the PPWR proposal)

Cat. No (new)	Cat. No (old)	Predominant packaging material	Packaging type	Format (illustrative and non-exhaustive)	Colour / Optical transmittance
1	1 + 2	Glass	Glass and composite packaging, of which the majority is glass	Bottles, jars, flacons, cosmetics pots, tubs, ampoules, vials made of glass (soda lime silica)	-
2	3	Paper/cardboard	Paper/cardboard packaging	Boxes, trays, grouped packaging, flexible paper packaging (e.g. films, sheets, pouches, lidding, cones, wrappers)	-
3	4	Paper/cardboard	Composite packaging of which the majority is paper/cardboard	Liquid packaging board, and paper cups (i.e. laminated with polyolefin and with or without aluminium), trays, plates and cups, metallised or plastic laminated paper/cardboard, paper/cardboard with plastic liners/ windows	-
4	5 + 6	Metal	Steel and composite packaging of which the majority is steel	Rigid formats (aerosols, cans, paint tins, boxes, trays, drums, tubes) made of steel, including tinplate and stainless steel	-
5	7 + 9	Metal	Aluminium and composite packaging of which the majority is aluminium – rigid	Rigid formats (food and beverage cans, bottles, aerosols, drums, tubes, cans, boxes, trays) made of aluminium	-
6	8 + 9	Metal	Aluminium and composite packaging of which the majority is aluminium – semi-rigid and flexible	Semi-rigid and flexible formats (containers and trays, tubes, foils, flexible foil) made of aluminium	-
7	10 + 11	Plastic	PET – rigid	Bottles and flasks	Transparent clear / coloured, opaque
8	12	Plastic	PET – rigid	Rigid formats other than bottles and flasks (Includes pots, tubs, jars, cups, mono- and multilayer trays and containers)	Transparent clear / coloured, opaque
9	13	Plastic	PET – flexible	Films	Natural / coloured
10	14 + 15	Plastic	PE – rigid	Containers, bottles, trays, pots and tubes	Natural / coloured
11	16 + 17	Plastic	PE – flexible	Films, including multilayer and multi-material packaging	Natural / coloured
12	18 + 19	Plastic	PP – rigid	Containers, bottles, trays, pots and tubes	Natural / coloured
13	20 + 21	Plastic	PP – flexible	Films, including multilayer and multi-material packaging	Natural / coloured
14	22	Plastic	HDPE and PP – rigid	Crates and pallets, corrugated board plastic	Natural / coloured
15	23 + 25	Plastic	PS and XPS – rigid	Rigid formats (includes dairy packaging, trays, cups and other food containers)	Natural / coloured
16	24	Plastic	EPS – rigid	Rigid formats (includes fish boxes / white goods and trays)	Natural / coloured
17	26	Plastic	Other rigid plastics (e.g. PVC, PC) including multi-materials – rigid	Rigid formats, including e.g. intermediate bulk containers, drums	-
18	27	Plastic	Other flexible plastics including	Pouches, blisters, thermoformed packaging, vacuum packaging, modified	-

			multi-materials – flexible	atmosphere/modified humidity packaging, including e.g. flexible intermediate bulk containers, bags, stretch films	
19	N/A	Plastic	Biodegradable plastics ⁵ – rigid (e.g. PLA, PHB) and flexible (e.g. PLA)	Rigid and flexible formats	-
20	28	Wood, cork	Wooden packaging, including cork	Pallets, boxes, crates	-
21	29	Textile	Natural and synthetic textile fibres	Bags	-
22	30	Ceramics or porcelain stoneware	Clay, stone	Pots, containers, bottles, jars	-

If there is a need to further reduce the number of packaging categories, the following categories could be clustered:

- categories 14, 15, 18 and 19 (polyolefin rigid – containers, bottles and tubes)
- categories 16, 17, 20 and 21 (polyolefin flexible – films incl. multilayer and multi-material packaging)

This would result in a total of 20 packaging categories.

⁵ Please note that this category contains plastics that are readily biodegradable (meaning a proven ability to convert >90% of the original material into CO₂, water and minerals by biological processes within 6 months when tested according with ISO 14855 or other similar methods) and regardless of the feedstock used for their production. Bio-based polymers that are not readily biodegradable are covered under the other relevant plastic categories.

References

- 4evergreen. (2023). *Circularity by design guideline for fibre-based packaging* (Issue June). <https://4evergreenforum.eu/about/guidelinesandprotocol/>
- ACE. (2022). *Beverage Cartons: Design for Recyclability Guidelines*. October. <https://www.extr-act.eu/wp-content/uploads/2021/12/ACE-DesignForRecyclabilityGUIDELINES-25102022-2.pdf>
- APCO. (2019). *Design for recyclability. Quickstart guide for glass packaging*. <https://doi.org/10.1533/9780857095701.2.109>
- APEAL. (2022). *Why Steel Recycles Forever How To Collect, Sort and Recycle Steel for Packaging Report 2022*. <https://www.apeal.org/reports/why-steel-recycles-forever-2022-recycling-report/>
- APR. (2023). *APR Design Guidance for Plastic Packaging*. <https://plasticsrecycling.org/apr-design-guide>
- Briedis, R., & Syversen, F. (2019). *Plastic packaging recyclability in a Nordic context*. <https://doi.org/10.1108/eb011552>
- CEFLEX. (2023). *Designing for a Circular Economy Guidelines*. <https://guidelines.ceflex.eu/guidelines/#:~:text=The Guidelines - CEFLEX D4ACE The Guidelines 'Designing,value chain design packaging solutions which are recyclable.>
- CEN. (2023). *Standards on design-for-recycling of plastic packaging. Committee: CEN/TC 261/SC 4/WG 10*.
- 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*. https://www.cepi.org/wp-content/uploads/2020/10/Cepi_recyclability-guidelines.pdf
- CIRCPACK. (2022). *Design for Recycling Guidelines for Packaging*. <https://www.circpack.veolia.com/make-your-packaging-recyclable/design-guidelines>
- CONAI. (2023a). *Guidelines to facilitate recycling of aluminium packaging*. <http://www.progettarericiclo.com/en/docs/guidelines-facilitate-recycling-aluminium-packaging>
- CONAI. (2023b). *Guidelines to facilitate recycling of paper packaging*. <http://www.progettarericiclo.com/en/docs/guidelines-facilitating-recycling-packaging-made-predominantly-paper>
- CONAI. (2023c). *Guidelines to facilitate recycling of plastic packaging*. <http://www.progettarericiclo.com/en/docs/guidelines-facilitate-recycling-plastic-packaging>
- CPI. (2022). *Cellulose fibre-based packaging: Design for Recyclability Guidelines* (Issue October). https://thecpi.org.uk/library/PDF/Public/Publications/Guidance Documents/CPI_guidelines_2022-WEB.pdf
- Der Grüne Punkt. (2022). *Design for Recycling*. https://www.gruener-punkt.de/fileadmin/Dateien/Downloads/PDFs/2202_D4R_Guide_DE.pdf
- EC. (2022). *Proposal for a regulation of the European Parliament and of the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC*. European Commission.
- Eco Design. (2022). *Instruction Design for Recycling*. <https://ecodesign-packaging.org/en/downloads/>
- Egle, L., Pierri, E., Gaudillat, P., Gallo, F., Mathieux, F., Manfredi, S., & Saveyn, H. (2024). Technical recommendations on possible elements of a methodology to assess recyclability of packaging in the framework of the Packaging and Packaging Waste Regulation Proposal. *JRC Science for Policy Report*.
- EPBP. (2023). *Design Guidelines for PET bottles*. <https://www.epbp.org/design-guidelines>
- FH Campus Vienna. (2021). *Circular Packaging Design Guideline*. <https://www.fh-campuswien.ac.at/forschung/kompetenzzentren-fuer-forschung-und-entwicklung/kompetenzzentrum-fuer-sustainable-and-future-oriented-packaging-solutions/circular-packaging-design-guideline.html>
- GIZ. (2021). *Design-for-Recycling (D4R) - State of play*. https://www.giz.de/en/downloads/2021-06_Design_for_recycling_barrierefrei.pdf
- GROW International. (2023). *The Lightwood Packaging Industry*. <https://www.grow-international.eu/#benefits>
- RECOUP. (2023). *Plastic packaging recyclability by design*. <https://doi.org/10.1108/eb011552>

- Recyclclass. (2022). *Recyclclass recyclability methodology. Version 2.0*. https://recyclclass.eu/wp-content/uploads/2022/01/Recyclclass_methodology_UPDATED_-JANUARY-2022.pdf
- Recyclclass. (2023). *Design for Recycling Guidelines*. <https://recyclclass.eu/recyclability/design-for-recycling-guidelines/>
- Rilegno. (2014). *La filiera degli imballaggi di legno. Sostenibilità e virtuosità ambientale*. <https://www.rilegno.org/la-filiera-degli-imballaggi-di-legno/>
- UBA. (2019). *Altholz*. <https://www.umweltbundesamt.de/altholz>
- Watkins, E., Romagnoli, V., Kirhensteine, I., Ruckley, F., Mitsios, A., Pantzar, M., Saveyn, H., & Garbarino, E. (2020). *Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for- recycling of plastic products* (Issue November). <https://doi.org/10.2760/936397>
- WPO. (2021). *Packaging Design for Recycling. A global recommendation for circular packaging design*. https://worldpackaging.org/Uploads/2021-10/ResourcePDF37_1635406572.pdf
- ZSVR. (2021). *Minimum standard for determining the recyclability of packaging subject to system participation pursuant to section 21 (3) VerpackG (Verpackungsgesetz – Packaging Act). In consultation with the German Environment Agency (Umweltbundesamt) (Vol. 21, Issue August)*. https://www.verpackungsregister.org/fileadmin/files/Mindeststandard/Mindeststandard_VerpackG_Ausgabe_2022.pdf

List of abbreviations

CEN	European Committee for Standardization
DG ENV	Directorate General for the Environment
(DG) JRC	(Directorate General of the) Joint Research Centre
DfR	Design for Recycling
EC	European Commission
EPS	Expanded Polystyrene
EU	European Union
FIBC	Flexible Intermediate Bulk Container
HDPE	High Density Polyethylene
IBC	Intermediate Bulk Container
PC	Polycarbonate
PE	Polyethylene
PET	Polyethylene Terephthalate
PHB	Polyhydroxybutyrate
PLA	Polylactic acid
PP	Polypropylene
PPWR	Packaging and Packaging Waste Regulation
PS	Polystyrene
PVC	Polyvinyl Chloride
XPS	Extruded Polystyrene

List of boxes

Box 1. JRC proposal for glass packaging	14
Box 2. JRC proposal for paper/cardboard packaging	15
Box 3. JRC proposal for metal packaging	17
Box 4. JRC proposal for plastic packaging (rigid)	21
Box 5. JRC proposal for plastic packaging (flexible)	22
Box 6. JRC proposal for wood/cork packaging	23
Box 7. JRC proposal for textile packaging	23
Box 8. JRC proposal for ceramics/porcelain packaging	23

List of figures

Figure 1. Exemplary heatmap with dendogram plotted in RStudio	9
Figure 2. Heatmap glass packaging (combination g1: categories 1 and 2)	14
Figure 3. Heatmap paper and cardboard packaging (combination p1: categories 3 and 4).....	15
Figure 4. Heatmap metal packaging – steel (combination m1: categories 5 and 6).....	16
Figure 5. Heatmap metal packaging – aluminium (combination m2: categories 7, 8 and 9).....	17
Figure 6. Heatmap plastic packaging – rigid (combination r1: categories 10, 11 and 12).....	18
Figure 7. Heatmap plastic packaging – rigid (combination r2: categories 14, 15, 18 and 19)	19
Figure 8. Heatmap plastic packaging – rigid (combination r3: categories 23, 24 and 25).....	20
Figure 9. Heatmap plastic packaging – flexible (combination f1: categories 16, 17, 20 and 21)	22

List of tables

Table 1. Selected combinations of packaging categories to be used for the statistical analysis of similarities.	7
Table 2. Proposed amendment of Table 1 of Annex II of the PPWR proposal (text highlighted in cyan represents new additions or amendments compared to Annex II of the PPWR proposal)	25
Table 3. Indicative list of packaging materials, types and categories referred to in Article 6.	33
Table 4. Overview of DfR guidelines or other relevant reports screened and packaging materials covered.	34
Table 5. Input file for combination g1 (glass packaging)	36
Table 6. Input file for combination p1 (paper and cardboard packaging)	39
Table 7. Input file for combination m1 (metal packaging – steel)	44
Table 8. Input file for combination m2 (metal packaging – aluminium)	45
Table 9. Input file for combination r1 (plastic packaging – rigid)	48
Table 10. Input file for combination r2 (plastic packaging – rigid)	51
Table 11. Input file for combination r3 (plastic packaging – rigid)	54
Table 12. Input file for combination f1 (plastic packaging – flexible)	57

Annexes

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

Annex II - Categories and parameters for assessment of recyclability of packaging

Table 3. 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. Available DfR guidelines identified by JRC (non-exhaustive list)

Table 4. 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 methodology	EU				x			
(Recyclass, 2023)	Recyclass 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: <i>La filiera degli imballaggi di legno. Sostenibilità e virtuosità ambientale</i>)	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. Input files for statistical analysis using the software RStudio

Table 5. Input file for combination g1 (glass packaging)

Sub-parameters	cat1	cat2	sim1_2
Material: Soda lime glass	1	1	a
Material: Heat-resistant glass	1	1	a
Material: Lead crystals	1	1	a
Material: Heavy metal concentration compliant with 2001/171/EC	1	1	a
Material: Glass content in packaging	1	1	a
Material: Mono-material glass	1	0	b
Standard colours	1	1	a
Metallic colours	1	1	a
Non standard colours	1	1	a
Optical transmission factor	1	1	a
No additives/fillers	1	1	a
No barriers/coatings	1	1	a
External coating (hot-end /cold-end coating)	1	1	a
No coding	1	1	a
Coding: Direct printing - minimal	1	1	a
Coding: Direct printing - extensive	1	1	a
Coding: Laser printing	1	1	a
Coding: Laser engraving	1	1	a
Coding: Embossing	1	1	a
Coding: other printing techniques	1	1	a
No ink/lacquer/varnish on packaging	1	1	a

Toxicity of inks (EuPIA guideline)	1	1	a
PVC based inks on packaging	1	1	a
Metallic inks on packaging	1	1	a
Ceramic inks on packaging	1	1	a
Organic inks on packaging	1	1	a
Silver/gold pastes on packaging	1	1	a
No labels	1	1	a
Wet-strength paper label	1	1	a
Dry-strength paper label	1	1	a
Plastic film label (PE, PP)	1	1	a
Plastic film label (PET)	1	1	a
Plastic film label (PS)	1	1	a
Plastic film label (biobased and/or compostable blends with PCL)	1	1	a
Plastic film label (PVC/PVDC)	1	1	a
Metallised paper label	1	1	a
Metallised plastic film label	1	1	a
Metal film label	1	1	a
Paper laminate / multilayer label	1	1	a
Textile label	1	1	a
Wood label	1	1	a
Ceramic labels (ACL - applied ceramic labels)	1	1	a
Foil embossing label	1	1	a
Label: % of surface coverage	1	1	a
No sleeves	1	1	a
Plastic film sleeve (biobased and/or compostable blends with PCL)	1	1	a
Plastic film sleeve (PO)	1	1	a
Plastic film sleeve (PS)	1	1	a
Silicone sleeve	1	1	a
Perforated sleeve	1	1	a
Non-perforated sleeve	1	1	a
Shrunked sleeve	1	1	a
Wrap around sleeve	1	1	a
Sleeve: % of surface coverage	1	1	a
No tamper evident element	1	1	a
Plastic based TESW (density <1 g/cm ³)	1	1	a

Plastic based TESW (density >1 g/cm ³)	1	1	a
Metallised TESW	1	1	a
PET based TESW with washable ink	1	1	a
Tamper-evident plastic rings	1	1	a
Tamper-evident aluminium rings	1	1	a
No closures/openings	1	1	a
Cork closure	1	1	a
Ferromagnetic metal closure	1	1	a
Non-ferromagnetic metal closure	1	1	a
Plastic closure	1	1	a
Ceramic/porcelain closure	1	1	a
Closure bonded to main packaging body	1	1	a
Closure not bonded to main packaging body	1	1	a
Fixed closure insert and pourer systems	1	1	a
Swing top	1	1	a
Pump dispenser	1	1	a
Synthetic rubber closure	1	1	a
No liners/seals/valves	1	1	a
Plastic liner/seal/valve	1	1	a
Aluminium liner/seal/valve	1	1	a
Water-releasable label adhesive	1	1	a
Permanent label adhesive	1	1	a
Detectable and sortable size of packaging	1	1	a
Separability of labels/sleeves	1	1	a
Separability of other components	1	1	a
Separation by consumer	1	1	a
Separation in sorting process	1	1	a
Separation in recycling process	1	1	a
% product residues in packaging	1	1	a
Recycling disruptive residues	1	1	a
hazardousness of product residues	1	1	a
% of recycled material in packaging	1	1	a
% of biodegradable material in packaging	1	1	a
Other components: RFID tags	1	1	a
Other components: Enamel components	1	1	a

Other components: roll-on (in deodorants)	1	1	a
Other: Wicker bottles	1	1	a
Material: Glass-ceramics	0	1	c
Material: Glass composites	0	1	c

Table 6. Input file for combination p1 (paper and cardboard packaging)

Sub-parameters	cat3	cat4	sim3_4
Material: wood based fibres	1	1	a
Material: non-wood fibres	1	1	a
Material: moulded pulp, highly compressed	1	1	a
Material: kraft paper	1	1	a
Material: corrugated fibre board with kraft liner	1	1	a
Material: bleached paper	1	1	a
Material: unbleached paper	1	1	a
Colourants in the additive parts	1	1	a
No colourants	1	1	a
NIR detectable colours	1	1	a
Optical brighteners/Blueing agents	1	1	a
No additives/fillers	1	1	a
Fillers	1	1	a
Additive: wet strength agents	1	1	a
Additive: dry strength agents	1	1	a
Additive: sizing agents	1	1	a
Additive: retention agents	1	1	a
Additive: optical brightening agent	1	1	a
Additive: fluorescent whitening agent	1	1	a
Additive: lignin	1	1	a
Additive: PVOH	1	1	a
No barriers/coatings	1	1	a
Wax impregnation/dipping	1	1	a
Chlorine-containing coatings	1	1	a
Water-based wet-barrier coatings	1	1	a
Solvent-based coatings	1	1	a
Pigment coatings with colours suitable for de-inking	1	1	a
No lamination	1	1	a
No coding	1	1	a

Coding: direct printing	1	1	a
Coding: laser marking	1	1	a
Coding: digital watermark	1	1	a
Coding: transfer printing	1	1	a
Bleeding inks	1	1	a
Toxicity of inks (EuPIA guideline)	1	1	a
Water-based varnishes	1	1	a
Solvent-based varnishes	1	1	a
Vegetable-oil based varnishes	1	1	a
Mineral-oil based varnishes	1	1	a
UV curing varnishes	1	1	a
EB curing varnishes	1	1	a
Water-based inks	1	1	a
Solvent-based inks	1	1	a
Vegetable-oil based inks	1	1	a
Mineral-oil based inks	1	1	a
UV curing inks	1	1	a
EB curing inks	1	1	a
Plasticised inks	1	1	a
Metallic inks	1	1	a
Hot melt inks	1	1	a
Binders for inks	1	1	a
Hot and cold foil stamping	1	1	a
Transfer printing	1	1	a
Glitter	1	1	a
No labels	1	1	a
Paper label	1	1	a
Plastic label	1	1	a
Biodegradable plastic label	1	1	a
Paper laminate label	1	1	a
Direct thermal paper label	1	1	a
Metallised film label	1	1	a
Metallised paper label	1	1	a
Metal foil label	1	1	a
Paper based label: % of surface coverage	1	1	a

Non-paper based label: % of surface coverage	1	1	a
No sleeves	1	1	a
Paper sleeve	1	1	a
Plastic sleeve	1	1	a
Biodegradable plastic sleeve	1	1	a
Paper based sleeve: % of surface coverage	1	1	a
Non-paper based sleeve: % of surface coverage	1	1	a
No tamper evident elements	1	1	a
TESW: biobased and/or compostable blends with PCL	1	1	a
No closure	1	1	a
(Bio-)plastics caps	1	1	a
Paper caps	1	1	a
Metal spouts	1	1	a
Plastic spouts	1	1	a
(Bio-)Plastic pull strips	1	1	a
Zippers	1	1	a
Paper tapes	1	1	a
Staples	1	1	a
Plastic adhesive tapes	1	1	a
Fibre-based lid	1	1	a
(Bio-)plastic lid	1	1	a
Tapes reinforced with glass fibre	1	1	a
Tapes reinforced with carbon fibre	1	1	a
Metallised reclosable lid	1	1	a
Pump	1	1	a
No liners/seals/valves	1	1	a
Fibre-based seal	1	1	a
(Bio-)plastic seal	1	1	a
Hotmelt seal	1	1	a
Starch based seal	1	1	a
Synthetic based seal	1	1	a
Aluminium liner	1	1	a
(Bio-)plastic liner	1	1	a
Foamed plastic liner	1	1	a
Cellulosic foam liner	1	1	a

Film liner	1	1	a
Cotton thread	1	1	a
Plastic valves	1	1	a
Water-soluble adhesives	1	1	a
(Alki) dispersible adhesives	1	1	a
Hot melt adhesives	1	1	a
Pressure sensitive adhesives	1	1	a
PVA adhesives	1	1	a
Latex adhesives	1	1	a
Detectable and sortable size	1	1	a
Separability of labels/sleeves	1	1	a
Separability of other components	1	1	a
Separation by consumer	1	1	a
Separation in sorting process	1	1	a
Separation in recycling process	1	1	a
% product residues in packaging	1	1	a
Recycling disruptive residues	1	1	a
hazardousness of product residues	1	1	a
% of recycled material in packaging	1	1	a
% of biodegradable material in packaging	1	1	a
Carrying handle (fibre-based)	1	1	a
Carrying handle (non fibre-based)	1	1	a
Space fillers	1	1	a
No decoration	1	1	a
Material: plastic fibres	0	1	c
Material: metal	0	1	c
Material: plastic film	0	1	c
One-sided plastic extrusion coating	0	1	c
Two-sided plastic extrusion coating	0	1	c
Silicone coating	0	1	c
Adhesive lamination	0	1	c
Lamination with bio-degradable polymers	0	1	c
Polymer-film laminate at the inside of paper	0	1	c
One-side thermoplastic lamination	0	1	c
Two-side thermoplastic lamination	0	1	c

Barrier metallisation	0	1	c
Direct metallisation via vacuum deposition	0	1	c
Transfer metallisation (hot/cold foil)	0	1	c
Laminate with Aluminium foil	0	1	c
Aluminium film barrier	0	1	c
Thin film deposition other than metallisation	0	1	c
Lining coatings	0	1	c
Inorganic coatings	0	1	c
Polymer coatings	0	1	c
Biobased polymers coatings	0	1	c
Compostable coatings	0	1	c
Biodegradable resins and biodegradable resin variants coatings	0	1	c
Starch based coatings	0	1	c
Aqueous polymer dispersion coatings	0	1	c
Silan coatings	0	1	c
MFC/NFC coatings	0	1	c
One-side extrusion coating	0	1	c
Two-side extrusion coating	0	1	c
Heat seal coatings	0	1	c
Dispersion coating	0	1	c
Vacuum deposition coating	0	1	c
Coldseal (Latex) coating	0	1	c
Steel rings	0	1	c
Attachment: Paper straws	0	1	c
Attachment: Plastic straws	0	1	c
Plastic wrappers for straws	0	1	c
Paper wrappers for straws	0	1	c
Cellulosic windows (pergamin)	0	1	c
Plastic windows	0	1	c
Decoration: Hot and cold transfer metallisation	0	1	c
Decoration: PP/PET metallised laminates	0	1	c
Decoration: PET metallised film	0	1	c
Decoration: Direct Vacuum Metallised Paper	0	1	c
Decoration: Direct metallisation	0	1	c

Table 7. Input file for combination m1 (metal packaging – steel)

Sub-parameters	cat5	cat6	sim5_6
Material: mono-material steel	1	0	b
Material: stainless steel (mono-material)	1	0	b
Material: other ferromagnetic metals	1	0	b
Material: Fe content in packaging (%)	1	1	a
No colours	1	1	a
No additives/fillers	1	1	a
No barriers/coatings	1	1	a
Tin coating	1	1	a
Chromium coating	1	1	a
Any other metal coating	1	1	a
Epoxy BPA coatings	1	1	a
Paint coatings	1	1	a
Lacquer coating (PVC / Organosol lacquers)	1	1	a
EuPIA compliant coatings	1	1	a
No coding	1	1	a
Toxicity of inks (EuPIA guideline)	1	1	a
Metallic ink	1	1	a
No labels	1	1	a
Paper labels	1	1	a
Plastic labels	1	1	a
Plastic labels (PVC)	1	1	a
Label: % of surface coverage	1	1	a
No sleeves	1	1	a
Paper sleeve	1	1	a
Plastic sleeve	1	1	a
Sleeve: % of surface coverage	1	1	a
No tamper evident element	1	1	a
PE/PP/PVC TESW	1	1	a
Aluminium TESW	1	1	a
Steel closure	1	1	a
Other ferromagnetic metals closure	1	1	a
Plastic closure	1	1	a
Non-ferromagnetic metal closure	1	1	a

Closure made of plastic/aluminium combinations	1	1	a
No liners/seals/valves	1	1	a
PVC liners	1	1	a
PVC containing liners	1	1	a
No adhesives	1	1	a
Thickness: Fe [µm]	1	1	a
Detectable and sortable size of packaging	1	1	a
Separability of labels/sleeves	1	1	a
Separability of other components	1	1	a
Separation by consumer	1	1	a
Separation in sorting process	1	1	a
Separation in recycling process	1	1	a
% product residues in packaging	1	1	a
Recycling disruptive residues	1	1	a
hazardousness of product residues	1	1	a
% of recycled material in packaging	1	1	a
% of biodegradable material in packaging	1	1	a
Other components: Widget nitrogen ball can	1	1	a
Other components: Spray system with pump sprayer	1	1	a
Other components: Spray system with actuator	1	1	a
Other components: Small loose steel parts	1	1	a
Other components: Aluminium parts inside steel packaging	1	1	a
Others: Aerosol cans	1	1	a
Material: steel composites with other ferromagnetic metals	0	1	c
Material: steel composites with non-ferromagnetic metals	0	1	c
Material: steel composites with materials other than metal	0	1	c

Table 8. Input file for combination m2 (metal packaging – aluminium)

Sub-Parameters	cat7	cat8	cat9	sim7_8	sim7_9	sim8_9
Material: mono-material Aluminium	1	1	0	a	b	b
Material: Aluminium containing Cu	1	1	0	a	b	b
Material: Aluminium containing Fe	1	1	0	a	b	b
Material: Al content in packaging (%)	1	1	1	a	a	a
No colours	1	1	1	a	a	a
No additives/fillers	1	1	1	a	a	a

No barriers/coatings	1	1	1	a	a	a
Tin coating	1	0	1	b	a	c
Chromium coating	1	0	1	b	a	c
Any other metal coating	1	0	1	b	a	c
Epoxy BPA coatings	1	0	1	b	a	c
Paint coatings	1	1	1	a	a	a
Lacquer coatings	1	1	1	a	a	a
EuPIA compliant coatings	1	1	1	a	a	a
No coding	1	1	0	a	b	b
Toxicity of inks (EuPIA guideline)	1	1	1	a	a	a
Paints on packaging with water or reduced VOC content	1	1	1	a	a	a
No labels	1	1	1	a	a	a
Paper labels	1	1	1	a	a	a
Plastic labels	1	1	1	a	a	a
Plastic labels (PVC)	1	1	1	a	a	a
Label: % of surface coverage	1	1	1	a	a	a
No sleeves	1	1	1	a	a	a
Paper sleeve	1	1	1	a	a	a
Plastic sleeve	1	1	1	a	a	a
Sleeve: % of surface coverage	1	1	1	a	a	a
No tamper evident element	1	1	1	a	a	a
PE/PP/PVC materials TESW	1	0	1	b	a	c
Aluminium TESW	1	0	1	b	a	c
Aluminium closure	1	1	1	a	a	a
Plastic valve and caps closures	1	0	1	b	a	c
Ferromagnetic metal closure	1	1	1	a	a	a
Non Al material liners	1	0	1	b	a	c
PVC liners	1	0	1	b	a	c
PVC containing liners	1	0	1	b	a	c
No adhesives	1	1	1	a	a	a
Thickness: Al [μm]	1	1	1	a	a	a
Detectable and sortable size of packaging	1	1	1	a	a	a
Separability of labels/sleeves	1	1	1	a	a	a
Separability of other components	1	1	1	a	a	a
Separation by consumer	1	1	1	a	a	a

Separation in sorting process	1	1	1	a	a	a
Separation in recycling process	1	1	1	a	a	a
% product residues in packaging	1	1	1	a	a	a
Recycling disruptive residues	1	1	1	a	a	a
hazardousness of product residues	1	1	1	a	a	a
% of recycled material in packaging	1	1	1	a	a	a
% of biodegradable material in packaging	1	1	1	a	a	a
Other components: Widget nitrogen ball can	1	0	0	b	b	d
Other components: Spray system with pump sprayer	1	0	0	b	b	d
Other components: Small loose steel parts	1	0	0	b	b	d
Others: Aerosol cans	1	0	1	b	a	c
Others: Wire shaped packaging	1	0	0	b	b	d
Polyolefin coating	0	1	1	c	c	a
PVC/PVDC coating	0	1	1	c	c	a
Metallic coatings	0	1	0	c	d	b
Metallic ink	0	1	0	c	d	b
Plastic valves and caps closures	0	1	0	c	d	b
Plastic closure	0	1	1	c	c	a
No liners/seals/valves	0	1	1	c	c	a
Non Al material liner	0	1	0	c	d	b
Water soluble glue	0	1	0	c	d	b
Ultra adhesive glue	0	1	0	c	d	b
Material: Aluminium composites with other non-ferromagnetic metals	0	0	1	d	c	c
Material: Aluminium composites with ferromagnetic metals	0	0	1	d	c	c
Material: Aluminium composites with plastics	0	0	1	d	c	c
Material: Aluminium composites with paper/cardboard	0	0	1	d	c	c
Material: Aluminium composites with PVC/PVDC	0	0	1	d	c	c
Nitrocellulose binder for ink	0	0	1	d	c	c
PVC binder for ink	0	0	1	d	c	c
PU binder for ink	0	0	1	d	c	c
Polyurethan adhesives	0	0	1	d	c	c
Acrylates adhesives	0	0	1	d	c	c
Epoxy (SBA) adhesives	0	0	1	d	c	c

Table 9. Input file for combination r1 (plastic packaging – rigid)

Sub-Parameters	cat10	cat11	cat12	sim10_1 1	sim10_1 2	sim11_1 2
Material: mono PET-A	1	1	1	a	a	a
Material: multilayer PET	1	1	1	a	a	a
Material: PET variants	1	1	0	a	b	b
Material: PET with other plastic resins	1	1	1	a	a	a
Material: PET with non-plastic material	1	1	1	a	a	a
Material: recycled PET	1	1	1	a	a	a
No colours	1	1	1	a	a	a
Light blue	1	0	0	b	b	d
No additives/fillers	1	1	1	a	a	a
Additive: UV stabilizers	1	1	1	a	a	a
Additive: AA blockers	1	1	1	a	a	a
Additive: optical brighteners	1	1	1	a	a	a
Additive: scavengers	1	1	1	a	a	a
Additive: nanoparticles / nanocomposites	1	1	1	a	a	a
Additive: PA	1	1	1	a	a	a
Additive: chain extenders	1	1	0	a	b	b
Mineral fillers	1	1	0	a	b	b
Additive: re-heat agents	1	1	0	a	b	b
Additive: antistatic agent	1	1	1	a	a	a
No barriers/coatings	1	1	1	a	a	a
SiOx coating	1	1	0	a	b	b
Clear coating	1	1	0	a	b	b
Carbon coating	1	1	0	a	b	b
PA monolayer blends barrier	1	1	1	a	a	a
PA multilayer barrier	1	1	1	a	a	a
PTN alloy barrier	1	1	0	a	b	b
PGA multilayer barrier	1	1	0	a	b	b
EVOH barrier	1	1	1	a	a	a
Metallised film barrier	1	1	1	a	a	a
AlOx coating	1	1	1	a	a	a
UV barrier (middle layer of a bottle)	1	1	0	a	b	b
PEF multilayer barrier	1	1	0	a	b	b
No coding	1	1	1	a	a	a

Coding: direct printing - minimal	1	1	1	a	a	a
Coding: direct printing - extensive	1	1	1	a	a	a
Coding: laser engraving	1	1	1	a	a	a
Coding: embossed/minted	1	1	1	a	a	a
Coding: tracer	1	1	1	a	a	a
Coding: watermark	1	1	1	a	a	a
Toxicity of inks (EuPIA guideline)	1	1	1	a	a	a
PVC based inks	1	1	1	a	a	a
Metallic inks	1	1	1	a	a	a
Bleeding inks	1	1	1	a	a	a
Washable inks	1	1	1	a	a	a
Carbon black based inks	1	1	0	a	b	b
Hot stamp ink	1	1	0	a	b	b
No labels	1	1	1	a	a	a
PET-A label	1	1	1	a	a	a
Plastic label with density < 1 g/cm ³	1	1	1	a	a	a
Plastic label with density > 1 g/cm ³	1	1	1	a	a	a
Wet-strength paper label	1	1	1	a	a	a
Metallised label	1	1	1	a	a	a
In-mould label	1	1	1	a	a	a
Label made of NIR detectable material	1	1	0	a	b	b
Label: % of surface coverage	1	1	1	a	a	a
No sleeves	1	1	1	a	a	a
Plastic sleeve with density < 1 g/cm ³	1	1	0	a	b	b
Plastic sleeve with density > 1 g/cm ³	1	1	0	a	b	b
Metallised sleeve	1	1	0	a	b	b
Perforated sleeve	1	1	0	a	b	b
Non-perforated sleeve	1	1	0	a	b	b
Double perforated sleeve	1	1	0	a	b	b
Sleeve: % of surface coverage	1	1	1	a	a	a
No tamper evident element	1	1	1	a	a	a
TEE plastics with density < 1 g/cm ³	1	1	0	a	b	b
TEE plastics with density > 1 g/cm ³	1	1	0	a	b	b
Metallised TEE	1	1	0	a	b	b
Rigid closure: plastics with density < 1 g/cm ³	1	1	1	a	a	a

Rigid closure: plastics with density > 1 g/cm ³	1	1	1	a	a	a
Rigid closure: non detaching or welded closures	1	1	0	a	b	b
Rigid closure: metals	1	1	0	a	b	b
Rigid closure: thermosets	1	1	0	a	b	b
Rigid closure: integrated silicone closure (e.g. valves)	1	1	0	a	b	b
Rigid closure: glass and metal springs in pumping systems	1	1	0	a	b	b
No liners/seals/valves	1	1	1	a	a	a
Mono PE or PP liner/seal/valve	1	1	0	a	b	b
PE composites liner/seal/valve	1	1	0	a	b	b
Plastics liner/seal/valve with density < 1 g/cm ³	1	1	0	a	b	b
Plastics liner/seal/valve with density > 1 g/cm ³	1	1	0	a	b	b
Floatable TPO and TPS liner/seal/valve	1	1	0	a	b	b
Aluminium liner/seal/valve	1	1	0	a	b	b
Water-releasable adhesive	1	1	1	a	a	a
Permanent adhesive	1	1	1	a	a	a
Detectable and sortable size of packaging	1	1	1	a	a	a
Separability of labels/sleeves	1	1	1	a	a	a
Separability of other components	1	1	1	a	a	a
Separation by consumer	1	1	1	a	a	a
Separation in sorting process	1	1	1	a	a	a
Separation in recycling process	1	1	1	a	a	a
% product residues in packaging	1	1	1	a	a	a
Recycling disruptive residues	1	1	1	a	a	a
hazardousness of product residues	1	1	1	a	a	a
% of recycled material in packaging	1	1	1	a	a	a
% of biodegradable material in packaging	1	1	1	a	a	a
Other components: RFID tags	1	1	1	a	a	a
Standard bright colours without light blue	0	1	0	c	d	b
Dark / heavy colours	0	1	1	c	c	a
Metallic pigments	0	1	1	c	c	a
Fluorescent pigments	0	1	1	c	c	a
Carbon black based colours	0	1	1	c	c	a
Standard bright colours	0	0	1	d	c	c
Additive: silicone layer	0	0	1	d	c	c
Additive: antiblocking agents	0	0	1	d	c	c

Additive: antifogging agents	0	0	1	d	c	c
Barrier: oxygen absorber on PET Basis without yellowing effect	0	0	1	d	c	c
PE barrier	0	0	1	d	c	c
Barrier lacquers	0	0	1	d	c	c
Cardboard sleeve	0	0	1	d	c	c
Rigid closure: unprinted PET	0	0	1	d	c	c
Flexible closure: plastics with density < 1 g/cm ³	0	0	1	d	c	c
Flexible closure: plastics with density > 1 g/cm ³	0	0	1	d	c	c
Flexible closure: unprinted PET	0	0	1	d	c	c
Flexible closure: foamed PET foils	0	0	1	d	c	c
Flexible closure: SiOx-, AlOx Plasma with barrier	0	0	1	d	c	c
Flexible closure: aluminium	0	0	1	d	c	c
Ventilation membranes	0	0	1	d	c	c
IBC/DRUMS sealing membranes	0	0	1	d	c	c
Other components: soaker pads	0	0	1	d	c	c
Other components: bubble pads	0	0	1	d	c	c
Insert: HDPE / LDPE / PP / PET	0	0	1	d	c	c
Insert: paper	0	0	1	d	c	c
Insert: PVC / PS / EPS / PU / PA	0	0	1	d	c	c
Insert: PC	0	0	1	d	c	c
Insert: PMMA	0	0	1	d	c	c
Insert: metallic	0	0	1	d	c	c
Other components: attached straws or cuttlery	0	0	1	d	c	c

Table 10. Input file for combination r2 (plastic packaging – rigid)

Sub-Parameters	cat14	cat15	cat18	cat19	sim14_15	sim14_18	sim14_19	sim15_18	sim15_19	sim18_19
Material: HDPE	1	1	1	1	a	a	a	a	a	a
Material: LDPE	1	1	0	0	a	b	b	b	b	d
Material: LLDPE	1	1	0	0	a	b	b	b	b	d
Material: PE plastomers	1	1	0	0	a	b	b	b	b	d
Material: Combinations (e.g. bi-injection, assemblies)	1	1	0	0	a	b	b	b	b	d
Material: Soft touch/TPE	1	1	0	0	a	b	b	b	b	d
Material: Recycled PE	1	1	0	0	a	b	b	b	b	d
Material: PE copolymers	1	1	0	0	a	b	b	b	b	d
Material: Polar PE	1	1	0	0	a	b	b	b	b	d
Material: Non-polar PE	1	1	0	0	a	b	b	b	b	d
No colours	1	0	1	0	b	a	b	c	d	b
No additives/fillers	1	1	1	1	a	a	a	a	a	a

Additive: Nanoparticles / nanocomposites	1	1	1	1	a	a	a	a	a	a
Additive: Mineral fillers	1	1	1	1	a	a	a	a	a	a
Additive: Softener	1	1	1	1	a	a	a	a	a	a
No barriers/coatings	1	1	1	1	a	a	a	a	a	a
EVOH barrier	1	1	1	1	a	a	a	a	a	a
Metallised film barrier	1	1	1	1	a	a	a	a	a	a
PA barrier	1	1	1	1	a	a	a	a	a	a
PVC/PVDC barrier	1	1	1	1	a	a	a	a	a	a
PVOH barrier	1	1	1	1	a	a	a	a	a	a
SiOx coating	1	1	1	1	a	a	a	a	a	a
AlOx coating	1	1	1	1	a	a	a	a	a	a
Barrier lacquers	1	1	0	0	a	b	b	b	b	d
No coding	1	1	1	1	a	a	a	a	a	a
Coding: direct printing - minimal	1	1	1	1	a	a	a	a	a	a
Coding: direct printing - extensive	1	1	1	1	a	a	a	a	a	a
Coding: laser engraving	1	1	1	1	a	a	a	a	a	a
Coding: embossed/minted	1	1	1	1	a	a	a	a	a	a
Coding: tracer	1	1	1	1	a	a	a	a	a	a
Coding: watermark	1	1	1	1	a	a	a	a	a	a
Toxicity of inks (EuPIA guideline)	1	1	1	1	a	a	a	a	a	a
PVC based inks	1	1	1	1	a	a	a	a	a	a
Metallic inks	1	1	1	1	a	a	a	a	a	a
Nitrocellulose based inks	1	1	1	1	a	a	a	a	a	a
Bleeding inks	1	1	1	1	a	a	a	a	a	a
Washable inks	1	1	1	1	a	a	a	a	a	a
Carbon black based inks	1	1	1	1	a	a	a	a	a	a
No labels	1	1	1	1	a	a	a	a	a	a
Plastic label with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastic label with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Wet-strength paper label	1	1	1	1	a	a	a	a	a	a
Metallised label	1	1	1	1	a	a	a	a	a	a
In-mould label	1	1	1	1	a	a	a	a	a	a
Labels made of NIR detectable material	1	1	1	1	a	a	a	a	a	a
Label: % of surface coverage	1	1	1	1	a	a	a	a	a	a
No sleeves	1	1	1	1	a	a	a	a	a	a
Plastic sleeve with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastic sleeve with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Metallised sleeve	1	1	1	1	a	a	a	a	a	a
Cardboard sleeve	1	1	1	1	a	a	a	a	a	a
Perforated sleeve	1	1	1	1	a	a	a	a	a	a
Non-perforated sleeve	1	1	1	1	a	a	a	a	a	a
Double perforated sleeve	1	1	1	1	a	a	a	a	a	a
Sleeve: % of surface coverage	1	1	1	1	a	a	a	a	a	a
Sleeve hindering recognition of underlaying polymer	1	1	1	1	a	a	a	a	a	a
NIR detectability of container	1	1	1	1	a	a	a	a	a	a

No tamper evident element	1	1	1	1	a	a	a	a	a	a
TEE plastics with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
TEE plastics with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Metallised TEE	1	1	1	1	a	a	a	a	a	a
Rigid closure: PS	1	1	1	1	a	a	a	a	a	a
Rigid closure: PE, PP	1	1	1	1	a	a	a	a	a	a
Rigid closure: EVA	1	1	1	1	a	a	a	a	a	a
Rigid closure: TPE	1	1	1	1	a	a	a	a	a	a
Rigid closure: metals	1	1	1	1	a	a	a	a	a	a
Rigid closure: Plastic with density < 1 g/cm ³	1	1	0	0	a	b	b	b	b	d
Rigid closure: Plastic with density > 1 g/cm ³	1	1	0	0	a	b	b	b	b	d
Flexible closure: PS	1	1	1	1	a	a	a	a	a	a
Flexible closure: PE, PP	1	1	1	1	a	a	a	a	a	a
Flexible closure: EVA	1	1	1	1	a	a	a	a	a	a
Flexible closure: TPE	1	1	1	1	a	a	a	a	a	a
Flexible closure: aluminium	1	1	1	1	a	a	a	a	a	a
Flexible closure: Plastic with density < 1 g/cm ³	1	1	0	0	a	b	b	b	b	d
Flexible closure: Plastic with density > 1 g/cm ³	1	1	0	0	a	b	b	b	b	d
No liners/seals/valves	1	1	1	1	a	a	a	a	a	a
Integrated silicone valves	1	1	1	1	a	a	a	a	a	a
PP, TPO, TPS liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Floatable TPE liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PE elastomers liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PE and its copolymers liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Plastics liner/seal/valve with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastics liner/seal/valve with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Any other TPE liner/seal/valve	1	1	0	0	a	b	b	b	b	d
Metal liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Aluminium liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Water-releasable adhesive	1	1	1	1	a	a	a	a	a	a
Detectable and sortable size of packaging	1	1	1	1	a	a	a	a	a	a
Separability of labels/sleeves	1	1	1	1	a	a	a	a	a	a
Separability of other components	1	1	1	1	a	a	a	a	a	a
Separation by consumer	1	1	1	1	a	a	a	a	a	a
Separation in sorting process	1	1	1	1	a	a	a	a	a	a
Separation in recycling process	1	1	1	1	a	a	a	a	a	a
% product residues in packaging	1	1	1	1	a	a	a	a	a	a
Recycling disruptive residues	1	1	1	1	a	a	a	a	a	a
hazardousness of product residues	1	1	1	1	a	a	a	a	a	a
% of recycled material in packaging	1	1	1	1	a	a	a	a	a	a
% of biodegradable material in packaging	1	1	1	1	a	a	a	a	a	a
Other components: metal handle grip	1	1	1	1	a	a	a	a	a	a
Other components: PP handle grip	1	1	1	1	a	a	a	a	a	a
Other components: spout	1	1	1	1	a	a	a	a	a	a
Other components: soaker pads	1	1	1	1	a	a	a	a	a	a

Other components: bubble pads	1	1	1	1	a	a	a	a	a	a
Insert: HDPE / LDPE / PP / PET	1	1	1	1	a	a	a	a	a	a
Insert: paper	1	1	1	1	a	a	a	a	a	a
Insert: PVC / PS / EPS / PU / PA	1	1	1	1	a	a	a	a	a	a
Insert: PC	1	1	1	1	a	a	a	a	a	a
Insert: PMMA	1	1	1	1	a	a	a	a	a	a
Insert: metallic	1	1	1	1	a	a	a	a	a	a
Other components: RFID tags	1	1	1	1	a	a	a	a	a	a
Other components: Desiccant	1	1	1	1	a	a	a	a	a	a
Standard bright colours	0	1	0	1	c	d	c	b	a	c
Dark / heavy colours	0	1	0	1	c	d	c	b	a	c
Metallic pigments	0	1	0	1	c	d	c	b	a	c
Fluorescent pigments	0	1	0	1	c	d	c	b	a	c
Carbon black based colours	0	1	0	1	c	d	c	b	a	c
Material: PP	0	0	1	1	d	c	c	c	c	a
Additive: UV stabilizers	0	0	1	1	d	c	c	c	c	a
Additive: AA blockers	0	0	1	1	d	c	c	c	c	a
Additive: optical brighteners	0	0	1	1	d	c	c	c	c	a
Additive: scavenger	0	0	1	1	d	c	c	c	c	a
Additive: plastisizers	0	0	1	1	d	c	c	c	c	a
Barrier lacquers	0	0	1	1	d	c	c	c	c	a
Carbon black as internal layer	0	0	1	1	d	c	c	c	c	a
Labels with PBT	0	0	1	1	d	c	c	c	c	a
Non-polar ethylene copolymers	0	0	1	1	d	c	c	c	c	a
Permanent adhesive	0	0	1	1	d	c	c	c	c	a
Rigid closure: plastics with density < 1 g/cm ³	0	0	1	1	d	c	c	c	c	a
Rigid closure: plastics with density > 1 g/cm ³	0	0	1	1	d	c	c	c	c	a
Flexible closure: plastics with density < 1 g/cm ³	0	0	1	1	d	c	c	c	c	a
Flexible closure: plastics with density > 1 g/cm ³	0	0	1	1	d	c	c	c	c	a

Table 11. Input file for combination r3 (plastic packaging – rigid)

Sub-Parameters	cat23	cat24	cat25	sim23_24	sim23_25	sim24_25
Material: PS	1	0	0	b	b	d
Material: PS foamed < 1 g/cm ³	1	0	0	b	b	d
Material: multilayer PS	1	0	0	b	b	d
No colours	1	1	1	a	a	a
Standard bright colours	1	1	0	a	b	b
Dark / heavy colours	1	1	0	a	b	b
Metallic pigments	1	0	0	b	b	d
Fluorescent pigments	1	0	0	b	b	d
Carbon black based colours	1	0	0	b	b	d
No additives/fillers	1	1	1	a	a	a
Mineral fillers	1	0	0	b	b	d
No barriers/coatings	1	1	1	a	a	a

EVOH barrier	1	0	0	b	b	d
PA barrier	1	0	0	b	b	d
PVDC barrier	1	0	0	b	b	d
Barrier lacquers	1	0	0	b	b	d
No coding	1	1	1	a	a	a
Coding: direct printing - minimal	1	0	0	b	b	d
Coding: direct printing - extensive	1	0	0	b	b	d
Coding: laser engraving	1	0	0	b	b	d
Coding: embossed/minted	1	0	0	b	b	d
Coding: tracer	1	0	0	b	b	d
Coding: watermark	1	0	0	b	b	d
Toxicity of inks (EuPIA guideline)	1	1	0	a	b	b
Bleeding inks	1	1	0	a	b	b
PVC based inks	1	0	0	b	b	d
Metallic ink	1	0	0	b	b	d
Wash off inks	1	0	0	b	b	d
Carbon black based ink	1	0	0	b	b	d
Deinkable ink	1	0	0	b	b	d
No labels	1	1	1	a	a	a
PS label	1	0	0	b	b	d
Plastic label with density < 1 g/cm ³	1	0	0	b	b	d
Plastic label with density > 1 g/cm ³	1	0	0	b	b	d
Wet-strength paper label	1	0	0	b	b	d
In-mould label	1	0	0	b	b	d
Labels with PBT	1	0	0	b	b	d
PS based in-mold label	1	0	0	b	b	d
In-mold label with another plastic resin	1	0	0	b	b	d
Label: % of surface coverage	1	1	1	a	a	a
No sleeves	1	1	1	a	a	a
PS sleeve	1	0	0	b	b	d
Plastic sleeve with density < 1 g/cm ³	1	0	0	b	b	d
Plastic sleeve with density > 1 g/cm ³	1	0	0	b	b	d
Cardboard sleeve	1	0	0	b	b	d
Aluminium sleeve	1	0	0	b	b	d
Perforated sleeve	1	1	1	a	a	a
Non-perforated sleeve	1	1	1	a	a	a
Double perforated sleeve	1	1	1	a	a	a
Sleeve: % of surface coverage	1	1	1	a	a	a
Thickness that does not hinder material recognition	1	0	0	b	b	d
No tamper evident element	1	1	1	a	a	a
Wrap from EPS/PS	1	0	0	b	b	d
Rigid closure: PS	1	0	0	b	b	d
Rigid closure: PE, PP	1	0	0	b	b	d
Rigid closure: EVA	1	0	0	b	b	d
Rigid closure: TPE	1	0	0	b	b	d

Rigid closure: metals	1	0	0	b	b	d
Rigid closure: plastics with density < 1 g/cm ³	1	0	0	b	b	d
Rigid closure: plastics with density > 1 g/cm ³	1	0	0	b	b	d
Flexible closure: PS	1	0	0	b	b	d
Flexible closure: PE, PP	1	0	0	b	b	d
Flexible closure: EVA	1	0	0	b	b	d
Flexible closure: TPE	1	0	0	b	b	d
Flexible closure: plastics with density < 1 g/cm ³	1	0	0	b	b	d
Flexible closure: plastics with density > 1 g/cm ³	1	0	0	b	b	d
Flexible closure: aluminium	1	0	0	b	b	d
Thermoset plastics closure	1	0	0	b	b	d
Wood closure	1	0	0	b	b	d
No liners/seals/valves	1	1	1	a	a	a
PS liner/seal/valve	1	0	0	b	b	d
PP, TPO, TPS liner/seal/valve	1	0	0	b	b	d
EVA liner/seal/valve	1	0	0	b	b	d
Floatable TPE liner/seal/valve	1	0	0	b	b	d
Plastics liner/seal/valve with density < 1 g/cm ³	1	0	0	b	b	d
Plastics liner/seal/valve with density > 1 g/cm ³	1	0	0	b	b	d
Metal liner/seal/valve	1	0	0	b	b	d
Aluminium liner/seal/valve	1	0	0	b	b	d
Integrated silicone valves	1	0	0	b	b	d
Any other TPE liner/seal/valve	1	0	0	b	b	d
Water-releasable adhesive	1	1	0	a	b	b
Permanent adhesive	1	1	0	a	b	b
Detectable and sortable size of packaging	1	1	1	a	a	a
Separability of labels/sleeves	1	1	1	a	a	a
Separability of other components	1	1	1	a	a	a
Separation by consumer	1	1	1	a	a	a
Separation in sorting process	1	1	1	a	a	a
Separation in recycling process	1	1	1	a	a	a
% product residues in packaging	1	1	1	a	a	a
Recycling disruptive residues	1	1	1	a	a	a
hazardousness of product residues	1	1	1	a	a	a
% of recycled material in packaging	1	1	1	a	a	a
% of biodegradable material in packaging	1	1	1	a	a	a
Other components: metal accessory	1	0	0	b	b	d
Other components: glass accessory	1	0	0	b	b	d
Other components: magnets	1	0	0	b	b	d
Other components: zamac	1	0	0	b	b	d
Other components: stainless steel	1	0	0	b	b	d
Other components: PS element	1	0	0	b	b	d
Other components: absorbent pad	1	0	0	b	b	d
Other components: metal element	1	0	0	b	b	d
Other components: RFID tags	1	0	0	b	b	d

Other components: thermoset plastics	1	0	0	b	b	d
Material: monomaterial EPS - moulded with PS foil	0	1	0	c	d	b
Material: Mmnomaterial EPS	0	1	0	c	d	b
Material: recycled EPS	0	1	0	c	d	b
Additive: flame retardant, plasticizer	0	1	0	c	d	b
Washable inks	0	1	0	c	d	b
Nitrocellulose based inks	0	1	0	c	d	b
Label made of same material as packaging	0	1	0	c	d	b
PO label	0	1	0	c	d	b
PET label	0	1	0	c	d	b
Paper label	0	1	0	c	d	b
No closures/openinigs	0	1	0	c	d	b
Material: XPS	0	0	1	d	c	c
No inks/lacquers/varnishes	0	0	1	d	c	c
No closures/openings	0	0	1	d	c	c

Table 12. Input file for combination f1 (plastic packaging – flexible)

Sub-Parameters	cat1 6	cat1 7	cat2 0	cat2 1	sim16_ 17	sim16_ 20	sim16_ 21	sim17_ 20	sim17_ 21	sim20_ 21
Material: PE	1	1	0	0	a	b	b	b	b	d
Material: multilayer built of different PE types	1	1	0	0	a	b	b	b	b	d
Material: multimaterial with different % of PE	1	1	0	0	a	b	b	b	b	d
Material: multilayers PE with PLA, PVC, PS, PET, PET-G	1	1	0	0	a	b	b	b	b	d
Material: PA	1	1	0	0	a	b	b	b	b	d
Material: PA+PE-g-MAH	1	1	0	0	a	b	b	b	b	d
Material: PA6 & its copolymers	1	1	0	0	a	b	b	b	b	d
Material: multilayer PE with PA and PE-g-MAH	1	1	0	0	a	b	b	b	b	d
Material: PE-X	1	1	0	0	a	b	b	b	b	d
Material: EVA	1	1	0	0	a	b	b	b	b	d
Material: COC	1	1	0	0	a	b	b	b	b	d
Material: EVA-PE-Blends	1	1	0	0	a	b	b	b	b	d
Material: EAA copolymers	1	1	0	0	a	b	b	b	b	d
Material: EMAA copolymers	1	1	0	0	a	b	b	b	b	d
Material: PE elastomers	1	1	0	0	a	b	b	b	b	d
Material: polar ethylene copolymers	1	1	1	1	a	a	a	a	a	a
Material: non-polar ethylene copolymers	1	1	0	0	a	b	b	b	b	d
Material: recycled PE	1	1	0	0	a	b	b	b	b	d
No colours	1	0	1	0	b	a	b	c	d	b
No additives/fillers	1	1	1	1	a	a	a	a	a	a
Additive: EVA	1	1	1	1	a	a	a	a	a	a
Additive: halogenated additives	1	1	1	1	a	a	a	a	a	a
Additive: antioxidants	1	1	1	1	a	a	a	a	a	a
Additive: stabilizers	1	1	1	1	a	a	a	a	a	a
Additive: polymeric modifier	1	1	1	1	a	a	a	a	a	a
Additive: slip agents	1	1	1	1	a	a	a	a	a	a

Additive: antiblocking agents	1	1	1	1	a	a	a	a	a	a
Additive: antistatic agents	1	1	1	1	a	a	a	a	a	a
Additive: scavengers	1	1	1	1	a	a	a	a	a	a
No barriers/coatings	1	1	1	1	a	a	a	a	a	a
SiOx coating	1	1	1	1	a	a	a	a	a	a
AlOx coating	1	1	1	1	a	a	a	a	a	a
Clear coating	1	1	0	0	a	b	b	b	b	d
PA barrier	1	1	1	1	a	a	a	a	a	a
PVOH barrier	1	1	1	1	a	a	a	a	a	a
PVC/PVDC barrier	1	1	1	0	a	a	b	a	b	b
Metallised film barrier	1	1	1	1	a	a	a	a	a	a
UV coating	1	1	0	0	a	b	b	b	b	d
No coding	1	1	1	1	a	a	a	a	a	a
Coding: direct printing - minimal	1	1	1	1	a	a	a	a	a	a
Coding: direct printing - extensive	1	1	1	1	a	a	a	a	a	a
Coding: laser engraving	1	1	1	1	a	a	a	a	a	a
Coding: embossed/minted	1	1	1	1	a	a	a	a	a	a
Coding: tracer	1	1	1	1	a	a	a	a	a	a
Coding: watermark	1	1	1	1	a	a	a	a	a	a
Toxicity of inks (EuPIA guideline)	1	1	1	1	a	a	a	a	a	a
PVC based inks	1	1	1	1	a	a	a	a	a	a
Metallic inks	1	1	1	1	a	a	a	a	a	a
Nitrocellulose based inks	1	1	1	1	a	a	a	a	a	a
Washable inks	1	1	1	1	a	a	a	a	a	a
PU based inks	1	1	1	1	a	a	a	a	a	a
PVB based inks	1	1	1	1	a	a	a	a	a	a
UV acrylics inks	1	1	1	1	a	a	a	a	a	a
Binder for inks	1	1	1	1	a	a	a	a	a	a
Carbon black based inks	1	1	1	1	a	a	a	a	a	a
Deinkable inks	1	1	1	1	a	a	a	a	a	a
Delaminatable inks and coatings	1	1	1	1	a	a	a	a	a	a
Hot-stamp	1	1	1	1	a	a	a	a	a	a
No labels	1	1	1	1	a	a	a	a	a	a
PE label	1	1	1	1	a	a	a	a	a	a
PP label	1	1	1	1	a	a	a	a	a	a
OPP label	1	1	1	1	a	a	a	a	a	a
EPS label	1	1	1	1	a	a	a	a	a	a
Plastic label with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastic label with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Wet-strength paper label	1	1	1	1	a	a	a	a	a	a
Paper label that float	1	1	0	0	a	b	b	b	b	d
Metallised label	1	1	1	1	a	a	a	a	a	a
In-mould labels	1	1	1	1	a	a	a	a	a	a
Label with PBT filler	1	1	0	0	a	b	b	b	b	d
Propylene-ethylene elastomers labels	1	1	0	0	a	b	b	b	b	d

Polar ethylene copolymers labels	1	1	0	0	a	b	b	b	b	d
Non-polar ethylene copolymers labels	1	1	0	0	a	b	b	b	b	d
Label: % of surface coverage	1	1	1	1	a	a	a	a	a	a
Labels made of NIR detectable material	1	1	0	0	a	b	b	b	b	d
No sleeves	1	1	1	1	a	a	a	a	a	a
Propylene-ethylene elastomers sleeves	1	1	0	0	a	b	b	b	b	d
Polar ethylene copolymers sleeves	1	1	0	0	a	b	b	b	b	d
Non-polar ethylene copolymers sleeves	1	1	0	0	a	b	b	b	b	d
Sleeve: % of surface coverage	1	1	1	1	a	a	a	a	a	a
No tamper evident element	1	1	1	1	a	a	a	a	a	a
Plastic closure with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastic closure with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Metal closure	1	1	1	1	a	a	a	a	a	a
PA/PE compatibilizer closure	1	1	0	0	a	b	b	b	b	d
TPE closure	1	1	1	1	a	a	a	a	a	a
Silicone oil closure	1	1	1	1	a	a	a	a	a	a
Textile closure	1	1	0	0	a	b	b	b	b	d
Glued closure	1	1	1	1	a	a	a	a	a	a
Sealing layer	1	1	1	1	a	a	a	a	a	a
No liners/seals/valves	1	1	1	1	a	a	a	a	a	a
PP liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PE liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PVC liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PET-G liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PS liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PLA liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Foiled paper liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Non PO liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Foamed liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Metal liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Aluminium liner/seal/valve	1	1	1	1	a	a	a	a	a	a
Plastics liner/seal/valve with density < 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
Plastics liner/seal/valve with density > 1 g/cm ³	1	1	1	1	a	a	a	a	a	a
SEBS liner/seal/valve	1	1	1	1	a	a	a	a	a	a
EVA liner/seal/valve	1	1	1	1	a	a	a	a	a	a
TPO liner/seal/valve	1	1	1	1	a	a	a	a	a	a
TPS liner/seal/valve	1	1	1	1	a	a	a	a	a	a
PE valve	1	1	0	0	a	b	b	b	b	d
PP valve	1	1	0	0	a	b	b	b	b	d
Water-releasable adhesive	1	1	1	1	a	a	a	a	a	a
Permanent adhesive	1	1	1	1	a	a	a	a	a	a
Laminating adhesives: aliphatic polyurethanes	1	1	1	1	a	a	a	a	a	a
Laminating adhesives: aromatic polyurethanes & water-based acrylics	1	1	1	1	a	a	a	a	a	a
Laminating adhesives: specifically developed for PET/Al with PE	1	1	1	1	a	a	a	a	a	a
Laminating adhesives: any other laminating adhesives	1	1	1	1	a	a	a	a	a	a

Detectable and sortable size of packaging	1	1	1	1	a	a	a	a	a	a
Separability of labels/sleeves	1	1	1	1	a	a	a	a	a	a
Separability of other components	1	1	1	1	a	a	a	a	a	a
Separation by consumer	1	1	1	1	a	a	a	a	a	a
Separation in sorting process	1	1	1	1	a	a	a	a	a	a
Separation in recycling process	1	1	1	1	a	a	a	a	a	a
% product residues in packaging	1	1	1	1	a	a	a	a	a	a
Recycling disruptive residues	1	1	1	1	a	a	a	a	a	a
hazardousness of product residues	1	1	1	1	a	a	a	a	a	a
% of recycled material in packaging	1	1	1	1	a	a	a	a	a	a
% of biodegradable material in packaging	1	1	1	1	a	a	a	a	a	a
Other components: PE handle	1	1	1	1	a	a	a	a	a	a
Other components: PP, OPP handle	1	1	1	1	a	a	a	a	a	a
Other components: reinforcement for handle in paper	1	1	1	1	a	a	a	a	a	a
Other components: thermoset PE handle	1	1	1	1	a	a	a	a	a	a
Other components: reinforcement for handle in PS d<1	1	1	1	1	a	a	a	a	a	a
Other components: tie layer type-graded	1	1	0	0	a	b	b	b	b	d
Others: formed packaging	1	1	1	1	a	a	a	a	a	a
Others: sheet packaging	1	1	1	1	a	a	a	a	a	a
Standard bright colours	0	1	0	1	c	d	c	b	a	c
Dark / heavy colours	0	1	0	1	c	d	c	b	a	c
Metallic pigments	0	1	0	1	c	d	c	b	a	c
Fluorescent pigments	0	1	0	1	c	d	c	b	a	c
Carbon black based colours	0	1	0	1	c	d	c	b	a	c
Material: PP	0	0	1	1	d	c	c	c	c	a
Material: multimaterials composite with PE	0	0	1	1	d	c	c	c	c	a
Material: multilayer PE/PP with PE <= 5%	0	0	1	1	d	c	c	c	c	a
Material: PP copolymers	0	0	1	1	d	c	c	c	c	a
Material: propylene-ethylene elastomers	0	0	1	1	d	c	c	c	c	a
Material: EVA-PP-blends	0	0	1	1	d	c	c	c	c	a
Material: PE type graduated	0	0	1	1	d	c	c	c	c	a
Material: PVDC	0	0	1	1	d	c	c	c	c	a
Material: multilayer with paper	0	0	1	1	d	c	c	c	c	a
Material: multilayer with textile / cotton	0	0	1	1	d	c	c	c	c	a
Material: recycled PP	0	0	1	1	d	c	c	c	c	a
EVOH barrier	0	0	1	1	d	c	c	c	c	a
PA6 barrier	0	0	1	1	d	c	c	c	c	a
EVA barrier	0	0	1	1	d	c	c	c	c	a
Others: tie layer type-graded	0	0	1	1	d	c	c	c	c	a
PVC, PVDC barrier	0	0	0	1	d	d	c	d	c	c

Getting in touch with the EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

Finding information about the EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

EU open data

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society



EU Science Hub

joint-research-centre.ec.europa.eu



@EU_ScienceHub



EU Science Hub - Joint Research Centre



EU Science, Research and Innovation



EU Science Hub



@eu_science



Publications Office
of the European Union