CIRCULAR ANALYTICS

ECR AUSTRIA
EFFICIENT CONSUMER RESPONSE

MINIMISATION OF PACKAGING

A RECOMMENDATION OF
THE ECR AUSTRIA TASK FORCE
"Circular Packaging 2.0"

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1 General Introduction

The EU's Circular Economy Package aims to significantly disrupt the packaging landscape. Reduction, reuse and recycling are the foundations of the circular economy. For this reason, ECR Austria, as the only platform for partnership-based cooperation between retailers and manufacturers, together with the technical expertise of FH Campus Wien and Circular Analytics, has set up the 'ECR Circular Packaging Initiative' working group already in 2019.

Four trend-setting publications have already been developed and published:

- The ECR recommendation '**Packaging Design for Recycling**' offers guidelines that are understandable even for non-experts on how packaging can be developed as circularly as possible.

- The ECR recommendation '**Sustainability Assessment of Packaging**' shows which criteria need to be taken into account when assessing packaging in order to enable a holistic approach.

- This publication was followed by the ECR recommendation '**Assessment of the Recyclability of Packaging**'. This method allows the calculation of the technical recyclability of a packaging system.

- The latest publication was the ECR recommendation '**Packaging Master Data**'. The aim of this working group was to define the necessary packaging data information and automated mapping as part of the master data exchange between retailer and manufacturers.

The **PPWR (Packaging & Packaging Waste Regulation)** was adopted by the EU Parliament on 24 April 2024. The regulation aims to reduce the amount of packaging and promote reuse and recycling. It covers the entire life cycle of packaging and provide for measures to reduce the amount of packaging and restrict certain forms of packaging.

In order to prepare the industry for the PPWR in the best possible way, the working group 'Circular Packaging Initiative 2.0' has been continued. Retailers, manufacturers, packaging manufacturers and disposal companies are intensively discussing new solutions to achieve the requirements.

This document is a first recommendation on packaging minimisation. There is currently no evaluation system to compare the current products on the market in order to fulfil the PPWR. The proposed models are aimed at testing products for PPWR compliance first and then pursuing general sustainability goals further down the line.

ECR Austria would like to thank all participating companies and their employees, as well as Circular Analytics, for their valuable contributions to the creation of this far-reaching and forward-looking recommendation. This document is a first version, that will be regularly updated according to new results to come.

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2 Introduction - Legal Background

The European Green Deal was first introduced in December 2019 by Ursula von der Leyen, current president of the European Commission. It presents a set of policy initiatives aiming at reaching climate neutrality in the European Union by 2050.

One of the main building blocks of the Green Deal, the Circular Economy Action Plan (CEAP), was adopted in March 2020. It comprises initiatives that cover the entire life cycle of products. Measures focus on resource-intensive sectors with high potential for circularity, such as electronics, batteries and vehicles, textiles, construction and buildings, food, water, nutrients, plastics and packaging. The Packaging and Packaging Waste Regulation (PPWR) can be seen as an integral part of the CEAP.

The following section shows the evolution of packaging legislation in the European Union, including the most current legislation, the Packaging and Packaging Waste Regulation.

2.1 Overview Packaging Legislation

Packaging legislation in the European Union had its starting point in 1994 when the currently effective Packaging and Packaging Waste Directive (PPWD, Directive 94/62/EC) was published, aiming at setting rules for the management of packaging and packaging waste, harmonising national circumstances and improving the overall quality of the environment by reducing or rather preventing the impact of packaging and packaging waste. It covers all packaging materials including commercial, industrial, household and other sectors.

The Packaging and Packaging Waste Directive (1994) has been revised and amended several times. For example, measures to reduce the use of plastic carrier bags were added in 2015 (Directive (EU) 2015/720). In addition, the PPWD was amended in 2018 by Directive (EU) 2018/852. This directive had to be transposed into national law by 5 July 2020. It updated the measures to prevent the generation of packaging waste production and to promote the reuse, recycling and other forms of recovery of packaging waste in the sense of a circular economy.

In November 2022 the legislative proposal for the Packaging and Packaging Regulation (PPWR) was published, with the intent of updating the packaging legislative framework in the European Union.

Figure 1: Timeline of packaging and packaging waste legislation in the European Union - most important steps

2.2 Packaging and Packaging Waste Regulation (PPWR)

The draft of the Packaging and Packaging Waste Regulation was published by the European Commission in November 2022. After a process lasting more than a year, a revised proposal was adopted in the first reading by the European Parliament in April 2024 (status August 2024).

The PPWR's objective is to tackle the problems associated with the growing generation of packaging waste, the barriers to packaging circularity and downcycling as well as the low amounts of high-quality recyclate.

In the following, the most important provisions are explained in more detail.

2.2.1 Recyclable Packaging

Article 6 of the PPWR stipulates that all packaging placed on the European market must be recyclable. This article is supported by the requirements defined in Annex II and further will be supported by delegated as well as implementing acts.

This article mandates that as a first step, the packaging must be designed for material recycling. Meaning, that the secondary material after the recycling process has to be of sufficient quality to be able to be used as a substitute for primary material. In order to be "designed for material recycling", design for recycling criteria must be developed and met by the packaging in question. This first requirement is expected to enter into force on 1 January 2030 or two years after entry into force of the accompanying delegated act.

From 2030 onwards packaging must additionally show at least a recyclability of 70% to be deemed recyclable. The degree of recyclability will be expressed by the performance grades A, B and C, which will be based on design for recycling criteria. If a packaging shows a recyclability below 70%, it is technically non-recyclable and is restricted from being placed on the European Market.

Table 1: Recyclability Performance Grades

2030	
Recyclability Performance Grade	Design for recycling (DfR) assessment of recyclability per unit, in terms of weighting
Grade A	≥ 95%
Grade B	≥ 80%
Grade C	≥ 70%
Technically non-recyclable	≤ 70%

Furthermore, Article 6 specifies that five years later (either 2035 or 5 years after entry into force of implementing act), packaging must additionally be collected separately, sorted in specific waste streams without an impact on the recyclability of other material streams, and recycled at scale.

In 2038, the rules on recyclability performance grades will be tightened. As of then, also packaging that meets Grade C (recyclability ≥ 70%) can no longer be placed on the European market. Resulting in every packaging to achieve a minimum recyclability of 80% per 2038.

With regards to innovative packaging, if it does not comply with the requirements on design for recycling and recycled at scale requirements, it may be placed on the European market for a maximum of five years. After this period, the packaging should comply with the requirements set out in Article 6.

18 months after the entry into force of the delegated acts, financial contributions should be paid by the producers in order to comply with their extended producer responsibilities. Those will be modulated based on the recyclability performance grades.

2.2.2 Minimum Recycled Content in Plastic Packaging

As detailed in Article 7 of the PPWR, any plastic part placed on the European market must contain a minimum recycled post-consumer recycled (PCR) content by 2030 (or three years after entry into force of implementing acts). It will be calculated as an average per manufacturing plant and year. The required minimum percentages of PCR material per packaging type, starting by 2030 and 2040, are displayed in the table below.

Table 2: Minimum PCR content per Packaging Type

Packaging Type	2030	2040
Contact sensitive packaging with PET as main component	30%	50%
Contact sensitive packaging (except for PET and single-use plastic beverage bottles)	10%	25%
Single-use plastic beverage bottles	30%	65%
Other plastic packaging	35%	65%

By 31 December 2026, the European Commission should adopt implementing acts, setting out the methodology for calculating, assessing, verifying and certifying of the minimum percentage of PCR content.

2.2.3 Packaging Minimisation and Excessive Packaging

By 1 January 2030, packaging manufacturers or importers should ensure that all packaging placed on the European market is designed in a way that weight and volume are reduced to the necessary minimum, taking into account the shape and the material of the packaging. However, all performance criteria set out in Annex IV, such as product protection, packaging manufacturing processes, logistics, packaging functionality, information requirements, hygiene and safety, legal requirements as well as requirements set out in the PPWR (recycled content, recyclability and reuse) are still to be fulfilled.

Two years after entry into force of the PPWR, the European Standardisation Organisations should establish harmonised standards, containing a methodology to check the conformity of the calculation and measurement of the minimisation criteria. Furthermore, those standards should define maximum adequate weight and volume limits as well as wall thickness and maximum empty space for the most common packaging types and formats.

In addition, operators who use e-commerce, transport or grouped packaging should ensure that the maximum empty space ratio of 50% per packaging unit is not exceeded. For the calculation thereof a separate implementing act should be adopted by the European Commission three years after the entry of the PPWR.

2.2.4 Reuse Targets

Reuse targets for determined packaging types must be met by 2030 and 2040, see table below:

Table 3: Reuse Targets per Packaging Type

Packaging Type	2030	2040
Transport and sales packaging for transporting products within the territory of the EU, incl. e-commerce[1]	at least 40%	at least 70%
Transport or sales packaging for transporting goods within the EU between different operation sites	100%	
Transport or sales packaging delivering products to another economic operator within the same member state	100%	
Grouped packaging in form of boxes, excl. cardboard (not sales packaging)	at least 10%	at least 40%
Alcoholic and non-alcoholic beverages[2/3/4]	at least 10%	at least 40%

[1] In the form of pallets, foldable plastic boxes, boxes, trays, plastic crates, intermediate bulk containers, pails, drums and canisters of all sizes and materials, incl. flexible formats or pallet wrappings or straps for stabilization and protection of products on pallets during transport
[2] excempted: milk and milk products, grape wine products, aromatised wine products, similar products to wine products and aromatized wine products other than grapes and vegetables as well as alcohol-based spiritous beverages
[3] Guidelines explaining in detail the products falling under this provision will be published by the Commission two years after entry into force of the PPWR.
[4] Economic operators have the possibility of forming pools. However, they may not exceed 40% of the market share of the relevant beverage category and a maximum of 5 operators is required.

The European Commission is empowered to adopt delegated acts to supplement the provision of reuse targets in order to be able to accommodate the latest scientific and economic developments and data. Additionally, a report reviewing the implementation of the 2030 targets should be presented by 1 January 2034. Accordingly, the feasibility of achieving the 2040 targets will be checked and depending on the result, the targets will be revised.

2.2.5 Labelling of Packaging and Waste Receptacles

Article 12 of the PPWR mandates, that 42 months after the entry into force of the PPWR (or 24 months after the entry into force of the implementing act), packaging should be marked with a label, containing the material composition of the packaging based on pictograms. The label should be easily understandable. Only transport, e-commerce, and packaging being part of a deposit and return system (DRS) will be exempted from this obligation. Additionally, all packaging obliged to contain a minimum content of PCR material have to be marked with a label stating the share of PCR content or alternatively, where applicable, a QR-Code or other digital data carrier should contain this information.

DRS packaging should also be marked with a distinctive label. Besides bearing a national label, DRS packaging must additionally be marked with a harmonised colour label that will be established in the supplementing implementing act.

The obligation for labelling packaging also applies to reusable packaging, starting 48 months after the entry of the PPWR or 30 months after the entry of the implementing act. Reusable packaging must bear a label containing further information on the reusability. This information can either be transposed by a QR-code or by another digital data carrier. Hereby, open-loop systems will be excluded from this provision.

Similarly, waste receptacles should also be labelled by harmonised labels that will be affixed, printed or engraved on all waste receptacles.

2.2.6 Prevention of Packaging Waste

Under the provisions of Article 43, member states must reduce the packaging waste generated per person in comparison to the waste generated per capita in the base year 2018. The reduction targets are set at:

- at least 5% until 2030,
- at least 10% until 2035,
- at least 15% until 2040.

The set minimum targets may be exceeded by the member states. Furthermore, to reach the set targets, member states should especially aim at reducing their plastic packaging waste. If member states would prefer another base year to 2018, they can send a request to the European Commission. However, a possible change is conditioned to substantiated evidence of either a significant increase of packaging waste during the year used as a basis for calculation, that the increase occurred due to changes in the reporting procedure, the increase is not due to increased consumption or to ensure better compatibility between member states.

2.2.7 Deposit and Return Systems

Article 50 mandates that by 1 January 2029, member states must ensure a separate collection of single-use plastic beverage bottles as well as for single-use metal beverage containers both with a capacity of up to three litres of at least 90% per year and weight of the two packaging materials. In order to achieve those targets, member states should set up deposit return systems for the two packaging formats and ensure that a deposit is charged at the point of sale. In addition to the targets set for single-use plastic beverage bottles and single-use metal beverage containers, the member states are encouraged to implement additional deposit and return systems for single-use glass beverage bottles as well as for beverage cartons.

Wine and categories of wine products, alcohol-based spiritous beverages as well as milk and milk products are exempted from this provision. Another exemption applies to member states, that can exhibit a separate collection rate of above 80% of the respective packaging format and material in the calendar year 2026. Lastly, if member states apply at least 12 months before the deadline for an exemption to the European Commission they must provide an implementation plan showing specific actions and a timeline in which the 90% separate collection rate by weight of packaging can be achieved.

2.3 Key Terms and Definitions

Delegated Acts

Delegated acts are non-legislative acts adopted by the European Commission. They are based on a delegation granted in an EU legislative act. Delegated acts modify or supplement existing legislation, particularly to introduce new, non-essential rules (European Commission[1]).

Implementing Acts

Implementing acts provide detailed rules when uniform conditions across the EU are required. It has to be noted that any deletions, additions or modifications of the underlying legislative act are not permitted (European Commission).

[1] European Commission (n.a.): Adopting EU law. Online available at: https://commission.europa.eu/law/law-making-process/adopting-eu-law_en

Recycled at Scale

Packaging waste that is recycled at scale, "[...] is collected separately, sorted and recycled in installed infrastructure, using established processes proven in an operational environment which ensure at Union level, an annual quantity of recycled material [...], equal or greater than 30% for wood and 55% for all other materials [...]" (European Parliament 2024d, Article 3 (38)[2]).

[2] European Parliament (2024): P9_TA(2024)0318. Packaging and Packaging Waste. European Parliament legislative resolution of 24 April 2024 on the proposal for a regulation of the European Parliament and the Council on packaging and packaging waste, amending Regulation (EU) 2019/904, and repealing Directive 94/62/EC (COM(2022)06787 - C9-0400/2022 – 2022/0396(COD)) (Ordinary legislative procedure: first reading). Online available at https://www.europarl.europa.eu/doceo/document/TA-9-2024-0318_EN.pdf

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3 Fit for 2030: Packaging Minimisation

The Fit for 2030 Packaging Minimisation methodology is based on the requirements of the PPWR as well as the Viennese Model for Holistic Sustainability Assessment, which is discussed in ECR Publication "Sustainability Assessment of Packaging".

3.1 Alignment of PPWR and Viennese Model for Holistic Sustainability Assessment

This section presents the alignment of the PPWR requirements with the Viennese Model for Holistic Sustainability Assessment. Accordingly, the combined parameters derived have to be taken into account for the Fit for 2030 Packaging Minimisation Model (hereafter referred to as the ***Fit for 2030 Model***). The relevant parameters are outlined below.

In order to facilitate the handling of the parameters, they are clustered based on the Viennese Model clustering system (see ECR Publication "Sustainability Assessment").

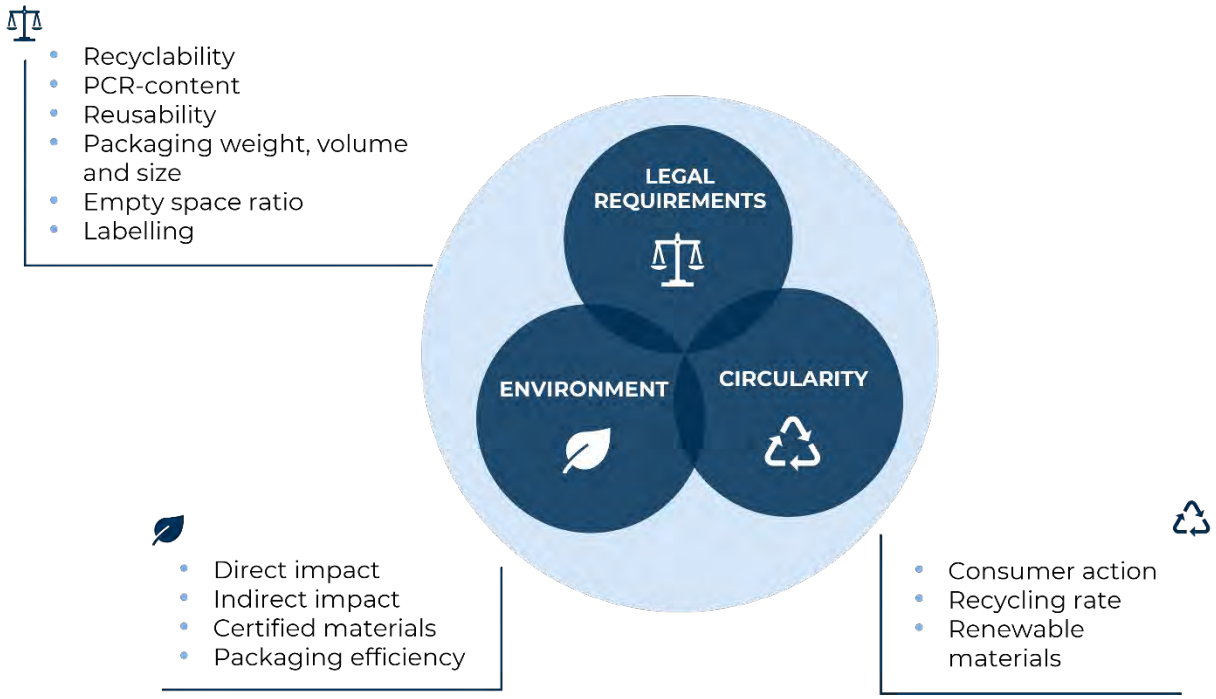

Figure 2: Fit for 2030 Packaging Minimisation Model

3.2 Overview of Parameters

The following section further describes the parameters of the categories “Legal requirements”, “Circularity” and “Environment”.

3.2.1 Legal Requirements

In the category “legal requirements”, the parameters are derived from the provisions of the Packaging and Packaging Waste Regulation. Some of those are also further explained in the ECR publication “Sustainability Assessment of Packaging” and in the ECR publication “Recyclability Assessment of Packaging”.

Table 4: Legal Requirements - Parameters

Parameter	Assessment Methodology
Recyclability	Until delegated acts to the PPWR determine a uniform approach to the recyclability calculation, the following equation applies: $\frac{weight\ of\ the\ components\ (evaluated\ with\ A\&B)}{total\ weight\ of\ the\ packaging\ system} \times 100$ *A … the material can be recycled in the supplied material flow and the recyclate can be used for high – quality applications that are suitable for the material. It can generally be assumed that the recycled material obtained is suitable for circular applications.* *B … the material can be recycled in the supplied material stream, but the quality of the recyclate is impaired. In addition, the recyclate quality of other materials in the disposal unit is negatively affected. The recyclate obtained is mainly used for downcycling applications.* (further explained in ECR publication “Recyclability Assessment of Packaigng”)
PCR-content	The parameter „PCR-content“ is only applicable for plastic packaging. However, exceptions also apply. The amount of PCR-content is assessed in weight in relation to the total weight of the packaging system. The amount of PCR-content can also be indicated in the packaging specification. If the packaging is subject to the requirements of the PPWR, the set targets apply.
Reusability	The parameter „reusability“ is only applicable for alcoholic and non-alcoholic drinks, transport, grouped and sales packaging. Furthermore, exceptions apply. First of all, it has to be assessed if the packaging falls under the categories having to meet the targets. Furthermore, packaging specifications must be checked and the PPWR targets be fulfilled.

Packaging weight	Packaging is weighted using a scale or derived from the packaging specification.
Packaging volume	The packaging volume is calculated or derived from the packaging specification. The packaging volume used here corresponds to the void volume of a package, as the methodology for calculating the packaging volume is still contingent on further standards in the context of the PPWR.
Packaging size	Packaging length, width and depth are measured or derived from the packaging specification.
Empty space ratio	The parameter “empty space ratio” is currently only applicable for transport, grouped and e-commerce packaging. It must be checked if packaging falls under the categories having to meet targets. It must be analysed if the empty space ratio equals more than 50%. Further assessments must be derived from future standards in accordance with the PPWR.
Labelling	Mandatory labelling requirements of the PPWR must be met, e.g. material composition, recyclate content, etc. and therefore, a check must be performed.

3.2.2 Circularity

In the category "circularity", the parameters are derived from the Viennese Holistic Sustainability Assessment Model, further explained in the ECR publication "Sustainability Assessment of Packaging".

Table 5: Circularity - Parameters

Parameter	Assessment Methodology
Consumer action	Depending on the design of the packaging, consumer action is essential for successful recycling. The separability of packaging is particularly relevant when it is made up of several materials that have to be disposed of in different ways. Consumer action is assessed on expert opinion.
Recycling rate	The assessment is based on the ratio of the quantity of packaging actually recycled (equals the output of the recycling plant) to the quantity of packaging placed on the market. It must be determined individually for each recyclable packaging component and an overall value is calculated on the basis of the different component weights. $$\begin{aligned} &total\ recycling\ rate \\ &= (recycling\ rate\ packaging\ component\ 1) \\ &\times (share\ of\ packaging\ component\ 1\ in\ the\ total\ weight\ of\ the\ packaging) \\ &+ (recycling\ rate\ packaging\ component\ 2) \\ &\times (share\ of\ packaging\ component\ 2\ in\ the\ total\ weight\ of\ the\ packaging) \end{aligned}$$
Renewable materials	The parameter "renewable materials" is assessed as the quantity of renewable materials in relation to the total weight of the packaging. The amount of renewable materials can also be indicated in the packaging specification. $$\frac{weight\ of\ the\ \text{quantity of}\ renewable\ materials}{total\ weight\ of\ the\ packaging} \times 100$$

3.2.3 Environment

In the category "environment", the parameters are derived from the Viennese Holistic Sustainability Assessment Model, further explained in the ECR publication "Sustainability Assessment of Packaging".

Table 6: Environment - Parameters

Parameter	Assessment Methodology
Direct impacts	Direct impacts are assessed by applying Life Cycle Assessment.
Indirect impacts	The use of non-optimised packaging design can result in the loss of products. The quantification of these losses is frequently a significant challenge, but can be determined empirically with the assistance of an emptiability analysis.
Certified materials	The amount of certified material content is the quantity of certified materials in relation to the total weight of the packaging: $$\frac{weight\ of\ the\ quantity\ of\ certified\ materials}{total\ weight\ of\ the\ packaging} \times 100$$
Packaging efficiency	The packaging efficiency is assessed by applying the following equation: $$\frac{packaging\ weight}{product\ weight + packaging\ weight} \times 100$$

3.3 Fit for 2030 Packaging Evaluation Process

The Fit for 2030 packaging evaluation process starts with choosing the right evaluation model – Basic (contains only the direct PPWR requirements) and Plus (contains additional sustainability KPIs according to the Viennese Holistic Sustainability Assessment Model). Both methods – the basic and the plus models – can be combined with benchmarking (strongly recommended when available, because it enables direct comparison with alternative packaging formats on the market).

3.3.1 Knock-out Criteria – First Step of the Assessment

In order to ensure the practical applicability of the Fit for 2030 Model, two knock-out criteria are defined. The first knock-out criterion is based on the assumption that all packaging that has already been placed on the market meets the requisite product protection requirements. Therefore, the protection against mechanical and non-mechanical influence as well as potential migration is seen as a prerequisite for an assessment according to the Fit for 2030 Model. If a packaging does not provide for the required product protection it is not fit for purpose.

The second knock-out criterion is derived from the Packaging and Packaging Waste Regulation which mandates that packaging must demonstrate a minimum recyclability of 70%, in order to be allowed to be placed on the European market. Consequently, when the minimum recyclability of 70% is not reached the packaging is not ready for the market.

Figure 3 shows the application of the knock-out criteria.

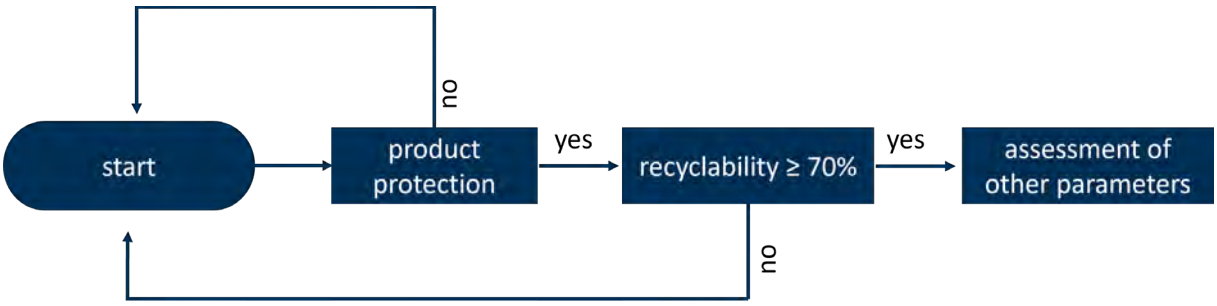

Figure 3: Knock-out criteria

3.3.2 Decision Tree

The decision tree as shown in Figure 4 is intended to assist in the selection of the best model for the intended application.

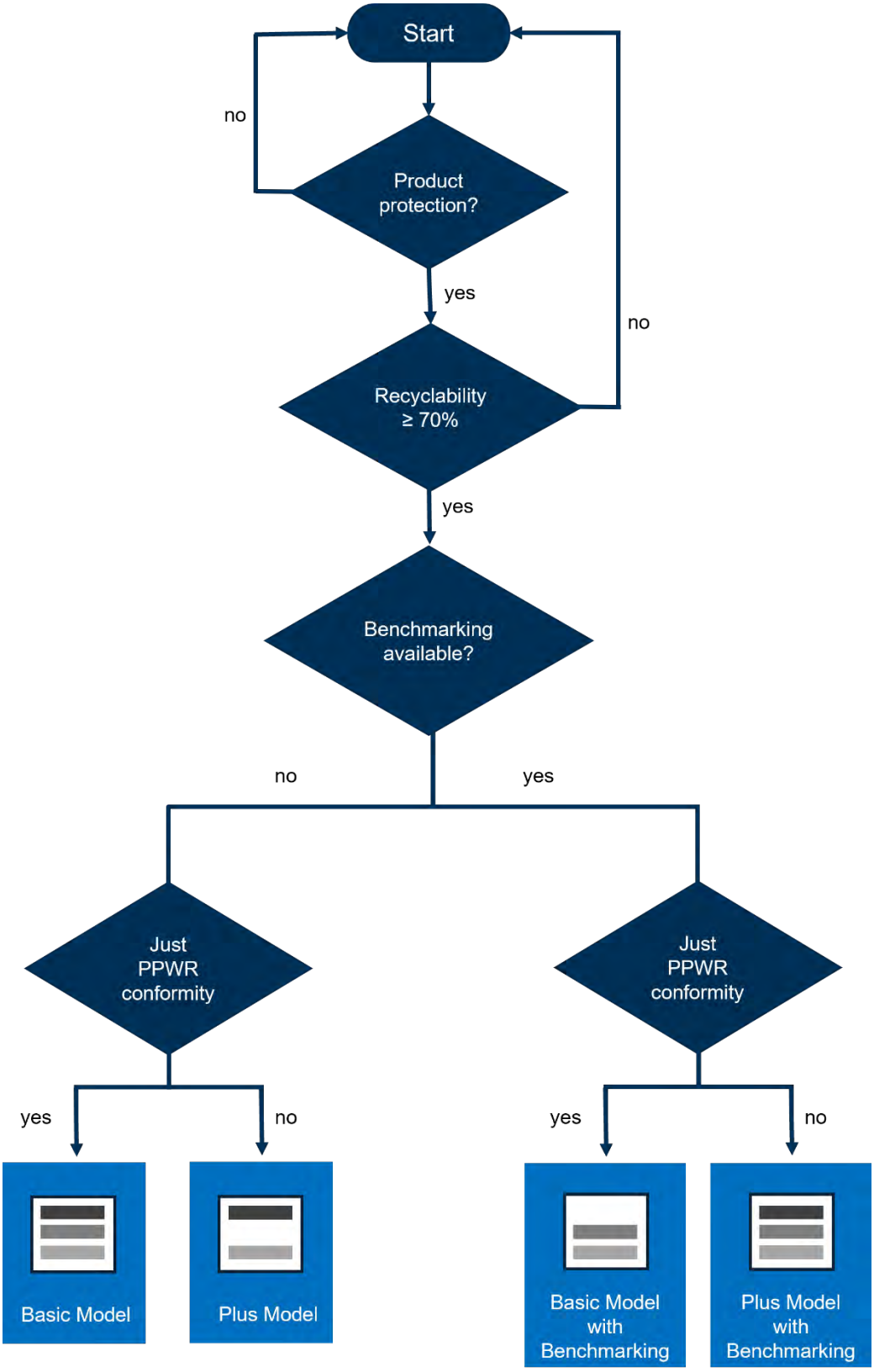

Figure 4: Decision Tree - Model Application

3.3.3 Basic Model

The Basic Model assesses the minimum criteria that packaging has to meet by 2030 in order to comply with the requirements of the Packaging and Packaging Waste Regulation. The model may be regarded as an initial conformity assessment tool for the requirements of the PPWR.

The following parameters are assessed when applying the Basic Model:

Figure 5: Basic Model: Parameters

The Basic Model without benchmarking is particularly useful for preliminary evaluations, rapid assessments and for products where no benchmarking studies are available. The assessment must be performed on a parameter-by-parameter basis. Therefore, the parameters should be presented in tabular form in order to facilitate the comparison of parameter per parameter. Additionally, either the individual cells of the table or the text written in the cells, are colour-coded to facilitate the differentiation between the parameters associated with superior performance and those associated with suboptimal performance. The colour-coding system is used to indicate whether the packaging analysed is recommended, conditionally recommended, or not recommended in view of the respective parameter and in comparison to the other packaging systems that are analysed.

The following colour-coding system should be applied:

Table 7: colour-coding system

Category	Colour Code - Version 1	Colour-Code – Version 2
Recommended		„Recommended“
Conditionally recommended		„Conditionally recommended“
Not recommended		„Not recommended“

3.3.4 Plus Model

The *Plus Model* includes the minimum PPWR requirements and additional sustainability KPIs from the Viennese model of holistic sustainability assessment and constitutes an advanced sustainability assessment methodology.

The following parameters are included in the Plus Model:

Figure 6: Plus Model: Parameters

The assessment is performed on a parameter-by-parameter basis as in the Basis model. The parameters should be presented in tabular form and colour-coded according to Table 7: colour-coding system.

3.3.5 Basic Model with Benchmarking

The Fit for 2030 Basic Model with Benchmarking assesses the compliance of packaging with the Packaging and Packaging Waste Regulation and uses additional benchmarking of competing products. This means that the parameters to be assessed are compared with other packaging formats on the market for the same product category. In this way, a market status quo can be depicted, and the packaging can be classified according to the benchmark.

The parameters to be assessed in the Fit for 2030 Basic Model with Benchmarking are the same as for the Basic Model. However, by weighting each individual parameter the Basic Model with Benchmarking gives a single score as a result.

In order to evaluate the parameters of the Basic Model with Benchmarking, the benchmarking quartiles are being employed. The assessment is conducted in the following manner: If the packaging in question is situated within the first quartile (comprising the 25% of packaging with the highest performance), one point is awarded. For the second quartile (25-50%), two points, for the third quartile (50-75%), three points and for the fourth quartile (75-100%), four points are assigned. The packaging with the highest performance will be found in the first quartile, while the packaging with the lowest performance will be found in the fourth quartile.

In contrast, the system is reversed for the parameters “recyclability” and “PCR content”, as a higher result is indicative of superior performance in these two parameters. This indicates that packaging with a result in the first quartile is among the 25% of packaging with the poorest results, whereas packaging with results in the fourth quartile is among the best 25%. In consequence, points are awarded for these two parameters in the following manner: for the first quartile four points, for the second quartile three points, for the third quartile two points and for the fourth quartile one point is awarded[3].

Therefore, the fewer points that are acquired, the better the performance of the packaging in terms of compliance with the PPWR, sustainability and minimisation requirements. The assessment model is further displayed in the following:

[4] The selected assessment methodology was chosen for didactic reasons, though a different standardisation of the parameters is also a possibility.

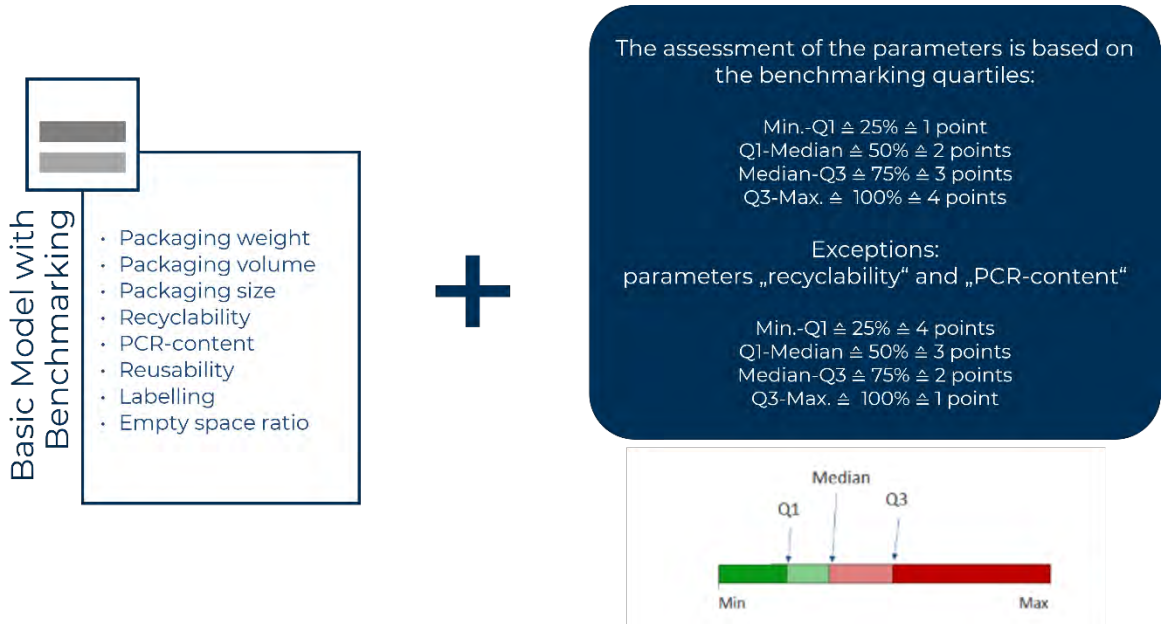

Figure 7: Basic Model with Benchmarking: Parameters and Assessment

Subsequently, a weighting of individual parameters is applied in accordance to theirsignificance in contributing to the conformity with the PPWR and packaging minimization. In the following, the weighting system for the Basic Model with Benchmarking is presented:

Table 8: Weighting of Parameters: Basic Model with Benchmarking

Weighting of 3 Parameters	
Parameter	Weighting
Recyclability	37%
Packaging Weight	37%
Packaging Volume	26%

The parameters of recyclability, packaging weight and packaging volume were selected in order to best display the interaction of different parameters for packaging minimisation. Nevertheless, with regard to packaging volume, the precise methodology for calculation remains contingent upon the establishment of harmonised standards. Consequently, the proportion allocated to this parameter is established at a lower level than that assigned to the other two parameters. Furthermore, the weighting may be modified if this aligns with the company's strategic objectives.

Subsequently, the assessment based on the benchmarking quartiles is combined with the weighting of parameters in order to calculate a single score. For each parameter, the performance score based on quartile placement is multiplied by its respective weighting factor, resulting in a weighted score for each parameter. The weighted scores of each parameter are aggregated to derive a single score. The resulting single score provides a comprehensive measure of the packaging's overall performance, balancing how well it performed in relation to the established benchmarks and the relative weighting of the different performance parameters, with lower scores indicating better overall performance.

Equation 1: Equation for Calculating the Single Score

$$Single\ Score\ = \sum_{i=1}^{n} P_i * W_i$$

$$P_i: point(s)\ for\ quartile\ placement\ of\ the\ parameter$$

$$W_i: weighting\ factor\ of\ parameter\ i$$

In a next step, the assessed packaging samples are ranked according to their performance and single-scores. Accordingly, the packaging sample with the lowest single-score is ranked first, and so forth.

3.3.6 Plus Model with Benchmarking

The assessment with the Plus Model with Benchmarking is analogue to the assessment with the Basic Model with Benchmarking. However, the parameters assessed are not only contingent upon the requirements of the PPWR. Consequently, in applying the Plus Model with Benchmarking the overall sustainability of packaging is assessed in comparison to other products on the market. In this way, a market status quo can be depicted, and the packaging can be classified according to the benchmark.

In the following the Plus Model with Benchmarking is displayed:

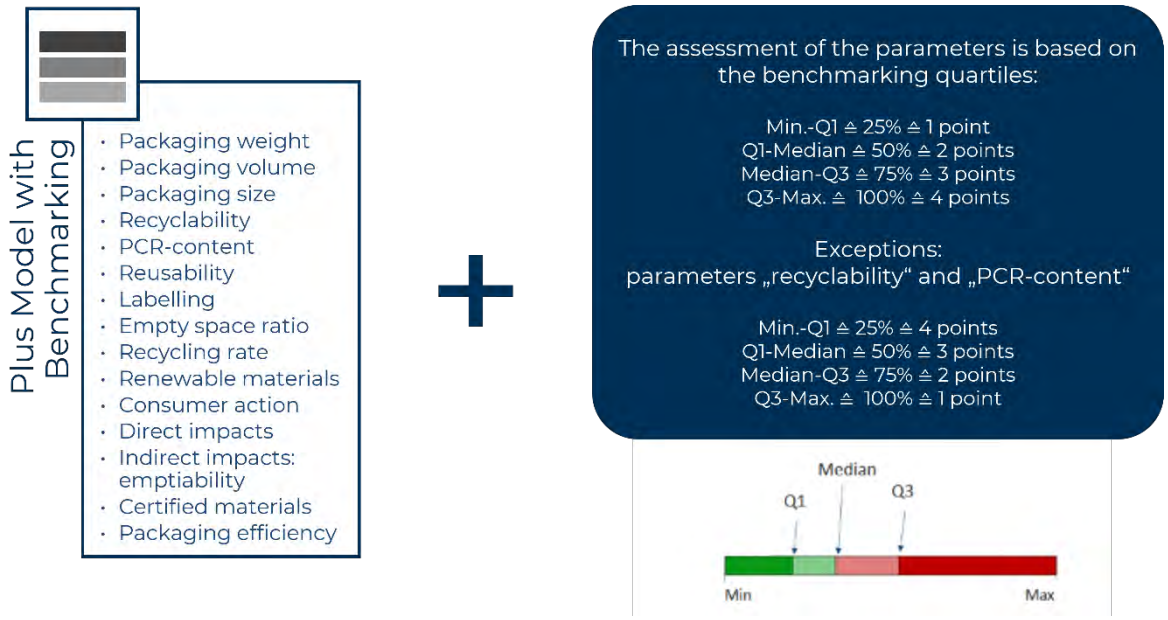

Figure 8: Plus Model with Benchmarking: Parameters and Assessment

Subsequently, a weighting of individual parameters is applied in accordance with the parameter's significance in contributing to sustainability KPIs. Due to the diversity of parameters in the Plus Model, a weighting system with five parameters is established.

If the objective of the assessment utilising the Plus Model with Benchmarking is to demonstrate compliance with PPWR and sustainability KPIs, the parameter selection and weighting outlined in Table 9 is recommended.

Table 9: Weighting of Parameters: Plus Model with Benchmarking – Application A: PPWR and Sustainability KPIs

Weighting of 5 Parameters (Application A)	
Parameter	Weighting
Recyclability	30%
Packaging Weight	30%
Packaging Volume	20%
Climate Change	10%
Packaging Efficiency	10%

As Application A (see Table 9) is concerned with PPWR conformity, it is reasonable to accord greater weight to the factors of recyclability, packaging weight and packaging volume, as previously stated. Moreover, the assessment is expanded to include the parameters of climate change and packaging efficiency, as these are significant sustainability KPIs. Nevertheless, the weighting or choice of parameters may be modified in accordance with the company's strategic objectives.

Conversely, if the intention is to solely showcase adherence to sustainability KPIs, the methodology outlined in **Fehler! Ungültiger Eigenverweis auf Textmarke.** is advised.

Table 10: Weighting of Parameters: Plus Model with Benchmarking – Application B: Sustainability KPIs

Weighting of 5 Parameters (Application B)	
Parameter	Weighting
Recyclability	30%
Climate Change	30%
Packaging Efficiency	20%
Emptiability	10%
Packaging Weight	10%

As Application B (see Table 10) is primarily concerned with Sustainability KPIs, the greatest weight is accorded to recyclability and climate change. Furthermore, packaging efficiency, along with emptiability and packaging weight, represent crucial elements in the evaluation of packaging sustainability. Consequently, they have been included in the assessment. However, the weighting or the selection of parameters may be subject to modification in accordance with the company's strategic objectives.

In a next step, the single-score is calculated according to Equation 1. Subsequently, the packaging samples are ranked according to the lowest single-score.

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4 Case Studies

4.1 Products and Benchmarking Data

The Fit for 2030 Model is applied to two product categories – milk-based coffee drinks and cosmetic serums. The benchmarking data used for the assessment has been derived from the Benchmarking Studies on Milk and Dairy Packaging and Cosmetic Packaging, which were conducted in 2023 by Circular Analytics and University of Applied Sciences FH Campus Vienna.

4.1.1 Milk and Dairy – Milk-based Coffee Drinks

For the case study on milk and dairy products, the product category of milk-based coffee drinks was chosen. For the case study, the following four packaging types, usually used for milk-based coffee drinks applications, are assessed:

Table 11: Case Study: Milk-based Coffee Drinks - Packaging Samples

Sample No.	Product	Pack-aging System	Main Body Material	Closure Material	Deco-ration Material	Filling quan-tity
01		Cup	PP	Alu-minium (lid)	Paper-board (Sleeve)	250ml
02		To-Go Cup	PP	Alu-minium (lid) PET (slip lid)	PS (Sleeve)[4]	250ml
03		Bottle	PET	HDPE (cap) Alu-minium (lid)	APET (Sleeve)	250ml
04		Can	Aluminium	-	-	250ml

[4] Assumption PS-Sleeve: not NIR permeable

The categorisation of the individual parameter results in the overall benchmarking process is based on the benchmarking data from the Benchmarking Study on Milk and Dairy Products in 2023.

Boxplots were used to visualize the results. In accordance with the boxplots, a division into minimum, lower quartile, median, upper quartile and maximum was made. Based on this system, packaging can be categorized accordingly in the respective quantile. The following table shows the boxplot distribution according to the Benchmarking Study for milk-based coffee drinks.

Table 12: Benchmarking Data – Milk-based Coffee Drinks

Parameter	Minimum (Q_0)	Lower Quartile (Q_1)	Median (Q_2)	Upper Quartile (Q_3)	Maximum (Q_4)
Recyclability [%]	14,85	40,51	94,32	99,00	99,52
Carbon Footprint [kg CO_2]	0,03	0,05	0,06	0,08	0,36
Packaging Efficiency	3,36	4,08	4,52	5,00	7,28
Emptiability [%]	0,52	0,71	0,79	1,19	1,54
Packaging Weight [g]	10,26	11,65	12,25	12,57	20,33
Packaging Volume [cm^3]	295,60	336,30	434,90	503,64	512,47

4.1.2 Cosmetics - Serums

For the case study of cosmetic products, the product category of serums was chosen. In cosmetics, a serum is defined as an oil or water-based liquid that is readily absorbed into the skin. Despite their moisturising properties, serums are of a considerably lighter consistency than, for example, lotions. A serum is typically used on the face, although there are also specialized serums for hair and body.

For the case study, the following four packaging types, usually used for serum applications, are assessed:

Table 13: Case Study: Serums - Packaging Samples

Sample No.	Product	Pack-aging System	Main Body Material	Closure Material	Decoration Material	Filling quantity
C01		pipette flask with dropper	Glass	Glass, PP	PP	30ml
C02		pump dispenser	Glass	PP, EVA, glass	Paper	30ml
C03		airless pump dispenser	PP	PP, glass, tinplate, LDPE	PP	30ml
C04		tube with airless pump dispenser	HDPE	PP, tinplate, HDPE	-	30ml

The categorisation of the individual parameter results in the overall benchmarking process is based on the benchmarking data from the Benchmarking Study on Cosmetic Products in 2023.

Boxplots were used to visualize the results. In accordance with the boxplots, a division into minimum, lower quartile, median, upper quartile and maximum was made. Based on this system, packaging can be categorized accordingly in the respective quantile. The following table shows the boxplot distribution according to the Benchmarking Study for serums.

Table 14: Benchmarking Data - Serums

Parameter	Minimum (Q_0)	Lower Quartile (Q_1)	Median (Q_2)	Upper Quartile (Q_3)	Maximum (Q_4)
Recyclability [%]	0,00	21,19	24,21	91,10	94,95
Carbon Footprint [kg CO_2]	0,029	0,048	0,063	0,137	0,319
Packaging Efficiency	38,24	48,36	63,27	73,31	80,60
Emptiability [%]	0,20	5,49	10,75	11,72	21,28
Packaging Weight [g]	10,90	29,40	51,94	67,85	100,5
Packaging Volume [cm^3]	239,35	325,00	346,11	409,66	603,35

4.2 Basic Model

The Basic Model is applied to the four different packaging samples defined for milk-based coffee drinks and serums. It has to be noted that the recyclability assessment is performed by the Packaging Cockpit for Austria, as a uniform assessment methodology method is still subject to delegated acts to the PPWR. Furthermore, the knock-out criteria of product protection and recyclability of less than 70% are applied as well as parameter results colour-coded.

Milk and Dairy Products: Milk-based Coffee Drinks

Table 15: Milk-based Coffee Drinks - Basic Model

Samples	**Sample 01** (Cup) 	**Sample 02** (To-go cup) 	**Sample 03** (Bottle) 	**Sample 04** (aluminium can) 
Parameters				
Filling volume [ml]	250	250	250	250
Packaging size [mm]	ø75x114	ø75x113	ø55x159	ø53x134
Packaging weight [g]	11,65	-*	19,00	10,26
Packaging volume [cm^3]	434,9	-*	336,3	259,6
Recyclability [%]	97,54	40,51	99,41	97,00
PCR-content [%]	0	-*	0	0
Reusability	Milk-based coffee drinks are exempted from the reusability requirements for non-alcoholic drinks			
Labelling	Labels not yet established, contingent on implementing act			
Empty space ratio	Empty space ratio for milk-based coffee drinks is not yet established, contingent on future standards			

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

Cosmetic Products: Serums

Table 16: Serums - Basic Model

Samples	**Sample 01** (pipette flask with dropper) 	**Sample 02** (pump dispenser) 	**Sample 03** (airless pump dispenser) 	**Sample 04** (tube with airless pump dispenser) 
Parameters				
Filling volume [ml]	30 ml	30 ml	30 ml	30 ml
Packaging size [mm]	⌀ 35 x 80	⌀ 33 x 100	⌀ 39 x 102	⌀ 35 x 80
Packaging weight [g]	67,8	51,7	24,7	10,9
Packaging volume [cm^3]	307,88	342,12	-*	-*
Recyclability [%]	94,05	89,08	22,69	38,26
PCR-content [%]	0	0	-*	-*
Reusability	Reusability requirements do not apply for cosmetic packaging			
Labelling	Labels not yet established, contingent on implementing act			
Empty space ratio	Empty space ratio for cosmetic packaging is not yet established, contingent on future standards			

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

4.3 Plus Model

In the following, the Plus Model is applied to the four distinct packaging samples for milk-based coffee drinks and serums.

It should be noted that the Plus Model incorporates the parameters of the Basic Model. The parameter results are colour-coded.

Milk and Dairy Products: Milk-based Coffee Drinks

Table 17: Milk-based Coffee Drinks - Plus Model

Samples	Sample 01 (Cup)	Sample 02 (To-go cup)	Sample 03 (Bottle)	Sample 04 (aluminium can)
Parameters				
Filling volume [ml]	250	250	250	250
Packaging size [mm]	ø75x114	ø75x113	ø55x159	ø53x134
Packaging weight [g]	11,65	-*	19,00	10,26
Packaging volume [cm^3]	434,9	-*	336,3	259,6
Recyclability [%]	97,54	40,51	99,41	97,00
PCR-content [%]	0	-*	0	0
Reusability	Milk-based coffee drinks are exempted from the reusability requirements for non-alcoholic drinks			
Labelling	Labels not yet established, contingent on implementing act			
Empty space ratio	Empty space ratio for milk-based coffee drinks is not yet established, contingent on future standards			
Recycling rate [%]	51,75	-*	53,22	79,00
Renewable materials [%]	45,00	-*	0,00	0,00
Consumer action [1-3]	2	-*	3	3
Climate Change [kg CO2eq]	0,0340	-*	0,0797	0,0510
Emptiability [%]	1,19	-*	0,79	0,66
Certified materials [yes/no]	no	-*	no	no
Packaging efficiency [%]	4,25	-*	7,35	3,91

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

Cosmetic Products: Serums

Table 18: Serums - Plus Model

Samples	**Sample 01** (pipette flask with dropper) 	**Sample 02** (pump dispenser) 	**Sample 03** (airless pump dispenser) 	**Sample 04** (tube with airless pump dispenser) 
Parameters				
Filling volume [ml]	.30 ml	30 ml	30 ml	30 ml
Packaging size [mm]	⌀ 35 x 80	⌀ 33 x 100	⌀ 39 x 102	⌀ 35 x 80
Packaging weight [g]	67,8	51,7	24,7	10,9
Packaging volume [cm^3]	307,88	342,12	-*	-*
Recyclability [%]	94,05	89,08	22,69	38,26
PCR-content [%]	0	0	-*	-*
Reusability	Reusability requirements do not apply for cosmetic packaging			
Labelling	Labels not yet established, contingent on implementing act			
Empty space ratio	Empty space ratio for cosmetic packaging is not yet established, contingent on future standards			
Recycling rate [%]	72,00	53,00	-*	-*
Renewable materials [%]	9	17	-*	-*
Consumer action [1-3]	3	3	-*	-*
Climate Change [kg CO2eq]	0,044	0,0630	-*	-*
Emptiability [%]	2,88	11,46	-*	-*
Certified materials [yes/no]	yes	no	-*	-*
Packaging efficiency [%]	71,39	67,17	-*	-*

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

4.4 Basic Model with Benchmarking

In the following, the Basic Model with Benchmarking is applied to the four distinct packaging samples defined for milk-based coffee drinks and serums. In order to apply the Basic Model with Benchmarking the weighting of three parameters was selected. In this case study, the parameters to be assessed are packaging weight, packaging volume, and recyclability. These parameters are selected due to the minimisation requirements of the PPWR and the absence of PCR-content in the packaging samples. Additionally, reusability is not applicable to milk and milk-based beverage packaging as well as cosmetic packaging and the requirements for labelling and empty space ratio are still contingent on future implementing acts and standards under the PPWR.

The weighting of parameters is as follows:

- Recyclability: 37%
- Packaging Weight: 37%
- Packaging Volume: 26%

The weighting and scoring are applied according to the quartile placement of the individual parameters per packaging sample. Subsequently, the single score is calculated, and the packaging samples are ranked accordingly.

Milk and Dairy Products: Milk-based Coffee Drinks

Table 19: Milk-based Coffee Drinks - Basic Model with Benchmarking

Samples	**Sample 01** (Cup) 	**Sample 02** (To-go cup) 	**Sample 03** (Bottle) 	**Sample 04** (aluminium can) 
Parameters				
Recyclability [37%]	2	-*	1	1
Packaging weight [37%]	1	-*	4	1
Packaging volume [26%]	2	-*	1	1
Single Score	1,63	-*	2,11	1,00
Ranking**	2	-*	3	1

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment of milk-based coffee drinks shows that, in the context of PPWR minimisation requirements, the aluminium shows the best results, followed by the cup and the PET bottle.

Cosmetic Products: Serums

Table 20: Serums - Basic Model with Benchmarking

Samples	**Sample 01** (pipette flask with dropper) 	**Sample 02** (pump dispenser) 	**Sample 03** (airless pump dispenser) 	**Sample 04** (tube with airless pump dispenser) 
Parameters				
Recyclability [37%]	1	2	-*	-*
Packaging weight [37%]	1	3	-*	-*
Packaging volume [26%]	1	2	-*	-*
Single Score	1,0	2,37	-*	-*
Ranking**	1	2	-*	-*

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.
**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment shows that in the context of PPWR requirements and this assessment for serums, the pipette flask with a dropper shows the best results, followed by the pump dispenser. The airless pump dispenser and the tube with airless pump dispenser were not subjected to further assessment due to not meeting the requirement of a minimum recyclability of 70%.

4.5 Plus Model with Benchmarking

In the following, the Plus Model with Benchmarking is applied to the four distinct packaging samples defined for milk-based coffee drinks and serums. As the Plus Model, the Plus Model with Benchmarking incorporates more parameters than those directly derived from the requirements of the PPWR.

For the application of the Plus Model with Benchmarking, the weighting for five parameters is applied. Moreover, the application of the Plus Model with Benchmarking is performed twice. In Application A of the model, the parameters are chosen with the minimisation requirements of the PPWR in mind. In Application B of the model, the parameters are selected in a manner that indicates the most sustainable packaging sample overall.

4.5.1 Application A: Packaging Minimisation

For application A of the model, the weighting of parameters is as follows:

- Recyclability: 30%
- Packaging Weight: 30%
- Packaging Volume: 20%
- Climate Change: 10%
- Packaging Efficiency: 10%

The weighting and scoring are applied according to the quartile placement of the individual parameters per packaging sample. Subsequently, the single score is calculated, and the packaging samples are ranked accordingly.

Milk and Dairy Products: Milk-based Coffee Drinks

Table 21: Milk-based Coffee Drinks - Plus Model with Benchmarking (Application A)

Samples	**Sample 01** (Cup)	**Sample 02** (To-go cup)	**Sample 03** (Bottle)	**Sample 04** (aluminium can)
Parameters				
Recyclability [30%]	2	-*	1	1
Packaging weight [30%]	1	-*	4	1
Packaging volume [20%]	2	-*	1	1
Climate change [10%]	1	-*	3	1
Packaging efficiency [10%]	1	-*	3	1
Single Score	1,5	-*	2,3	1,0
Ranking**	2	-*	3	1

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.

**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment for milk-based coffee drinks shows that with a focus on the PPWR minimisation requirements, the aluminium also shows the best results, followed by the cup and the PET bottle, when applying the Plus Model with Benchmarking.

Cosmetic Products: Serums

Table 22: Serums - Plus Model with Benchmarking (Application A)

Samples	**Sample 01** (pipette flask with dropper) 	**Sample 02** (pump dispenser) 	**Sample 03** (airless pump dispenser) 	**Sample 04** (tube with airless pump dispenser) 
Parameters				
Recyclability [30%]	1	2	-*	-*
Packaging weight [30%]	1	3	-*	-*
Packaging volume [20%]	1	2	-*	-*
Climate change [10%]	1	2	-*	-*
Packaging efficiency [10%]	3	3	-*	-*
Single Score	1,2	2,4	-*	-*
Ranking**	1	2	-*	-*

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.
**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment for serums shows that with a focus on the PPWR minimisation requirements, the pipette flask with a dropper shows again the best results, followed by the pump dispenser.

4.5.2 Application B: Overall Packaging Sustainability

For application B of the model, the weighting of parameters is as follows:

- Recyclability: 30%
- Climate Change: 30%
- Packaging Efficiency: 20%
- Emptiability: 10%
- Packaging Weight: 10%

The weighting and scoring are applied according to the quartile placement of the individual parameters per packaging sample. Subsequently, the single score is calculated, and the packaging samples are ranked accordingly.

Milk and Dairy Products: Milk-based Coffee Drinks

Table 23: Milk-based Coffee Drinks - Plus Model with Benchmarking (Application B)

Samples	**Sample 01** (Cup)	**Sample 02** (To-go cup)	**Sample 03** (Bottle)	**Sample 04** (aluminium can)
Parameters				
Recyclability [30%]	2	-*	1	1
Climate change [30%]	1	-*	3	1
Packaging efficiency [20%]	1	-*	3	1
Emptiability [10%]	3	-*	2	1
Packaging weight [10%]	1	-*	4	1
Single Score	1,5	-*	2,4	1,0
Ranking**	2	-*	3	1

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.
**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment for milk-based coffee drinks shows that with a focus on overall sustainability, the results remain the same.

Cosmetic Products: Serums

Table 24: Serums - Plus Model with Benchmarking (Application B)

Samples	**Sample 01** (pipette flask with dropper) 	**Sample 02** (pump dispenser) 	**Sample 03** (airless pump dispenser) 	**Sample 04** (tube with airless pump dispenser) 
Parameters				
Recyclability [30%]	1	2	-*	-*
Climate change [30%]	1	2	-*	-*
Packaging efficiency [20%]	3	3	-*	-*
Emptiability [10%]	1	3	-*	-*
Packaging weight [10%]	1	3	-*	-*
Single Score	1,4	2,4	-*	-*
Ranking**	1	2	-*	-*

*The packaging is not subjected to further assessment due to the application of the knockout - criterion of recyclability less than 70%.
**This is an illustrative example and does not represent an actual ranking of packaging materials.

This assessment for serums shows that with a focus on overall sustainability of the packaging samples, the ranking of samples is identical to the other assessments.

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