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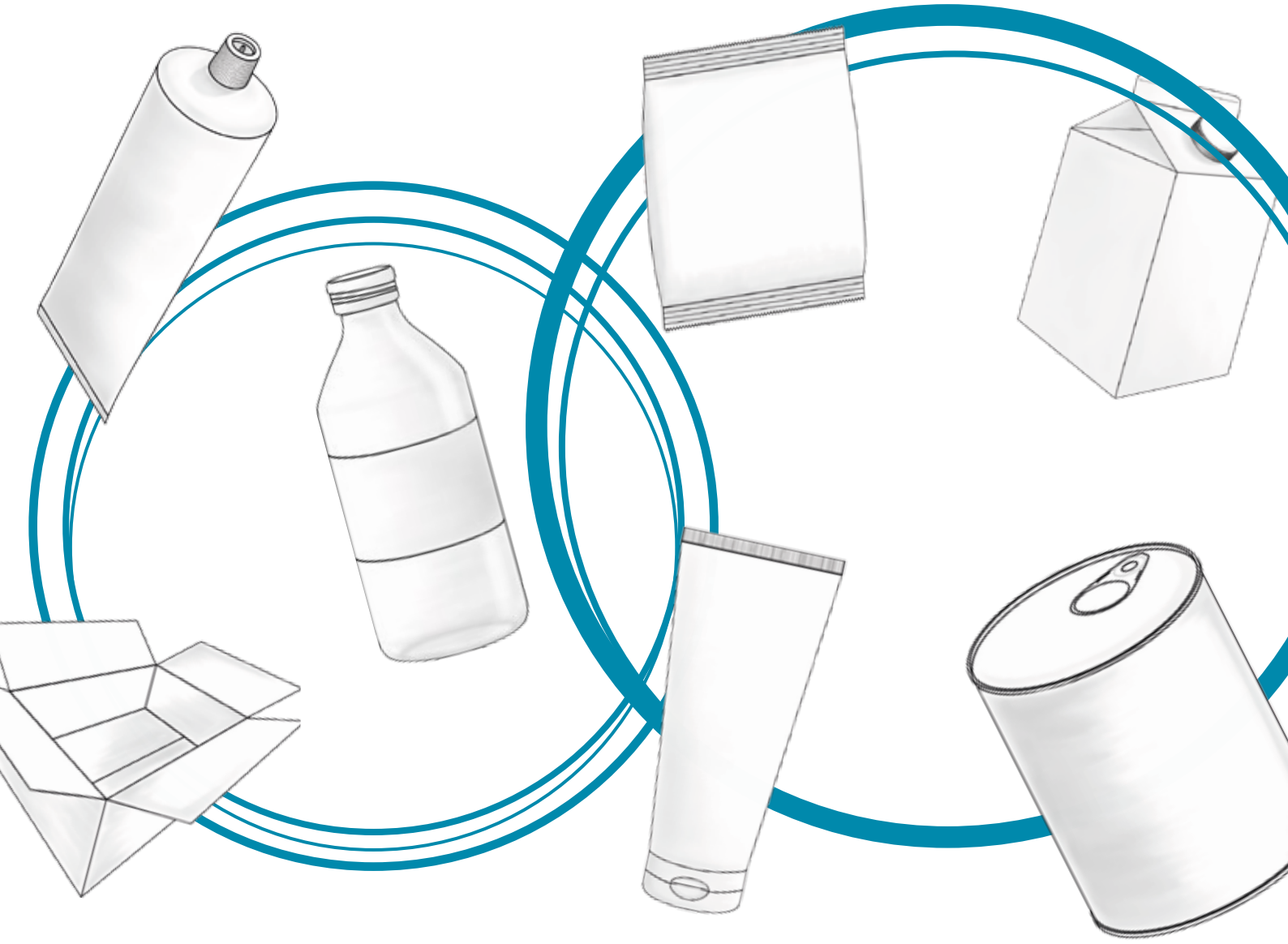
Circular Packaging Design Guideline

Design Recommendations for Recyclable Packaging

Version 03, September 2020

APPLIED LIFE SCIENCES



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“Cooperation, innovation and knowledge exchange!

The cornerstones of a cross-border circular economy strengthen the sustainable future of packaging solutions, especially in challenging times!”

Johannes Bergmair, General Secretary World Packaging Organisation (WPO)

CONTENTS

REVISIONS

The *Circular Packaging Design Guideline* has been reviewed. The following amendments have been included or revised in the areas mentioned, in relation to version 02:

- Update of legal and structural framework conditions
- Revision of the definition for classification of recyclability
- Revision and additions to the chapters holistic approach and sustainable packaging design - new model for holistic sustainability assessment
- Revision and expansion of the main criteria for recyclable packaging design
- Separation of general and material-specific design recommendations
- Extension and addition of details for the design recommendation tables for all materials
- Revision of the application recommendations for specific packaging types
- Extension of the composite materials containing plastic - beverage carton recommendation table
- Extension of the chapter recommendations for packaging aids – an overview
- New chapter: *country-specific collection structures*
- Addition to the use of recycling material in the Food / Near-Food sector
- Recommendations on recyclable adhesives and topics related to adhesives are initially being revised in a separate work group (Focus Group Recycling-Ready Adhesives)
- Expansion of sources

LIST OF ABBREVIATIONS

AA-Blocker	*acetaldehyde blocker*
Al_2O_3	*aluminium oxide*
APET	*amorphous polyethylene terephthalate*
APR	*The Association of Plastic Recyclers*
$CaCO_3$	*calcium carbonate (lime)*
CO_2	*carbon dioxide*
CPET	*crystalline polyethylene terephthalate*
CPI	*Confederation of Paper Industries*
EPS	*expanded polystyrene*
EPBP	*European PET Bottle Platform*
ERPC	*European Recovered Paper Council*
EuPIA	*European Printing Ink Association*
EVA	*ethylene vinyl acetate*
EVOH	*ethylene vinyl alcohol copolymer*
FPO	*filled polyolefin*
HDPE	*high-density polyethylene*
INGEDE	*Internationale Forschungsgemeinschaft Deinking-Technik e. V. (International Association of the Deinking Industry)*
LDPE	*low-density polyethylene*
LLDPE	*linear low-density polyethylene*
MDPE	*medium-density polyethylene*
DMD	*date of minimum durability*
NIAS	*non-intentionally added substances*
NIR	*near-infrared (spectrometer)*
OPET	*oriented polyethylene terephthalate*
OPP	*oriented polypropylene*
PA	*polyamide*
PC	*polycarbonate*
PCEP	*Polyolefin Circular Economy Platform*
PE	*polyethylene*
PET	*polyethylene terephthalate*
PETG	*polyethylene terephthalate glycol*
PET GAG	*Combination of PET film types A and G (outer layers PET-G film, inner layer PET-A film)*
PE-X	*cross-linked polyethylene*
PGA	*Polyhydroxy acid or polyglycolic acid*
PLA	*polylactic acid*
PO	*polyolefin (for example polyethylene, polypropylene)*
POM	*polyoxymethylene*
PP	*polypropylene*
PS	*polystyrene*
PTN	*polytrimethylene terephthalate*
PVC	*polyvinyl chloride*
PVDC	*polyvinylidene chloride*
rPE	*recycled polyethylene*
rPET	*recycled polyethylene terephthalate*
rPP	*recycled polypropylene*
SiOx	*silicon oxide*
TiO_2	*titanium dioxide*
TPE	*thermoplastic elastomer*

OVERVIEW AND SCOPE OF APPLICATION

Packaging fulfils many essential roles; from protection, storage and transport functions to aspects such as ease of use and the provision of product information. These functions essentially contribute to sustainability, as packaging prevents damage to sensitive products and loss of food. In addition, the environmental impact of producing the packaged good is, in many cases, considerably greater than the impact of producing the packaging itself. In other words, both sustainable packaging design, as well as the protection of products, must be given top priority.

Even though packaging can contribute to a sustainable economy, as a consumer good, its public reputation tends to be negative. Furthermore, problems such as littering, the generation of emissions and use of resources for packaging are still associated with this topic. In recent years, a growing demand for greater sustainability in packaging design has definitely been apparent.

Sustainable packaging incorporates maximum functionality and the highest possible protection of products, while keeping its ecological footprint to a minimum and enabling maximum circularity. Circular aspects of packaging have become especially important as, in the context of the Circular Economy Package, the European Union advocates greater resource efficiency and reuse of products, considerably higher material recycling rates and the use of recycling material as a secondary raw material. This is currently posing challenges in the plastic sector in particular. The options for using recyclates primarily depend on the technical requirements of application; for re-use in the food sector EFSA requirements must be met in accordance with EU 282/2008. Only PET recyclate from post-consumer waste (mainly bottles) is currently used on a large scale in the food sector. The Circular Economy Package also includes the demand for a reduction of food waste, the use of non-toxic substances, as well as the increased use of bio-based raw materials. A circular approach to materials will thus protect the environment while reducing emissions.
However, to achieve higher material recycling rates we need to rethink the design of packaging to improve its future recyclability while guaranteeing its functionality. In addition, we need to open up markets for the use of the secondary raw materials that are produced, which must be of a quality that enables full substitution for virgin material of the same type.

The *Circular Packaging Design Guideline* aims to provide recommendations for the recyclable design of packaging and addresses all actors along the entire value chain. The Guideline will be updated continuously and amended in response to changes in collection, sorting and recycling technologies, as well as future material developments. This document should by no means be regarded as an obstacle to innovation (e.g. bio-based materials, new barrier materials etc.), on the contrary, new technologies can contribute to improving ecological performance and need to be analysed separately.

Information from the following sources has been used as a basis for drawing up the present version of this Guideline:

- Design for Recycling Guidelines (Plastics Recyclers Europe)
- Verification and examination of recyclability (cyclos-HTP)
- PET Bottles Design Guidelines (European PET Bottle Platform)
- Recyclability by Design (Recycling of Used Plastics Limited: RECOUP)
- Design for Recycling (Packaging SA)
- APR Design Guide for Plastics Recyclability (The Association of Plastics Recyclers)
- Guide to measuring the recyclability of packaging with a system participation requirement - German Central Agency Packaging Register
- KIDV Recycle Check (Netherlands Institute for Sustainable Packaging)
- Recyclability of packaging – definitions, investigation framework and list of criteria - bifa Environmental Institute
- Paper and Board Packaging Recyclability Guidelines (Confederation of Paper Industries, CPI)
- Design for Recycling Guidelines, RecyClass
- Recyclability of plastic packaging - Eco-design for improved recycling (Cotrep)
- Quickstart Guide to Designing for Recyclability (APCO)
- Guidelines to facilitate the recycling of packaging (CONAI)
- Design4Recycling Guide (The Green Dot])
- Design Guide - Reuse and recycling of plastic packaging for private consumers (Network for Circular Plastic Packaging)

In addition, an expert council was involved for consultation andbm the contents were coordinated according to the meaning of the European framework conditions. This guideline can be used for Austria, Germany, the Netherlands and other countries with similar waste management systems. An important goal is the international harmonisation of packaging design for recycling to increase the amount of recyclable packaging material. Nonetheless, it is always necessary to consider the specific conditions in different countries. A comparison of country-specific collection structures is available in a separate chapter.

Furthermore, testing procedures for examining the recyclability of specific packaging materials are already available to producers. Test processes have been developed for PET packaging (European PET Bottle Platform) and plastic packaging in general (American Association of Plastic Recyclers). There are also various software-supported tools available online to assess the recyclability, which help to design packaging suitable for recycling.

Sustainability with regard to packaging also includes several other relevant aspects, which, even though they do not play a key role in this Guideline, are worthy of mention in order to present a complete picture of product development.

Innovation to enhance recyclability

In order to target enhanced recyclability, in addition to a circular design that has been adapted to present-day structures and technologies, the existing sorting, separation and recycling technologies also need to be continually advanced. Furthermore, it is advisable to expand collection and recovery structures in order to meet the planned recycling rates. Technological and structural developments must go hand in hand and complement each other through innovation in order to enable the progress of the circular economy.

Structure

The *Circular Packaging Design Guideline* is structured as follows:

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FUNDAMENTALS

HOLISTIC APPROACH

The circular economy and its holistic approach to the product involved, which takes material recovery into account, presents a new challenge for product design and the conception of packaging. Packaging must meet manifold requirements and cover a variety of functions. It must combine maximum functionality and protection of goods on the one hand whilst producing minimal ecological impacts on the other. In order to achieve sustainability in packaging, i.e. ecological value added over the entire life cycle, four basic design principles apply:

Effective

Packaging needs to be fit for purpose and add as much value as possible with regard to both the consumer and the product (e.g. retain shelf life). In order to assess effectiveness, detailed knowledge about the properties of the packaged good is required. The packaging must provide adequate protection against adverse environmental influences such as mechanical stress, oxygen, humidity or light. In addition, the packaging must ensure easy handling by the final consumer to the greatest possible extent. Finally, the influence of packaging on the product loss can be established empirically.

Efficient

The use of raw materials, emissions, energy, and the generation of waste need to be minimised throughout the entire life cycle. Life-cycle assessment (LCA) is the standard instrument for assessing the efficiency and thus the ecological sustainability of packaging. It takes into account the environmental impact of the packaging over its entire life cycle. The life cycle starts with raw material extraction, and ends with the final waste treatment of the packaging. The amount of CO2 equivalents that are emitted throughout the entire life cycle is a well-known parameter for assessing the ecological impact of the packaging.

Safety

Safe packaging is designed to minimise health and safety risks to human beings and ecosystems throughout its life cycle. Regarding admissibility for food contact, the applicable legal requirements need to be met and additional aspects such as end consumer safety, environmental protection and tamper evidence need to be considered.

Circular

Cyclic packaging is designed to maximise the re-use and recovery of materials used. This is aimed at longevity, full substitution for virgin materials of the same type (closed-loop recycling) and/or the use of renewable materials. Circular packaging design refers to the principle of cyclic approaches. Products should be designed and produced in a way which, after use (single or multiple), permits the recovery of materials to a high degree (to be employed as secondary raw materials), the reuse of the packaging, and/or the manufacture of the packaging from renewable raw materials.

REGULATORY CONTEXT

'Design for recycling' of packaging is a sub-area of circular design and describes whether a packaging is fit for correct handling in a sorting process and for material recovery in an established recycling process..

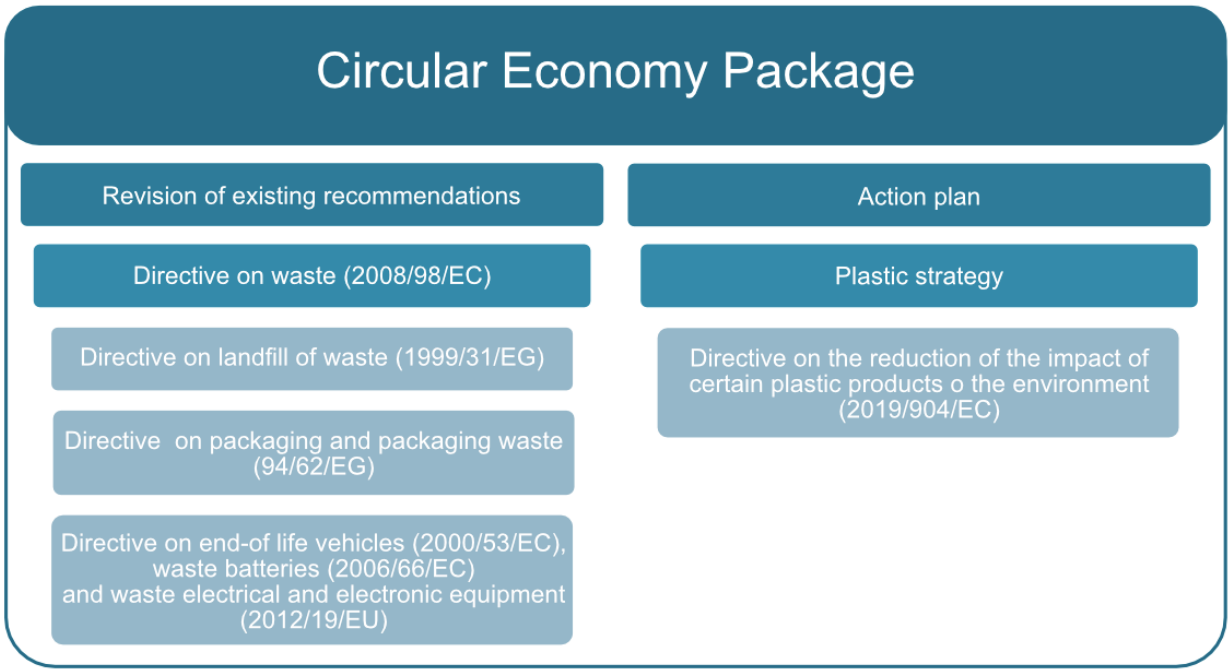
'Design from recycling' refers to the second sub-aspect of the circular approach. Here, the focus is on the use of recycled material that can be used as a full substitute for virgin material of the same type. For this purpose, markets need to be opened up that permit the fully functional use of the secondary raw materials that have been recovered. In addition, regarding closed-loop packaging design (e.g. PET beverage bottle recycling), it is particularly relevant to take specific material properties into account in order to avoid possible manufacturing defects.

"The focus is on increasing the recycling rates for all packaging materials and on intensifying extended producer responsibility schemes".

It is mainly due to legal requirements that the present focus of ecological sustainability in the packaging industry is on closing material and product cycles. The Circular Economy Package of the EU that entered into force in July 2018 includes provisions for enhancing circular approaches to raw materials at the European level. In 2018, the package led to modifications of the EU Directive on packaging and packaging waste (94/62/EC), in combination with the Landfill Directive (1999/31/EC), as well as the superordinate Waste Framework Directive (2008/98/EC). The Package also includes a specific paper on plastics - the European Strategy for Plastics in a Circular Economy ('EU Plastics Strategy'). This focus is on increasing the recycling rates for all packaging materials, and on intensifying extended producer responsibility schemes. Producers of plastic packaging are facing important challenges, since mandatory recycling rates will be raised from the current value of 22.5% to 55% by 2030 (2018/852/EC amending Directive 94/62/EC). The new Single-Use Plastics Directive (2019/904/EC) also includes regulations on partially or wholly plastic single-use products. The guideline limits the sale of individual plastic products and bans straws or cotton bud sticks, for example. Article 9 of the Directive also prescribes a 90% separate collection target for plastic bottles of up to three litres (including caps) by 2029 (77% by 2025). In accordance with Article 6 and from 3 July 2024, caps and lids are to remain attached for all wholly or partially plastic beverage containers of up to three litres for the duration of intended use (this also applies to composite beverage packaging). New regulations on minimum recyclate content are also set in the directive: For PET bottles, a new minimum content applies of 25% by 2025. For plastic drink containers of up to three litres, this is 30% by 2030. EPS take-out food packaging will be banned in full.

New calculation regulations for determining the recycling rate have also been set by the European Commission. For recycling rates, the weight of produced and recycled packaging waste in a calendar year is considered in relation to the amount put into circulation. The weight of packaging waste that counts as recycled should be determined at the location at which the packaging waste is fed into the recycling process (2018/852/EC to change guideline 94/62/EC, in accordance with Article 1). This means that this is the amount which has already gone through the specific material sorting process and losses from pre-processing steps have been taken into account (for example the plastic material which is directly inserted into the extruder for re-melting). The recycling rate can therefore be differentiated from technical recyclability.

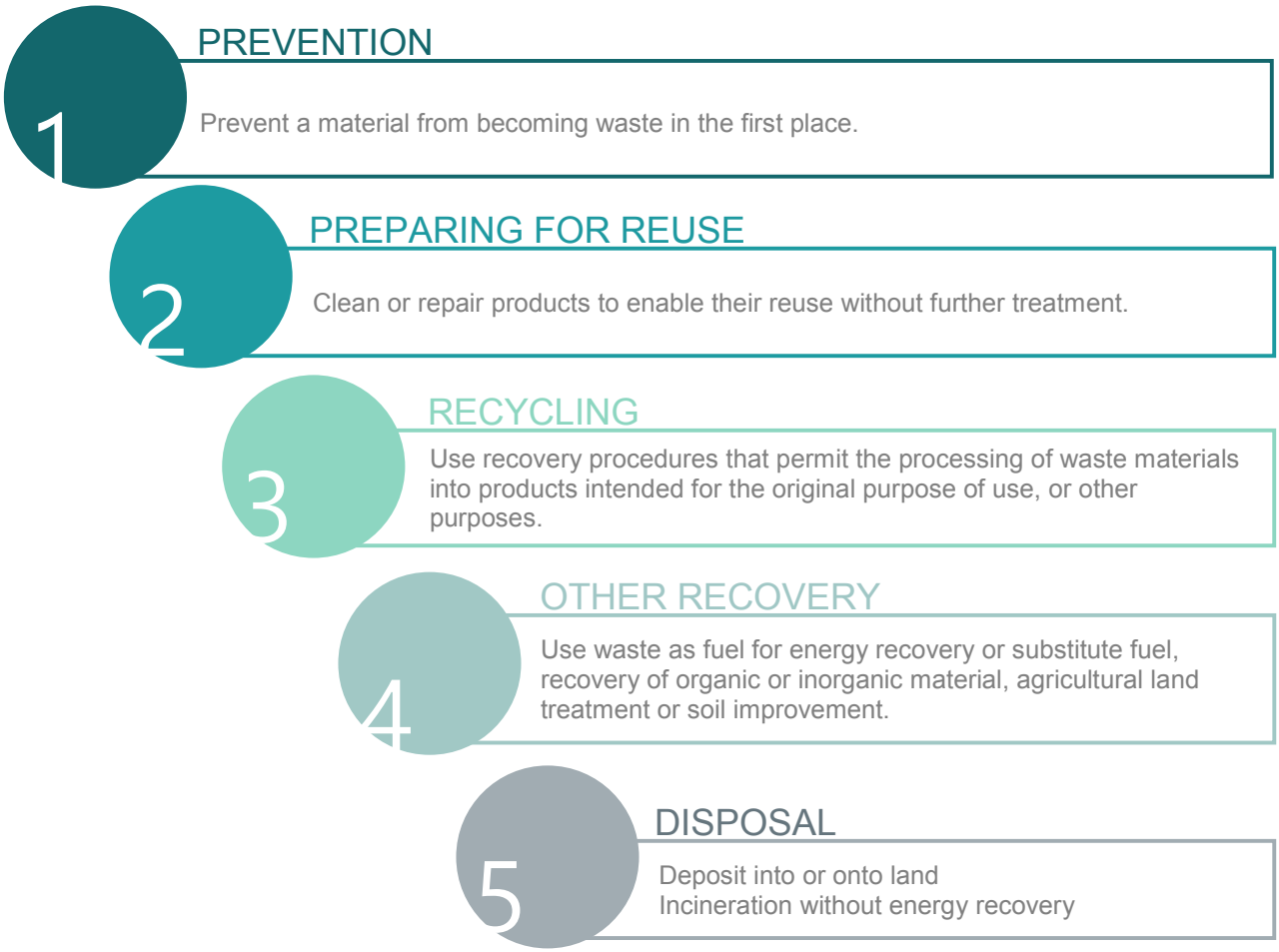
The diagram below provides an overview of the focuses of the Circular Economy Package (as at April 2020). The Package aims to reduce waste and improve preparation for reuse and recycling.



The waste hierarchy

The waste hierarchy covers the fundamental aspects of an all-encompassing approach to sustainable packaging design. Its legal basis focuses on an order of preference regarding levels of protection of resources.

As a rule, solutions that avoid packaging waste – e.g. by reducing the amount of material – are to be given priority. However, in all cases, the option with the best ecological result with regard to the entire life cycle should be chosen. Identifying the most ecological packaging solutions shall be based on up-to-date studies (data not older than five years). Changes to regional collection and recovery structures should be taken into account.



This Guideline primarily focuses on recyclability. However, the other aspects of the waste hierarchy also need to be taken into account when designing packaging.

ASSESSMENT OF RECYCLABLE PACKAGING

The term ‘recyclable packaging’ refers to packaging systems that enable industrial-scale recycling. In this context, the current state of collection and recovery structures in the regions and countries in question needs to be taken into account. Glass, paper, tin plate and aluminium are generally well-suited for recycling. The situation varies more for plastics. For instance, in Austria PET bottles are recyclable as a recovery system is currently in place that permits the full reprocessing of PET for manufacturing food-contact packaging and for the full substitution of virgin materials of the same type. PP bottles for food packaging are also recyclable, but for legal reasons, the recycled PP can only be used for non-food-contact products, such as flower pots or detergent packaging. In the household product sector, ongoing developments are aiming to optimise recycling processes (for example removing smells from recyclate) so that polyolefin recyclates (rPP, rPE) can also be used for cosmetic packaging in the future. Efforts are also in progress for the food sector.

Generally, the recovery process must result in a product that can fully substitute virgin material of the same type, i.e. the secondary material must meet the quality and safety standards that permit its replacement of primary material. Recycling in the sense of this Guideline does not include energy recovery and composting. Today, comprehensive research is being pursued in the area of chemical recycling (e.g. for polystyrene and polyolefins). It is expected that new processes will be implemented in the coming years.

Whenever packaging is classified as recyclable, this refers to a clearly defined geographical area and period of application. A PET bottle that is regarded as recyclable in Austria would be classified as non-recyclable in a country where the necessary collection and recovery systems do not exist. In order to improve recyclability, the entire packaging needs to be assessed. For this purpose, the packaging can be analysed in either qualitative or quantitative terms. The table below outlines the differences between the two methods.

CURRENT METHODS OF RECYCLABILITY ASSESSMENT

Method	Description	Metric
Quantitative	Calculation of the mass fraction of the packaging that, after the recovery process, can substitute virgin material of the same type.	Percentage by mass (wt %)
Qualitative	Questionnaire-based assessment methods that survey product properties such as material composition, colour or full emptiability	Scale (e.g. from A to F; or categories such as very good/good/limited/no recyclability)

In the case of a quantitative assessment, material loss due to sorting and recycling processes must be taken into account. In addition, extensive knowledge on specific sorting and recovery procedures is required. In a qualitative assessment, data on the packaging are gathered, mostly by means of questionnaires, and assessed for subsequent assignment to a category. In some cases, a combination of both assessment methods is taken into account.

The following terminology applies to recyclability and sortability:

Sortability

Sortability is a basic requirement for recyclability. It must be ensured, that material-specific, commercially available sorting technology can be used. Sortability depends on both detectability and correct identification (for example, material is detected by a specific near-infrared spectrum) and also the sortability of the packaging (for example, picking out using pressurised air).

Recyclability

Products must meet the following criteria to be recyclable:

- The material used is collected by specific country or regional collection systems
- It can be sorted into defined streams according to the commercial sorting technologies
- It can be processed in commercial recycling processes
- There is a market potential for the derived secondary raw material, and it can be used to substitute virgin material

(Definition according to the Plastics Recycling Europe & Association of Plastic Recyclers, 2018)

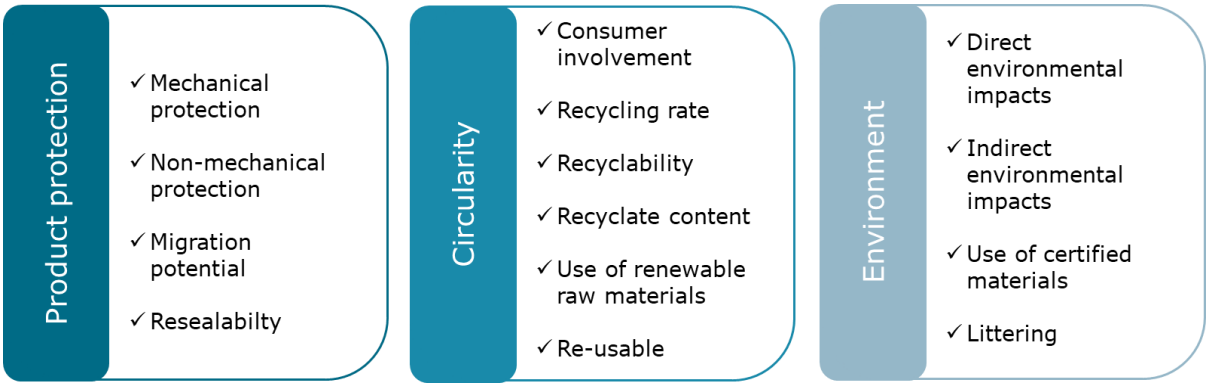
Recyclability should be differentiated from the actual recycling rate (see the “Regulatory Context” chapter, recycling rate paragraph).

SUSTAINABLE PACKAGING DESIGN

As described in the previous section, the assessment procedures that are currently available on the market differ with regard to interpretation and degrees of specialisation. Which system is better for a user depends on the individual case. One must bear in mind that the possibility of conflicting goals (e.g. recyclability vs. efficient use of resources) requires an all-encompassing approach in order to enable sustainable product development. For instance, a packaging can have maximum recyclability if a certain barrier is eliminated — which, however, poses the risk of premature spoilage of the food product and thus negative environmental impacts.

As a result of the research carried out by the FH Campus Wien, a model for the holistic sustainability assessment of packaging was developed, which is based on the legal framework and the four fundamental design principles (see *holistic approach* section). It focuses on the ecological aspects of the packaging and includes recyclability as an important part of the "circularity" category.

Model for holistic sustainability assessments of packaging



Product protection

Guaranteeing appropriate product protection is one of the packaging's most important tasks. The product must be as well-protected as possible from mechanical impacts (e.g. bumps, blows, deformations) and non-mechanical impacts (e.g. oxygen, humidity). The migration potential of the packaging should be kept to a minimum. The possibility of re-sealing should also be considered since additional or improved product protection can be achieved by this.

Circularity (recyclability)

The aim of circular packaging design should be to permit long use life, full substitution (closed loop recycling) and/or the use of renewable materials. Ecological sustainability focuses on a circular approach, i.e. closing raw material and product loops. Important criteria for assessing the circularity of packaging include recyclability, current recycling rates, recyclate content and the proportion of renewable raw materials. However, suitability for re-use and consumer involvement (e.g notes on the packaging for correct disposal) are also important to be considered in this category.

Environment

In principle, a distinction can be made between direct environmental impacts, which can be described by a life-cycle assessment (16 impact categories according to PEF, for example global warming potential) and indirect environmental impacts. The latter includes product losses, which are caused by premature spoilage or insufficient emptiability. The packaging design and condition or viscosity of the product are some of the factors influencing emptiability. The environmental impacts of the packaging can be positively affected by using certified materials and reducing littering potential through appropriate packaging design (for example no separable small parts).

The points mentioned above are key aspects for the ecological sustainability of packaging. However, due to the diverse requirements that are placed on packaging, there are additional aspects to consider:

- Technical feasibility
- Suitability for processes in packaging facilities and processes
- User-friendliness for end consumers
- Information for end consumers

Packaging design can only contribute to sustainable development if all relevant influencing factors are taken into account and the entire supply chain is included.

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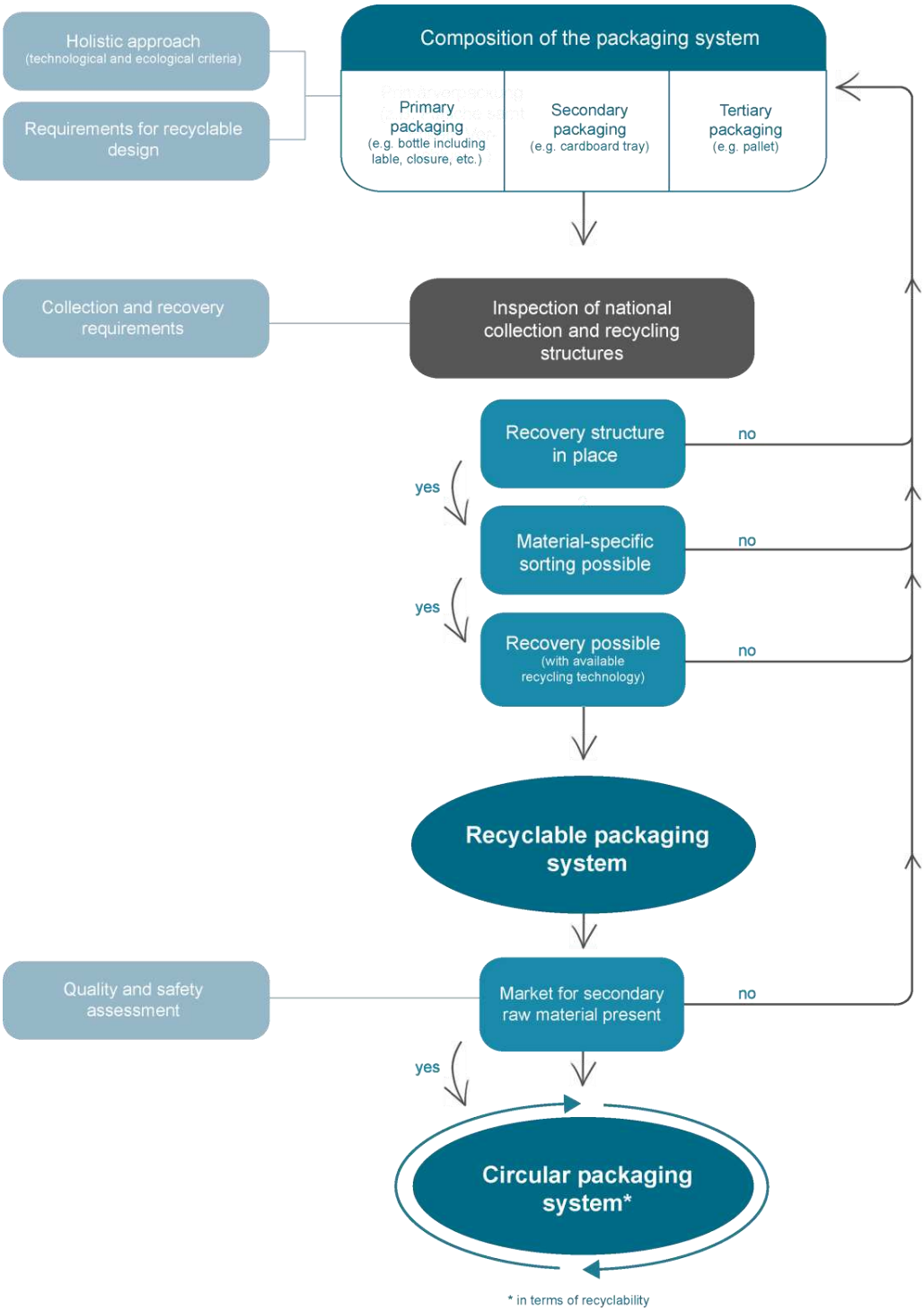
GENERAL DESIGN RECOMMENDATIONS

STEPS IN THE DESIGN PROCESS

The diagram below illustrates the key steps in the design process of recyclable packaging (this applies to disposable and reusable packaging).



In line with the waste hierarchy (see p.12), the first step is to encourage reduction of the use of packaging material as much as possible (prevention) or permit re-use of the packaging (reusable products). Design for recycling follows in third place in the hierarchy. This means that the packaging should be designed to permit a high degree of collection, sorting and material recovery. Decisive design criteria relate to the material and additives used, material and printing colours, decoration as well as toclosures and small parts. The suitability of packaging in relation to emptying and correct sorting and separation by end consumers are also significant aspects. The following recommendations should be followed to create sustainable and recyclable packaging design:

MAIN CRITERIA FOR RECYCLABLE PACKAGING DESIGN

MATERIALS AND ADDITIVES

- Generally speaking, the material used should be as homogeneous as possible, free from additives, and produced in accordance with the applicable legal framework.
- Use of monomaterials or material combinations that permit recycling is preferable.
- In addition, access to and availability of, regional recovery streams is essential. For this reason, uncommon materials constitute a problem as due to lack of appropriate infrastructure, they often cannot enter a recovery stream. Examples of this are packaging from PLA or polycarbonate for which no suitable or sufficient recovery structures are in place today.
- Where possible, recycling material should be used (depending on the specific product authorisation and availability on the market)
- Additives that lead to quality problems in the recyclate should be avoided where possible. One problem could be potential contamination of breakdown products. However, more research needs to be done in this area.
- If different materials are combined in composite materials, recycling is often impossible. Nevertheless, new barrier and recovery technologies are being continually developed and must also be taken into account.

MATERIAL COLOUR

- In general, avoid or minimise dyeing of packaging materials. Heavily dyed materials in paper or plastics can cause problems with regard to sorting, or the material value of the recyclates can, be reduced. As far as glass packaging is concerned, only standard dyes should be used.
- In addition, carbon black-based dyes, can, in the context of NIR detection during the plastics sorting process, lead to incorrect classification of the material, or the material being eliminated in the sorting process. However, there are already black and dark dyes available that can be detected with NIR and are not carbon-black based

.

PRINTING INKS AND DECORATION

- The printing inks used must be in conformity with the EuPIA Exclusion List.
- Direct printing applied by the filler to add the batch number or DMD should, whenever possible, be replaced by laser engraving in order to avoid contamination by solvents or dark pigments.
- The packaging should be considered as a whole, and should consist of a limited number of different materials or of material combinations that can be easily separated.
- In addition, adhesives, sleeves and labels must be compatible with the material of the packaging and take into account the sorting and recycling procedure currently in use (further research is required for material-specific details in the area of adhesives).

EMPTIABILITY

- Packaging should be designed so that it can be disposed of in a fully drained condition. In the case of certain types of filled products, particularly high-viscosity products, good emptiability can be difficult. Depending on the shelf life of the product, residues in the packaging can have negative effects on recycling fractions. When designing packaging, particularly in the case for high-viscosity products, good emptiability should be the aim (e.g. by means of containers that can be placed upside down).
- Heavy containers with large amounts of residue have also led to sorting problems.

CLOSURES AND SMALL PARTS

- For small parts, such as openers or closures, a system should be used, that prevents their complete removal by the end consumer for the duration of intended use. This is based on minimising the littering potential of packaging (release into the environment) and is in compliance with the EU-Directive 2019/904/EG for beverage containers (from plastic or partially plastic). This can, for instance, be achieved by integrating closures into the resealing process (e.g. screw caps) or by attaching it to the base packaging (e.g. stay-on closures). Whenever possible, small parts should be attached mechanically, in order to enable their subsequent removal in the sorting process.
- Closures such as sealing films which need to be separated for proper use are exceptions to this. These should be removable in full and not leave any residue (adhesives or film residues, etc.) on the base packaging.
- If the packaging is sealed using adhesives, this should be adapted to the given sorting and recycling process (further research is required for material-specific details in the area of adhesives)

CONSUMER INVOLVEMENT

- Correct separation of the components of a packaging should not be dependent on the (end) consumer, since their behaviour cannot be controlled. If this cannot be implemented, measures which make it as easy as possible for the end consumer to separate materials correctly are desirable. This can be in the form of easy to read information on the packaging, which allow for clear identification of material types or visible and easy to use perforations for removing the decoration. If the active participation of the end consumer is foreseen or required (for example when separating the cardboard wrap from a plastic cup), correct separation and disposal of the components must be proven and evidenced by empirical analysis (for example case studies).

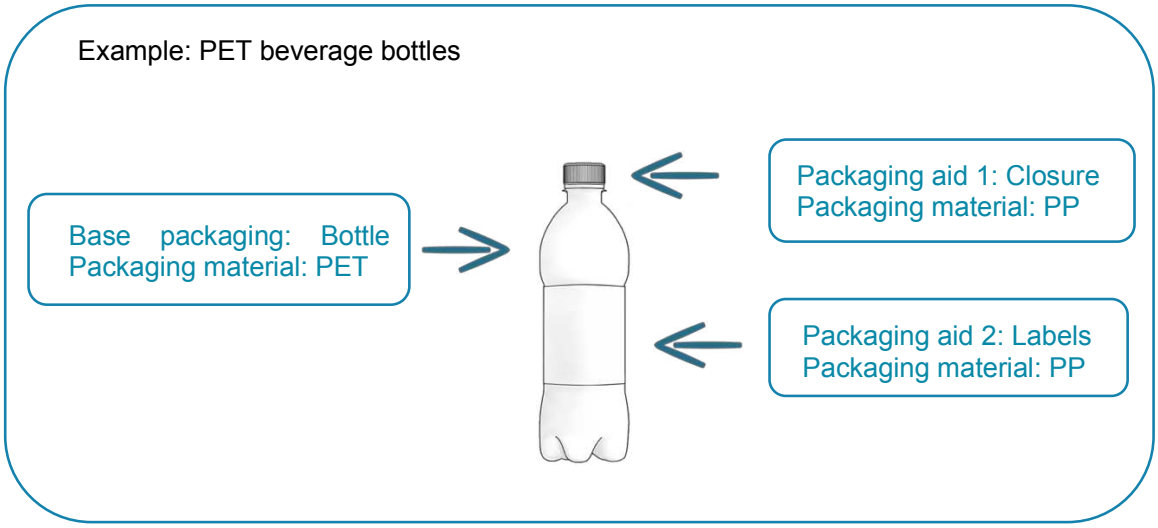
DEFINITION FOR RECYCLABILITY CLASSIFICATION

The following chapters present design recommendations for different types of packaging, which primarily refer to mechanical recycling processes. The factors taken into account for classification include the most important combinations of materials and the packaging components used with regard to their suitability for current state-of-the-art mechanical recycling procedures. Full recyclability means that the product obtained after recycling can be used as a full substitute for material identical new goods.

Packaging usually consists of several components. These can be divided into the base packaging and packaging aids and consist of different packaging materials. Base packaging refers to any component forming the main part of the packaging and surrounding or holding together the packaged goods (filled product). It builds the foundation, and may be in the form of a bottle, a tray or a pouch. Packaging aids are components that permit supplementary functions such as closing, labelling, handling and removal. This includes staples, sealing films, elastic bands, wrap-around labels, sleeves, closures, pull tapes and cushioning materials. Together, base packaging and packaging aids form the packaging.

Depending on the packaging function (e.g. sales or transport packaging) a distinction can be made between primary, secondary, and tertiary packaging, which form a packaging system (see p. 66).

Terminology and definition based on DIN 55405:2005-10



Recyclability of packaging also involves considering how it is disposed of and in which condition it reaches the respective recovery stream (= packaging disposal unit). The material combination plays a key role in this process. The individual components (base packaging and packaging aids) may be present separately during use or downstream during sorting, or may remain attached to each other. Example: A bottle can be disposed of with its adhesive label and closure attached (packaging disposal unit = bottle + label + cap), or the label could be separated beforehand (packaging disposal unit 1 = bottle + cap/ packaging disposal unit 2 = label).

It is generally beneficial if a disposal unit consists of a single material (Example: bottle and connected cap are both PP) or if the unit has been matched to the structural conditions of the sorting and recycling process (for example, the bottle and cap consist of different materials, but density separation is possible). Specific material combinations can also lead to detection and sorting problems and to the packaging being assigned to the wrong material stream.

Recyclability must be individually assessed for each packaging unit, taking the composition, structural conditions and intended use into account.

In addition, a distinction must be made as to the extent to which the individual packaging components influence the recycling process, which can sometimes also be traced back to the material composition of the packaging material (e.g. fillers and dyes, barriers, etc.). The following types of restrictions can be differentiated:

Restrictions concerning individual packaging components

Individual components of the packaging cannot be recycled for technical and/or structural reasons, but do not have a negative impact on the recyclability of the base packaging (e.g. removable label on a PET bottle with non-recyclable label material)

Restrictions due to insufficient sortability

Certain constructions or components prevent the packaging from being up-taken into the intended recycling stream and therefore being recycled. However, if these individual components are separated before disposal, other components can be recycled (e.g. PET bottle with a full-body OPS sleeve).

Restrictions due to the design of the complete packaging

The packaging design prevents the recycling of both individual packaging components and the base packaging material. The packaging must be completely redesigned in order to enable recycling (e.g. PET-EVOH multilayer trays).

The effort required to design the packaging in a recyclable way thus depends on the type of restrictions that have been identified.

Structural restrictions due to the respective country-specific recording structures are taken into account in the sense of circular design efforts (as uniform material flows as possible).

Structural restrictions due to the respective country-specific recovery structures are taken into account in the sense of circular design efforts (uniform material flows). However forms of packaging and materials that currently have low recycling rates (for example small-sized PE films) should also be considered, since a collection structures might be created for this packaging in the future.

The recyclability of packaging is always classified in relation to the packaging disposal unit and can be based on the following criteria:

Category	
Good compatibility	The packaging disposal unit can be collected, sorted and the material can be recovered with state-of-the art mechanical recycling processes. An industrial-scale recovery stream is available and the recyclate can be used for high-quality applications.
Limited compatibility	The packaging disposal unit is recyclable, but the quality of the recyclate is impaired (for example, grey coloured due to strong dye/printing of a bonded in-mould label). Individual components of the packaging disposal unit are separated during the recovery process and not recycled (e.g. a plastic label/sleeve on a glass bottle).
Poor compatibility	The packaging disposal unit is not recyclable in the sorting and recycling processes currently in place and/or no recovery structure is in place. One component of the disposal unit contaminates the other components so that recovery is no longer possible (for example, a PA barrier cannot be separated from PP packaging) - the whole packaging is assessed as having *poor recyclability*.

FH Campus Wien
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MATERIAL-SPECIFIC DESIGN RECOMMENDATIONS

PLASTIC PACKAGING

Due to the large number of different materials in the field of plastic packaging, general design-relevant recommendations are listed in advance. These apply to all types of plastic material.

GENERAL POINTS

The efficient collection, sorting and recycling of plastic packaging essentially depends on the following criteria:

- Use the most common types of materials (e.g. polyolefins, PET)
- Only use new materials if they are compatible with the prevalent collection and recovery structures
- Avoid additives in the material whenever possible
- Simple separation of the individual components in the sorting or recycling process
- Use of dyes should be kept to a minimum and should be translucent where possible
- Avoid using small parts that can be removed by the consumer
- Use packaging aids and components that do not impair the recyclability of the base packaging material (For details see the *Recommendations for packaging aids - an overview* chapter)

POLYETHYLENE TEREPHTHALATE (PET)

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for PET hollow bodies in Austria, Germany and the Netherlands. High-quality material-identical new products can be made from PET recyclate, even including closed-loop recycling, which also permits use for food-contact materials.

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

Recyclability for Packaging made of PET				
Components		Good	Limited	Poor
Base packaging	Material	PET		Composite with: Materials with a density > 1 g/cm³ (for example, PVC, PS), PLA, PC, PE PET-GAG structure PETG, CPET Expanded PET (LDPET)
	Additives		UV stabilisers AA blockers optical brighteners, oxygen absorbers	PA additive Density-modifying materials Nanoparticle, oxygen-/bio-/oxo-degradable additives
	Barrier	No barrier layer SiOx, Al_2O_3 barrier carbon plasma coating[1]	Aluminium vapour deposition (Metallizing)[2] Max. 5 wt % PA[3] PGA multilayer PTN alloy TPE and PO-based barriers	EVOH over 5 wt % PA Aluminium barriers blended barriers

[1] If the base packaging is transparent, this may cause discolouration
[2] Provided that material-specific sorting is not influenced
[3] The permitted mass percentage and design of a PA barrier varies depending on the type of packaging. Specific information is provided by RecyClass or the EPDP at: https://recyclass.eu/recyclass/design-for-recycling-guidelines/.

Recyclability for Packaging made of PET				
Components		Good	Limited	Poor
Base packaging	Colour	Transparent	Pale and light colours (for example blue or green) Dark or opaque material[4]	Carbon-black based colours Metallic or fluorescent colours
	Printing	Colours comply with EuPIA Non-bleeding colours No direct printing on the base packaging		Bleeding colours Extensive direct printing on the base packaging
	Direct printing (batch printing, DMD)	Engraving Laser-marking	The batch number and DMD can, if necessary, also be labelled using minimal direct printing with other marking systems (for example inkjet), provided that food-compliant colours are used	
Packaging aids - closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PP, HDPE Materials with a density < 1 g/cm³ Closure systems without liners, EVA or TPE liners if necessary	Silicon (density < 1 g/cm³)	Metals, thermosetting plastics, PS, PVC, seals or silicone that cannot be completely removed Glass and metal springs in pump systems Materials with a density > 1 g/cm³ POM

[4] Collection of opaque PET bottles established in Austria

Recyclability for Packaging made of PET				
Components		Good	Limited	Poor
Packaging aids - closures	Flexible closures (sealing films etc.)	PP, HDPE Materials with a density < 1 g/cm³ Sealing film should be removable by the end consumer without any residues PET PET-based foamed materials, for which the foam structure is not damaged at 90 °C	Silicon (density < 1 g/cm³)	Materials containing aluminium with a (metal) layer thickness > 5 µm Thermosetting plastics, PS, PVC, sealing films or silicone that cannot be completely removed Materials with a density < 1 g/cm³
Packaging aid – decoration	Label material	Materials with a density< 1 g/cm³ for example PP, PE, OPP, foamed PET, foamed PETG, LDPET	Paper labels (wet-strengthened)	Materials with a density < 1 g/cm³ for example PVC, OPS or PET, PETG, PLA Non- wet-strengthened paper labels Materials containing metal, materials containing aluminium with a (metal) layer thickness > 5 µm
	Label adhesive[5]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, banderole etc.)	Materials with a density< 1 g/cm³ for example PP, PE, OPP, foamed PET, foamed PETG, LDPET	PET in-mould label Paper	Materials with a density > 1 g/cm³ for example PVC, OPS or PET, PETG, PLA Materials containing metal, materials containing aluminium with a (metal) layer thickness > 5 µm

[5]specific adhesive requirements and recommendations are currently being developed in the „Focus Group Recycling-Ready Adhesives“

Recyclability for Packaging made of PET				
Components		Good	Limited	Poor
Packaging aid – decoration	Size restriction	Decoration covering max. 50% of packaging surface		Large-area decoration (covering > 50% of packaging surface)[6]

Avoid dark colours, since they may have a negative impact on the quality of recyclate.

In general, excessive direct printing on the base packaging should be avoided since the printing inks released can contaminate the recycling stream through the washing water (potential formation of NIAS), or, if the printing inks are not released during the pre-cleaning step, they can impair the transparency of the recycling stream. Instead, any printing should be applied to the decoration or the harmlessness of the colors for the recycling stream should be proven.

EXAMPLES/SPECIFIC APPLICATIONS RECOMMENDATIONS FOR PACKAGING TYPES

The following recommendations are specifically applicable to particular packaging types and should be seen as an expansion of the basic recommendations mentioned in the table above.

PET BOTTLES

- Avoid contaminants that can lead to the formation of acidic compounds in the extrusion process, as this can reduce intrinsic viscosity. This primarily applies to PVC and EVOH.
- Avoid polymers with a similar density or a density above 1 g/cm³, as they cannot be distinguished from PET in the sorting process. PLA melts at the same temperature at which PET dries, which can cause problems during processing.
- The recycling of PET beverage bottles to PET as a secondary raw material that can again be used for food contact is already well established. Other PET types (e.g. PETG) are not compatible with PET bottle recycling. PET packaging produced by deep drawing, as well as PET sleeve films, are contaminants in the recycling stream.
- The admissibility of PET additives, such as nucleating agents, fluorescent agents, opacifiers or absorbers, can interfere with the recycling process and needs to be assessed in each individual case.
- Carbon-black based colours primarily disturb NIR detection. Dark colours also reduce the quality of recycling fractions. In addition, PET bottles with white pigments are contaminants in the recycling process due to non-existent recovery structures. However, in case that PET recycling fractions are used for the production of micro-fibres, dyed granules can be used. Nevertheless, they should generally be avoided.
- PET sleeves should not be used for PET bottles if these have a density above 1 g/m³ and as a result cannot be differentiated from the PET bottle material. There is a risk of colour contamination and quality limitations from recycled PET.

[6] If the decoration covers more than 50% of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

PET FILMS

- There is currently no recovery stream for PET films
- The use of PET in composite film and blister packs is not advisable as it cannot be recycled.
- Further information on multilayer materials is provided in a separate chapter.

PET TRAYS/CUPS

- Trays and cups are manufactured by thermoforming (deep drawing). The difference between this and stretch-blow moulding (e.g. bottles from injection moulding preforms) is the composition of the polymer structure (e.g. PETG, CPET). Moreover, they are often combined with layers of LDPE and polyamide, which could contaminate the recyclate.
- PET trays and cups should thus not enter the recycling stream for PET bottles, as they are contaminants.
- The further expansion of collection and recycling structures for thermoformed PET packaging is advisable, as the use of mono-PET can be an alternative to multilayer composite packaging for many foodstuffs and recycling of thermoformed PET trays is promising.[7]
- In addition, improvements in NIR detection systems may, in future, enable the separation of APET and PETG or multilayer PET trays.
- A current guideline for designing recyclable thermoformed PET packaging has already been compiled by Petcore Europe and is available online.

DESIGN EXAMPLE OF RECYCLABLE COMPLETE PET PACKAGING

- ✓ Bottle or tray of 100 % PET without barrier
- ✓ Transparent material
- ✓ HDPE closure of a density of < 1 g/cm³
- ✓ PP label (or sleeve) with a density < 1 g/cm³, covering a maximum of 50 % of the surface
- ✓ Batch number/DMD as laser marking

[7] Collection of non-beverage bottles: PET (if APET) established in Austria

POLYPROPYLENE (PP)

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for polypropylene hollow bodies in Austria, Germany and the Netherlands. Regarding the collection of PP packaging other than hollow bodies, the specifications of the individual waste disposal agencies apply.

The Polyolefin Circular Economy Platform (PCEP) strives for harmonisation of polyolefin recycling on the European level.

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Components		Recyclability for Packaging made of PP Good	Limited	Poor
Base packaging	Material	PP	A multilayer composite material can be used if it is based on different material types of PP (for example OPP, BOPP) Multilayer composite with PE[8]	Composite with: PS, PVC, PLA, PET, PETG
	Additives		Additives if the density remains < 0.97 g/ cm³ (flexible packaging) / < 1 g/ cm³ (rigid packaging)	Additives (for example talcum powder, $CaCO_3$) that increase specific density to > 0.97 g/cm³ (flexible packaging) / ≥ 1 g/cm³ (rigid packaging) Foaming agent for chemical expansion, oxo-degradable additive
	Barriers	No barrier layer; SiOx, Al_2O_3 , barriers Carbon plasma coating[9]	EVOH[10] Aluminium vapour deposition (Metallizing)[11]	PVDC, PA, EVOH[10] Aluminium barriers[12]

[8] Specific limit values for the PE proportion are currently being discussed.
[9] If the base packaging is transparent, this may cause discolouration
[10] The permitted mass percentage and design of an EVOH barrier varies depending on the type of packaging and should not exceed a certain value. Specific information is provided by RecyClass at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[11] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallisation has been applied to the inside of a film bag.
[12] Possible exceptions must be tested in each individual case.

Recyclability for Packaging made of PP				
Components		Good	Limited	Poor
Base packaging	Colour	Transparent, white		Black, dark or opaque colours Carbon-black based colours
	Printing	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours		Bleeding colours
	Direct printing (batch printing, DMD)	Engraving; Laser marking	The batch number and DMD can, if necessary, also be labelled using minimal direct printing with other marking systems (for example inkjet), provided that food-compliant colours are used	
Packaging aids - Closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PP Closure systems without liners, EVA or TPE liners if necessary	PE (HDPE, LDPE, LLDPE, MDPE), PET PETG, PS, PLA	Metals, thermosetting plastics Seals or silicone that cannot be completely removed Pump systems (particularly if including glass and metal springs), flip-top wires PVC Foamed materials with a density < 1 g / cm³ (EPS)

Recyclability for Packaging made of PP				
Components		Good	Limited	Poor
Packaging aids - Closures	Flexible closures (sealing films etc.)	PP Sealing film should be removable by the end consumer without any residues PP and PE plastic laminate (can remain attached for disposal)	PE (HDPE, LDPE, LLDPE, MDPE), PET PETG, PS, PLA	Materials containing aluminium with a (metal) layer thickness > 5 µm, thermosetting plastics Sealing films or silicone that cannot be completely removed PVC Foamed materials with a density < 1 g / cm³ (EPS)
Packaging aids - decoration	Label material	PP label	Paper labels (wet-strengthened) PE Labels made from materials other than PP or PE must be water-washable; no adhesive is permitted to remain attached	Materials containing metal; materials containing aluminium with a (metal) layer thickness > 5 µm Labels from other materials such as PET, PLA or paper labels that are not water-washable PVC labels (even if water-washable)
Packaging aids - decoration	Label adhesive[13]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[13]Specific adhesive requirements and recommendations are currently being developed in the „Focus Group Recycling-Ready Adhesives“

Recyclability for Packaging made of PP				
Components		Good	Limited	Poor
Packaging aids - decoration	Adhesive-free decoration (sleeve, banderole etc.)	PP sleeve PP in-mould label (however an increased amount of printing on the label may have negative effects)	PE, PET Paper	Materials containing metal, materials containing aluminium with a (metal) layer thickness > 5 µm PVC In-mould label made from a material other than PP
	Size restriction	Non-PP decoration covers max. 50% of the packaging surface		Non-PP decoration covers > 50% of the packaging surface [14]

[14] If the decoration covers more than 50% of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable.

EXAMPLES/ SPECIFIC APPLICATIONS RECOMMENDATIONS FOR PACKAGING TYPES

The following recommendations are specifically valid for certain packaging types and should be seen as an expansion of the recommendations mentioned in the above table.

PP BOTTLES

- If a barrier is needed, do not use PA. The use of EVOH barriers is permitted in the recycling process up to a certain percentage[15].
- The bottle and its closures should be of the same material and colour where possible.
- Labels should either be of the same material as the bottle or they should be water-washable and cover a maximum of 50% of the bottle[16]. Paper labels should be wet-strength grade.

PP FILM/BAGS

- If a barrier needs to be applied, use a carbon plasma coating[17], SiOx or Al2O3. The use of an EVOH barrier is permitted in the recycling process up to a certain percentage[15]. Avoid PVDC and PA barriers.
- If metallization is used, ensure that this is within the laminate structure and therefore does not impair plastic detection (using NIR).
- Keep printing to a minimum; EuPIA-compliant and non-bleeding printing inks should be used.

PP CUPS/TRAYS

- If the cup/tray is covered with a sealing foil (for example, an aluminium foil lid), the cover must be designed in a way that allows its complete removal, without leaving any adhesive residues on the cup/tray.
- If barrier layers are needed, do not use PVDC or PA.
- Whenever possible, any product-related information should be provided on the lid or sealing foil in order to avoid contamination of the main packaging and additional packaging components.
- Paper labels should be used as sparingly as possible, and whenever they are used, they should be wet-strength grade and water-washable (detachable from the main body).

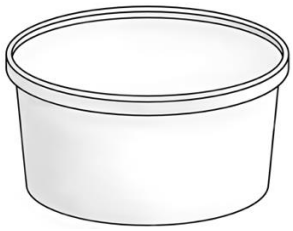
PP TUBES

- The tube itself and its shoulder, closure and label should preferably be made of the same material. If HDPE is used for the closure or the label, the proportion of HDPE should be as small as possible
- Printing over the entire surface is admissible if in conformity with the EuPIA Exclusion List.
- Avoid the use of fillers such as chalk (filled polyolefin - FPO) if this results in a density of over 0.995 g/cm³ (specific value for tubes).
- Aluminium proportions with a (metal) layer thickness > 5 µm should be avoided, as this may lead to an unintended removal of the packaging during sorting. Aluminium barrier tubes (ABL) with a PP/Alu/PP structure are therefore detrimental for recycling.

[15] The permitted mass percentage and design of an EVOH barrier varies depending on the type of packaging, and should not exceed a certain value. Specific information is provided by RecyClass at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[16] If the decoration covers more than 50% of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable.
[17] If the base packaging is transparent, this may cause discolouration

DESIGN EXAMPLE OF RECYCLABLE PP PACKAGING

- ✓ PP cup without barrier and with PP lid
- ✓ Transparent or white pigment
- ✓ Minimum direct printing with EuPIA-compliant colours or decoration with PP in-mould label
- ✓ Batch number/DMD as laser marking on lid



POLYETHYLENE (HDPE, LDPE, LLDPE)

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for polyethylene hollow bodies in Austria, Germany and the Netherlands.

The Polyolefin Circular Economy Platform (PCEP) strives for harmonisation of polyolefin recycling on the European level.

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Components		Recyclability for Packaging made of PE Good	Limited	Poor
Base packaging	Material	PE	a multilayer composite material can be used if it is based on different material types of PE (for example LDPE, HDPE) Multilayer composite with PP[18]	Composite with: PS, PVC, PLA, PET, PETG
	Additives		Additives if the density remains < 0.97 g/ cm³ (flexible packaging) / < 1 g/ cm³ (rigid packaging)	Additives (for example talcum powder, $CaCO_3$) that increase specific density to ≥ 0.97 g/cm³ (flexible packaging) / ≥ 1 g/cm³ (rigid packaging); Foaming agent for chemical expansion, oxo-degradable additive
	Barriers	No barrier layer; SiOx, Al_2O_3 , barriers Carbon plasma coating[19]	EVOH[20] Aluminium vapour deposition (Metallizing)[21]	PVDC, PA, PE-X EVOH[20] Aluminium barriers[22]

[18] Specific limit values for the PP proportion are currently being discussed.
[19] If the base packaging is transparent, this may cause discolouration
[20] The permitted mass percentage and design of an EVOH barrier varies depending on the type of packaging, and should not exceed a certain value. Specific information is provided by RecyClass at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[21] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallization has been applied to the inside of a film bag.
[22] Possible exceptions must be tested in each individual case.

Components		Recyclability for Packaging made of PE Good	Limited	Poor
Base packaging	Colour	Transparent, white		Black, dark or opaque colours Carbon-black based colours
	Printing	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours		Bleeding colours
	Direct printing (batch printing, DMD)	Engraving; Laser marking	The batch number and DMD can, if necessary, also be labelled using minimal direct printing with other marking systems (for example, inkjet), provided that food-compliant colours are used	
Packaging aids - closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liners, EVA or TPE liners if necessary	PP, PS, PET; PETG, PLA	Metals, thermosetting plastics, PVC Seals or silicone that cannot be completely removed Pump systems (particularly if including glass and metal springs), flip-top wires Foamed materials with a density < 1 g / cm³ (EPS)

Components		Recyclability for Packaging made of PE Good	Limited	Poor
Packaging aids - closures	Flexible closures (sealing films etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues PE and PP plastic laminate (can remain attached for disposal)	PP, PS, PET; PETG, PLA	Materials containing aluminium with a (metal) layer thickness > 5 µm Thermosetting plastics, PVC Sealing films or silicone that cannot be completely removed Foamed materials with a density < 1 g / cm³ (EPS)
Packaging aids - Decoration	Label material	PE (HDPE, LDPE, LLDPE, MDPE)	Paper labels (wet-strengthened) PP Labels made from materials other than PE or PP must be water-washable; no adhesive is permitted to remain attached	Materials containing metal, materials containing aluminium with a (metal) layer thickness > 5 µm Labels from other materials such as PET, PLA or paper labels that are not water-washable PVC labels (even if water-washable)
	Label adhesive[23]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[23]Specific adhesive requirements and recommendations are currently being developed in the „Focus Group Recycling-Ready Adhesives“

Components		Recyclability for Packaging made of PE Good	Limited	Poor
Packaging aids - Decoration	Adhesive-free decoration (sleeve, banderole etc.)	HDPE / LDPE sleeve PE in-mould label (however an increased amount of printing on the label may have negative effects)	PP/OPP, PET Paper	Full-surface sleeve Materials containing metal/ materials containing aluminium with a (metal) layer thickness > 5 µm PVC In-mould label made from a material other than PE
	Size restriction	Non-PE decoration covers max. 50% of the packaging surface		Non-PE decoration covers > 50% of the packaging surface[24]

EXAMPLES/ SPECIFIC APPLICATIONS RECOMMENDATIONS FOR PACKAGING TYPES

The following recommendations are specifically valid for certain packaging types and should be seen as an expansion of the recommendations mentioned in the above table.

PE BOTTLES

- Bottles made of HDPE should be non-pigmented whenever possible.
- Closures should ideally be designed to be of the same material and colour as the bottle. The tamper-evident closure should also be of the same material, of the same colour, and easily removable (in the recycling process).
- PP is one of the main contaminants of HDPE bottles in recycling; however, PP is tolerable up to a certain proportion.[25]
- Plastic labels should be of the same material as the bottle body.
- If paper labels are used, they should be of wet-strength grade and water-washable (detachable from the main body).

[24] If the decoration covers more than 50% of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable.
[25] Specific limit values for the PP proportion are currently being discussed.

PE FILM/BAGS

- If a barrier needs to be applied, use a plasma coating[26], SiOx or Al2O3. The use of an EVOH barrier is permitted in the recycling process up to a certain percentage[27]. Avoid PVDC, PA and PE-X barriers.
- If metallization is used, ensure that this is within the laminate structure and therefore does not impair plastic detection (using NIR).
- Avoid the use of additives which increase density and foaming agents for chemical expansion if this results in a density of ≥ 0.97 g/cm³.
- If PE film is combined with other types of plastics by means of co-extrusion, take care that PE polymers are used whenever possible. LDPE, LLDPE, MDPE and HDPE combinations can be recycled.

PE TRAYS/CUPS

- If the cup/tray is covered with sealing foil (for example, an aluminium foil lid), the cover must be designed in a way that allows its complete removal without leaving any adhesive residues on the cup/tray.
- Whenever possible, any product-related information should be provided on the lid or sealing foil in order to avoid contamination of the main packaging and additional packaging components.
- Paper labels should be used as sparingly as possible, and whenever they are used, they should be wet-strength grade labels and water-washable (detachable from the main body).

PE TUBES

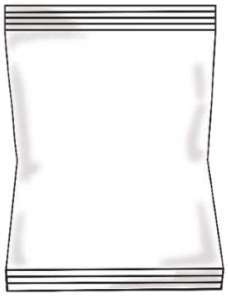
- Avoid the use of fillers such as chalk (filled polyolefin - FPO) if this results in a density of over 0.995 g/cm³.
- In addition, the closure and the tube itself should preferably be made of the same material (e.g. HDPE). The more PP is used, the lower the quality of the recycled polyethylene.
- Printing over the entire surface is admissible if in conformity with the EuPIA Exclusion List.
- Aluminium proportions with a (metal) layer thickness > 5 µm should be avoided, as this may lead to an unintended removal of the packaging during sorting. Aluminium barrier tubes (ABL) with PE/Alu/PE structure are therefore detrimental for recycling.

[26] If the base packaging is transparent, this may cause discolouration
[27] The permitted mass percentage and design of an EVOH barrier varies depending on the type of packaging, and should not exceed a certain value. Specific information is provided by RecyClass at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.

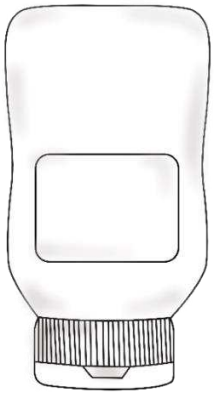
DESIGN EXAMPLES OF RECYCLABLE PE PACKAGING

- ✓ Tube made of 100 % LDPE, without a barrier
- ✓ White pigment colour
- ✓ HDPE closure
- ✓ Minimal printing with inks in conformity with EuPIA
- ✓ Batch number/DMD as laser marking

- ✓ Bag packaging made of 100 % LDPE with SiOx barrier
- ✓ Transparent or white pigment
- ✓ Sealed closure
- ✓ Minimal printing with inks in conformity with EuPIA
- ✓ Batch number/DMD as laser marking



- ✓ 100 % HDPE bottle
- ✓ Light/transparent or white colour
- ✓ HDPE closure without sealing foil
- ✓ PE label or PE sleeve
- ✓ Batch number/DMD as laser marking or on label
- ✓ Wide closure to allow bottle to be placed upside down (optimised emptying)



RECOMMENDATIONS FOR PACKAGING AIDS - AN OVERVIEW

The following list provides an overview on the recommended application of packaging components or their combinations, which are currently classified as non-disruptive in the plastics recycling process. In addition, there is information on knockout criteria for certain components. This list will be updated at regular intervals

CLOSURES

- As a general point, from the year 2024, closures will have to remain attached to beverage containers (up to three litres) made wholly or partially from plastic for the whole period in which the container is intended to be used. Therefore, closures should ideally be made from the same material as the base packaging so that these can be recycled together. If the closure is made from a different material to the base packaging, separating it during the recycling process should be possible (for example by rough shredding, etc.).
- In general: Avoid the use of closures containing metal on plastic packaging since they may lead to the base packaging being removed instead of retained during sorting.
- In general: Sealing films (including aluminium lids) should be removable by the consumer without leaving any residues.
- In general: Separable small parts such as removable pull tape should be avoided due to the high potential for littering.
- In the case of PE or PP packaging: Use closures of the same material whenever possible
- Closures in the case of PET packaging: Materials with a density < 1 g/cm³

SLEEVES (ADHESIVE-FREE DECORATION)

- In general: Sleeves should be made of the same material as the base packaging (exception PET). In addition, sleeves should generally be printed as little as possible and / or cover a small area of the packaging.
- In general: Sleeves can also consist of a different material than the packaging material, if separation is possible through different densities. However, these sleeves should not be cover by more than 50% of the packaging surface in order to avoid sorting errors.
- Sleeves in the case of PET packaging: Materials with a density of < 1 g/cm³
- In general: Avoid decorations which contain metal since these parts may lead to the base packaging being removed instead of retained during sorting.

If fully printed sleeves cover more than 50 % of the packaging surface and/or consist of a different material to the base packaging, they may affect the sortability. Sleeves that can be removed by the consumer are a special case. As an example, there are recommendations from the EPBP to use double-

perforated sleeves which provide end consumers with an indication on how to remove them. However, this rule only applies to personal care and cleaning products until 2022. From today's view, it is not clear whether the national authorities agree with this view.

LABELS

- In general: If a label is not made from the same material as the base packaging, it should not cover more than 50 % of the packaging surface[28].
- In general: Labels should be made from the same type of material as the base packaging (exception: PET). If this is not the case, adhesives must be designed so that the labels can be separated in the respective recycling process[29].
- In general: In-mould labels should always be of the same material as the packaging.
- Plastic labels in the case of PET packaging: Materials with a density of < 1 g/cm³
- Paper labels on plastic packaging should be wet-strength
- In general: Avoid decorations containing metal since these parts may lead to the base packaging being removed instead of retained during sorting.

Labels can be used in different designs and combinations. This results in different requirements for recycling. In addition, specific recommendations apply depending on the type of base packaging.

In-Mould Labelling

Ideally, injection-moulded or deep-drawn in-mould labels should be of the same material as the base packaging. Printing should be kept to a minimum since the firmly attached in-mould label is recycled together with the base packaging and excessive printing can lead to the recyclate quality being reduced. Carbon black-based dyes should be avoided since there is a risk of them absorbing near infrared radiation and the packaging ending up in the reject (waste).

Additional labels

Recommendations for self-adhesive labels (pressure sensitive labels), hot melt labels and general recommendations for using adhesive applications that are suited to recycling are currently being developed[26].

[28] If the decoration covers more than 50% of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable
[29] Specific adhesive requirements and recommendations are currently being developed in the „Focus Group Recycling-Ready Adhesives"

OTHER COMPONENTS AND PACKAGING AIDS (INSERTS, PADS, TAGS, ETC.)

In general, for other components, ensure that either the material of the base packaging is matched (for example, PE insert in PE tray) or is easy to be mechanically separated by the user or during the sorting process.

Attached components made from other materials, and in particular metals and non-plastics which cannot be easily and mechanically removed, may disturb recovery of the packaging (for example attached RFID tags).

RARE AND COMPOSTABLE PLASTICS

UNCOMMON PLASTICS

As a rule, recycling can only be efficient if the material to be recycled is available in large quantities and as homogeneous as possible. Over time, recycling infrastructure in Austria, Germany and the Netherlands has been adapted to the most frequently used materials. In the case of materials that are seldomly used on the market, no appropriate recovery stream may be available, even though the material may have an excellent recycling potential. Recyclable packaging design should thus be oriented towards the use of a small number of widely used materials. Materials that fall into the category of rare materials are for example polycarbonate (PC) and polyvinylchloride (PVC) and should therefore be avoided.

COMPOSTABLE PLASTICS

Bio-based plastics (e.g. bio-PE, bio-PP or bio-PET) can be treated in the same way as the materials listed in this Guideline, provided that they have the same technological properties. Compostable plastics (in accordance with DIN EN 13432) do, however, present a challenge in recycling. The goal of compostability runs counter the goal of recycling because material of good compostability has often already suffered a quality loss when it enters the recovery stream. If compostable plastics are disposed of through the Austrian separate collection system for organic waste, they are, at present, not distinguished from non-compostable plastics and are therefore eliminated in the sorting process and used as fuel for energy recovery. In the case of products that are excluded from material recycling, due to a risk of massive contamination or for other reasons, the use of bio-degradable materials could nevertheless be recommendable (e.g. coffee capsules, fresh meat packaging) in future. However, evidence of functioning industrial composting must be provided and finally also communicated to the end consumers.

It is specially advised not to use oxo-degradable plastics (conventional plastics with additives, which lead to disintegration in the environment). Apart from affecting the quality of the recycled material, the incomplete decomposition of oxo-degradable plastics leads to the formation of microplastics. Oxo-degradable plastics will in any case be banned under the Single Use Plastics Directive (2019/904, Article 5) from 3 July 2021.

MULTILAYER MATERIALS WITH PLASTIC CONTENT

Composites or multilayer materials, i.e. materials with two or more different constituents, can combine the best properties of each constituent. They are frequently used for packaging films with a high barrier function that prolong the shelf life of food. Composites can enable good product protection while reducing the weight of the packaging, but can impede, or even prevent, recycling. Recyclable plastic composites are listed in the respective (material-specific) table.

BEVERAGE CARTON

Beverage cartons (BCs) usually consist of paperboard with LDPE layers on one or both sides, and possibly an aluminium interim layer (for products with a longer shelf life). In Austria, Germany and the Netherlands, beverage cartons are collected together with plastic packaging waste. The sorting takes place by means of NIR (near-infrared) sensors, which recognize the specific packaging material composition of the beverage cartons. For this reason, sorting problems can occur if the outer layers are not made of LDPE and cardboard as usual[30]. The typical standard structure or specific packaging material composition of beverage cartons is as follows:

BCs for fresh products	Aseptic BC for longer-lasting products
• PE inner layer • PE adhesion layer • Cardboard • Printing • PE outer layer	• PE inner layer • PE adhesion layer • Aluminium film • PE adhesion layer • Cardboard • Printing • PE outer layer
The percentage by mass of the component is around 80 % paperboard and 20 % PE.	The percentage by mass of the component is around 75 % paperboard, 20 % PE and 5 % aluminium.

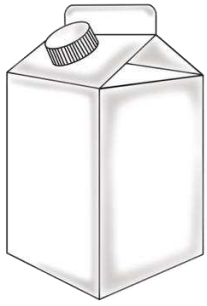
The processing takes place in special pulpers. In there, the fibre content of the shredded packaging material is separated from the plastic and aluminium components and can be used again for the production of new paper-based products. LDPE and aluminium fractions will usually be incinerated. However, the pulping process does not allow for the complete recovery of the fibres, as a small amount remains attached to the plastic coating and ends up in the reject. However, there are current developments that aim to increase the recycling of BCs and, in particular, of the polyethylene and aluminum components. Nevertheless, if you look at the current situation, it applies that the lower the non-fibre content of a beverage carton, the higher the efficiency of the recycling process. This is why it is important to keep the proportion of fillers and binders in the fibre part as low as possible. Although these do not negatively influence the pulping process, the fibre content is still reduced accordingly, making the whole fibre yield lower.

[30] The sorting process may vary depending on the facilities.

RECOMMENDATIONS FOR RECYCLABLE BEVERAGE CARTONS

Components		Recyclability of Beverage Cartons Good	Limited	Poor
Base packaging	Origin of fibres	Fibres derived from wood	Non-woody plants such as hemp, grass, cotton etc.	
	Additives	Mineral fillers such as kaolin, talk and calcium carbonate in the paper part; Titanium dioxide (white pigment) Starch (filler)		Wets-strength fibre content
	Coatings & seam sealing	One-sided plastic coating or plastic laminate made of PE Two-sided plastic coating or plastic laminate made of PE		Metallised surfaces or coatings which impair NIR detection
	Printing	EuPIA-compliant colours		Colours containing mineral oil
Packaging aids – closures		HDPE, PP, easy to separate from other packaging components in the pulper		
Designs		In accordance with specific packaging material composition (standard structure)		Designs which deviate from the standard structure

- ✓ Design in accordance with the standard BC structure
- ✓ HDPE or PP closure
- ✓ Printing with inks in conformity with EuPIA



PACKAGING FROM PAPER / BOARD / CARTON

CURRENT COLLECTION AND RECOVERY STRUCTURES

Paper packaging in Austria, Germany and the Netherlands is collected nationwide and consistently with other paper products (newspapers, magazines, etc.). Around three quarters of the paper used in Austria is currently being recycled. If packaging papers are collected in the household collection together with graphic papers, a waste paper sorting must be carried out. Only by sorting the waste paper types can be provided in such condition (according to EN643), that they then can be processed by the paper industry. Paper mills usually reprocess waste packaging paper into new packaging material, such as corrugated board or grey cardboard.

The recommendations summarised in the following table refer to the recyclability of paper packaging in a standard equipped paper mill, and are partly based on the *Paper and Board Packaging Recyclability Guidelines* (Confederation of Paper Industries - CPI).

The recycling of beverage cartons and silicone papers requires a special technology (for information on recycling beverage cartons, see the chapter *beverage carton*).

RECOMMENDATIONS FOR RECYCLABLE PAPER / BOARD / CARTON PACKAGING

Recyclability for Packaging made of Paper / Board / Carton				
Components		Good	Limited	Poor
Base packaging	Origin of fibres	Fibres derived from wood	Non-woody plants such as hemp, grass, cotton etc.	
	Coatings	Without coating; One-sided plastic coating or plastic laminate if fibre content is> 95%	One-sided plastic coating or plastic laminate if fibre content is 85 to 95% Metallised paper if metallisation is less than 60% of the surface	Plastic coating on both sides One-sided plastic coating or plastic laminate if fibre content is < 85% Wax coating Silicone paper
	Adhesive applications[31]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[31] Specific adhesive requirements and recommendations are currently being developed in the „Focus Group Recycling-Ready Adhesives“

Recyclability for Packaging made of Paper / Board / Carton				
Components		Good	Limited	Poor
Base packaging	Additives	Mineral fillers such as kaolin, talc and calcium carbonate Titanium dioxide (white pigment) Starch (filler)		Wets-strength fibre content[32]
	Printing	EuPIA-compliant colours[33]		Colours containing mineral oil
Designs		Minimal printing no combination with non-fibre-based materials Paper adhesive tape	Staples Plastic adhesive tape Integrated windows and other plastic components which can be easily separated from paper	Integrated windows and other plastic components which cannot be easily separated from paper

In principle, paper is very suitable for being recycled, but several factors impair its recyclability

Stickies

Recommendations are currently being developed[29].

Additives

Some specialty paper packaging contains moisture-proofing additives that can also cause issues in the recycling process. Such "wet strength agents" prevent the fibres from being released during recycling.

Coatings

Coatings or use of paper in multilayer composites, can impair recyclability. Although the fibres in composite packaging can be separated and recovered in the pulping process, the recycling efficiency is reduced. The plastic (mainly PE) and other contaminants end up in the reject (waste), for which the disposal is associated with additional expense. In addition, there is a risk that plastic residues stick to the fibres, which decimates the fibre yield. Plastic content should be kept as low as possible to guarantee efficient paper recycling. Where possible, integrated windows and other plastic components should be easily removable by the consumer.

[32] Possible exceptions must be tested in each individual case.
[33] There may be limitations when using UV-hardened printing inks since there is a risk of the quality of the secondary material being reduced (this primarily applies to the recycling process of the graphic paper industry).

Silicone papers (e.g. label carrier paper) cause problems in paper recycling because the silicone cannot be removed and significantly reduces the quality of the recycled paper. There are only a few, specialized paper factories that can effectively separate silicone from fibres and recycle such papers.

Printing inks

The use of toxic inks negatively affects recyclability, because disposing of them is complex or because their presence causes quality problems in recycled paper. Colours, to which the exclusion criteria of the European Printing Ink Association (EuPIA) apply, should be avoided. EuPIA-compliant UV-hardened printing inks and lacquer finishes can also lead to reductions in quality for paper recycling (for example, inclusion of coloured dots) since they are difficult to remove in the conventional de-inking process. This is particularly relevant for the recycling of graphic paper but should also be taken into account for packaging.

The use of mineral oil-containing inks is problematic as these substances can migrate into the packaged product and are potentially harmful for the health. In the recycling process, mineral oil residues cannot be completely removed, which is why there are restrictions on the use of recycled paper-based packaging for food.

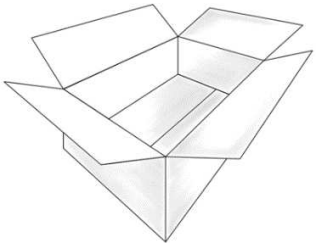
Special fibres

It is not completely clear how paper from non-woody (for example, grass, hemp, cotton, etc.) fibres affects the paper recycling process. However, a small portion of other fibres in the waste paper stream is considered unproblematic. Potential applications in this area still need to be investigated further.

DESIGN EXAMPLE FOR RECYCLABLE PAPER/PAPERBOARD PACKAGING

- ✓ Undyed paper/cardboard
- ✓ One-sided plastic coating < 5 % by weight of the total mass
- ✓ Printing with inks that are in conformity with the EuPIA guideline

- ✓ Undyed corrugated board
- ✓ Minimal printing with EuPIA-compliant inks
- ✓ Inlays also made of paperboard



GLASS PACKAGING

CURRENT COLLECTION AND RECOVERY STRUCTURES

Glass can be recycled almost infinitely while retaining its material specific properties. Everywhere in Austria, Germany and the Netherlands, glass packaging is collected in a uniform system, with separate bins for white glass and coloured glass. Glass manufacturing is highly energy-intensive, and with secondary material, the use of energy can be reduced by 2–3% for every 10% of cullet that is added. To produce green glass, almost any colour of glass can be used: therefore, the proportion of recycled glass is highest in green glass.

Labels with permanent adhesives, bottles with full sleeves as well as heavily lacquered bottles, can cause detection errors so that the glass is eliminated from the recycling process. Affixed labels can also impair the breaking process and lead to lower cullet yields. Ferromagnetic metals and aluminium can be eliminated in the sorting process.

RECOMMENDATIONS FOR RECYCLABLE GLASS PACKAGING

Components		Recyclability for Packaging made of Glass Good	Limited	Poor
Base packaging	Material and additives	Three-component packaging glass (silica, soda, lime); The heavy metal concentration meets Commission Decision 2001/171/EC		Glass not suitable for packaging, e.g. heat resistant glass such as borosilicate glass Lead glass; Cryolite glass; Enamel constituents
	Colour	Green, brown, white/transparent and similar hues	Opaque colours and metallic colours	Black, dark blue
	Printing/direct printing by filler	Direct printing EuPIA-compliant coatings and printing inks	Glass container is colour-coated over the whole area	
Packaging aids - closures		Ferromagnetic metals (alloys) Plastic Aluminium		Ceramic Flip-top caps with a ceramic/porcelain component

Components	Recyclability for Packaging made of Glass Good	Limited	Poor
Packaging aid – decoration	Engraving Paper labels (wet-strength)	Permanently attached plastic labels	Permanently attached and large-scale plastic labels/full-surface sleeves

DESIGN EXAMPLE OF RECYCLABLE GLASS PACKAGING

- ✓ Bottle made of three-component packaging glass
- ✓ Transparent, green or brown colour
- ✓ Aluminium screw-caps
- ✓ Wet-strength paper label with washable adhesive application

TIN PLATE PACKAGING

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for tin plate packaging in Austria, Germany and the Netherlands. After collection, the packaging is transported to sorting facilities or shredding plants where it is manually eliminated or segregated from other metal packaging by means of magnetic separators.

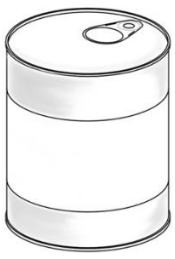
Tin plate cans thus have almost unlimited recyclability, without a loss of quality. Aerosol cans (spray dispensers with propellant) with residues of highly flammable liquid can lead to accidents in recycling plants. This packaging must therefore be free from residue or propellant or be removed from the recycling system by separate collection or sorting.

RECOMMENDATIONS FOR RECYCLABLE TIN PLATE PACKAGING

Recyclability for Packaging made of Tin Plate				
Components		Good	Limited	Poor
Base packaging	Material and additives	Ferromagnetic metals (alloys)		
	Printing/direct printing by filler	Lacquers EuPIA-compliant coatings and printing inks		Non-compliant colours
Designs			Aerosol cans with non-hydrocarbon-based propellants	Aerosol cans with hydrocarbon-based propellants Spray cans with residual content
Packaging aids - closures		Ferromagnetic metals (alloys)	Plastics	
Packaging aid – decoration		Paper banderoles Engraving		PVC label

DESIGN EXAMPLE OF RECYCLABLE TINPLATE PACKAGING

- ✓ Ferromagnetic metal can
- ✓ Protective coat on inside
- ✓ Paper wraps



ALUMINIUM PACKAGING

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for aluminium packaging in Austria, Germany and the Netherlands. After collection, the packaging is transported to sorting facilities or shredding plants where it is manually sorted out or segregated from other metal packaging by means of eddy-current separators. Aluminium packaging thus has good recyclability.

RECOMMENDATIONS FOR RECYCLABLE ALUMINIUM PACKAGING

Recyclability for Packaging made of Aluminium				
Components		Good	Limited	Poor
Base packaging	Material and additives	Non-ferrous metal constituents		Multilayer material[34]
	Printing/direct printing by filler	Lacquers Aluminium with direct printing EuPIA-compliant coatings and printing inks		Non-compliant colours
Designs		Monomaterial packaging (all components are aluminium)	Aerosol cans with non-hydrocarbon-based propellants Widget nitrogen balls in beer cans Spray systems with pumping atomisers	Plastic components in blister packaging Aerosol cans with hydrocarbon-based propellants Spray cans with residual content
Packaging aids - closures		Aluminium screw-cap	Plastic closures and valve caps, provided that these can be separated before disposal or during the sorting process	
Packaging aid – decoration		Engraving		PVC labels

[34] Possible exceptions must be tested in each individual case.

EXAMPLES/ SPECIFIC APPLICATIONS RECOMMENDATIONS FOR PACKAGING TYPES

The following recommendations are specifically valid for certain packaging types and should be seen as an expansion of the recommendations mentioned in the above table.

ALUMINIUM CANS

- In most cases, aluminium cans are made of 3000-series alloy, whereas the opening tab usually consists of 5000-series aluminium alloy.
- Major contamination, as well as tinplate cans and plastics, should be removed before the melting process. The use of plastics with cans reduces the quality and thus the price.
- Aerosol aluminium cans are spray dispensers which contain a propellant. A hydrocarbon-based propellant or compressed gases such as carbon dioxide are used for this. In particular, hydrocarbon-based propellants can lead to dangerous explosions in the recycling process. Using alternative non-hydrocarbon based propellants is preferred.
- In general, aerosol aluminium cans should be easy to empty, since the residues of highly flammable liquids can also be problematic for recycling. The packaging should inform the user that the spray cans should be fully emptied before disposal and that no propellant should be left when the packaging is collected.
- Aerosol cans are compatible with the recycling process in principle, but are usually collected separately, due to the above mentioned safety problems, and used as fuel for energy recovery. Parts of the aluminium in the resulting slag can be recovered, but only with considerable losses.
- If the contents need to be finely atomised, a pump dispenser can be used as an alternative, in order to avoid an aerosol system.

ALUMIUM TUBES

- Aluminium tubes are usually made from 1000-series aluminium alloy. In general, the walls of the aluminium tube shall be designed to be as thin as possible to permit better flexibility and thus simple removal and emptying of the tube and to save material. This can also be reinforced by consumer information on the packaging indicating that it should be fully emptied. However, it is also important to consider the fact that the thin ends of tubes often do not melt but oxidise due to the quick oxidation process.
- Aluminium composite tubes (For example PE/Alu/PE) should be avoided since the aluminium component cannot be recovered.
  Plastic screw caps should be easy for consumers to separate and dispose of separately.

ALUMINIUM FILMS

- Aluminium packaging film is usually made from 1000-series or 8000 series aluminium alloy so in theory it can be recycled.
- Frequently, the film is very thin and thus not suitable for the melting process. As a rule, very thin or contaminated film thus are not recycled.[35] To prevent this, aluminium foil should be compressed

[35] possible exceptions can be tested in each individual case

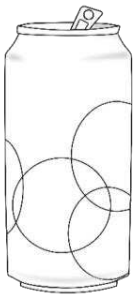
before disposal by the user and pressed together to guarantee that it can be selected and to avoid oxidation in the melting furnace.

ALUMINIUM CLOSURES

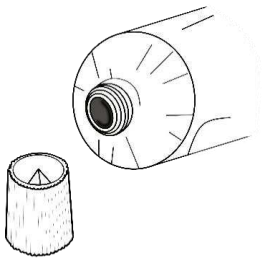
- Screw closures and caps made from pure aluminium have great potential for high-quality recycling, provided that these can be properly separated and sorted in the respective recycling process.

DESIGN EXAMPLES FOR RECYCLABLE ALUMINIUM PACKAGING

- ✓ Aluminium can with direct printing
- ✓ Stay-on opening tab
- ✓ No plastic constituents



- ✓ Aluminium tube with direct printing
- ✓ Closure seal made in one casting (for piercing with spike in closure cap)
- ✓ No removable sealing foil



FH Campus Wien
University of Applied Sciences

COUNTRY-SPECIFIC COLLECTION STRUCTURES

Internationalisation of design recommendations

A waste treatment structure (collection and recycling) for packaging waste which is as harmonised as possible is the foundation for a cross-country circular economy. The considerations in the packaging design process should therefore take the waste treatment structures available at international level into account. Conversely, the waste treatment structure of the individual country should be matched to the materials and products on the market. Uniform packaging design and well-established waste treatment structures permit long-term continuous increases in recycling rates and the quality of secondary raw materials obtained.

In some cases, there are currently very big differences in collection and recycling structures in individual countries. Systems also vary greatly within Europe. This is why there are also different design recommendations for recyclable packaging design. Therefore, the aim is to have a structure which is as harmonised as possible, in order to establish uniform design recommendations. Packaging producers currently face the tough challenge of meeting the various criteria for a global market.

The FH Campus Wien is working on determining the differences in nationally specific design criteria, from which future harmonisation efforts can be derived.

Collection structures in Austria, the Netherlands and Germany

The recommendations of the Circular Packaging Design Guideline can generally be applied to Austria, Germany and the Netherlands, since they have similar waste treatment systems in place. However, despite the similar structures there are also deviations in these countries due to technical and structural conditions.

Materials, which are recyclable but have low market value or are collected in small amounts, are often not sorted for economic reasons and not prepared for recycling. The collection and sorting in a separate material stream is therefore the basis for subsequent recycling processes. Technical possibilities are also not fully exploited for economic reasons. The recovery of thermoformed PET trays in Austria, for example, is currently subject to structural limitations, preventing high-quality closed-loop applications. However, in the Netherlands, they are already fed into high-quality recycling processes, which is a discrepancy that could lead to misunderstandings in terms of recyclability.

The table below represents the existing differences in the recovery structure of Austria, Germany and the Netherlands.

Overview of country-specific collection structures in Austria, Germany and the Netherlands

Packaging waste stream		Austria	Germany	The Netherlands
Beverage carton		Collection structure available	Collection structure available	Collection structure available
Paper		Collection structure available (also applies to paper coated on one side)	Collection structure available (also applies to paper coated on one side)	Collection structure available (also applies to paper coated on one side)
Aluminium		Collection structure available	Collection structure available	Collection structure available
Tin plate		Collection structure available	Collection structure available	Collection structure available
Glass		Collection structure available	Collection structure available	Collection structure available
PS	rigid	Collection structure available	Collection structure available	No separate collection structure available
	flexible	No separate collection structure available	No separate collection structure available	No separate collection structure available
PVC	rigid	No separate collection structure available	No separate collection structure available	No separate collection structure available
	flexible	No separate collection structure available	No separate collection structure available	No separate collection structure available
PE	rigid	Collection structure available	Collection structure available	Collection structure available
	flexible	Collection structure available	Collection structure available	Collection structure available
PP	rigid	Collection structure available	Collection structure available	Collection structure available
	flexible	Collection structure available	Collection structure available	Collection structure available
PET	Blow-moulded	Collection structure available	Collection structure available	Collection structure available
	Thermoformed	Limited recycling options	No separate collection structure available	Recycling is possible
	flexible	No separate collection structure available	No separate collection structure available	No separate collection structure available

APPENDIX

OUR SERVICES

The *Circular Packaging Design Guideline* was drawn up in the Section of *Packaging and Resource Management* at the *Department of Applied Life Sciences* of FH Campus Wien, and developed by the team at the Competence Centre for *Sustainable and Future-Oriented Packaging Solutions.*

The research of this team of experts focuses on the development of sustainable packaging, circular design, and the development of methods for assessing the sustainability and safety of packaging.

In order to enable packaging design that is recyclable, and as resource-efficient and environmentally friendly as possible while protecting the product, analyses are carried out on the basis of all-encompassing approaches.

The *Packaging Cockpit* project will work on providing a software-supported assessment of packaging in the future, which will also take international design criteria into account.

If you are interested in a comprehensive assessment of your packaging, please do not hesitate to contact our experts:

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CONSULTANCY AND SERVICE

You can obtain advice and support with specific questions, projects and product developments from various platforms. The following institutions have cooperated for this guideline:

Circular Analytics TK GmbH: Strategies for a Transition to Circular Economy

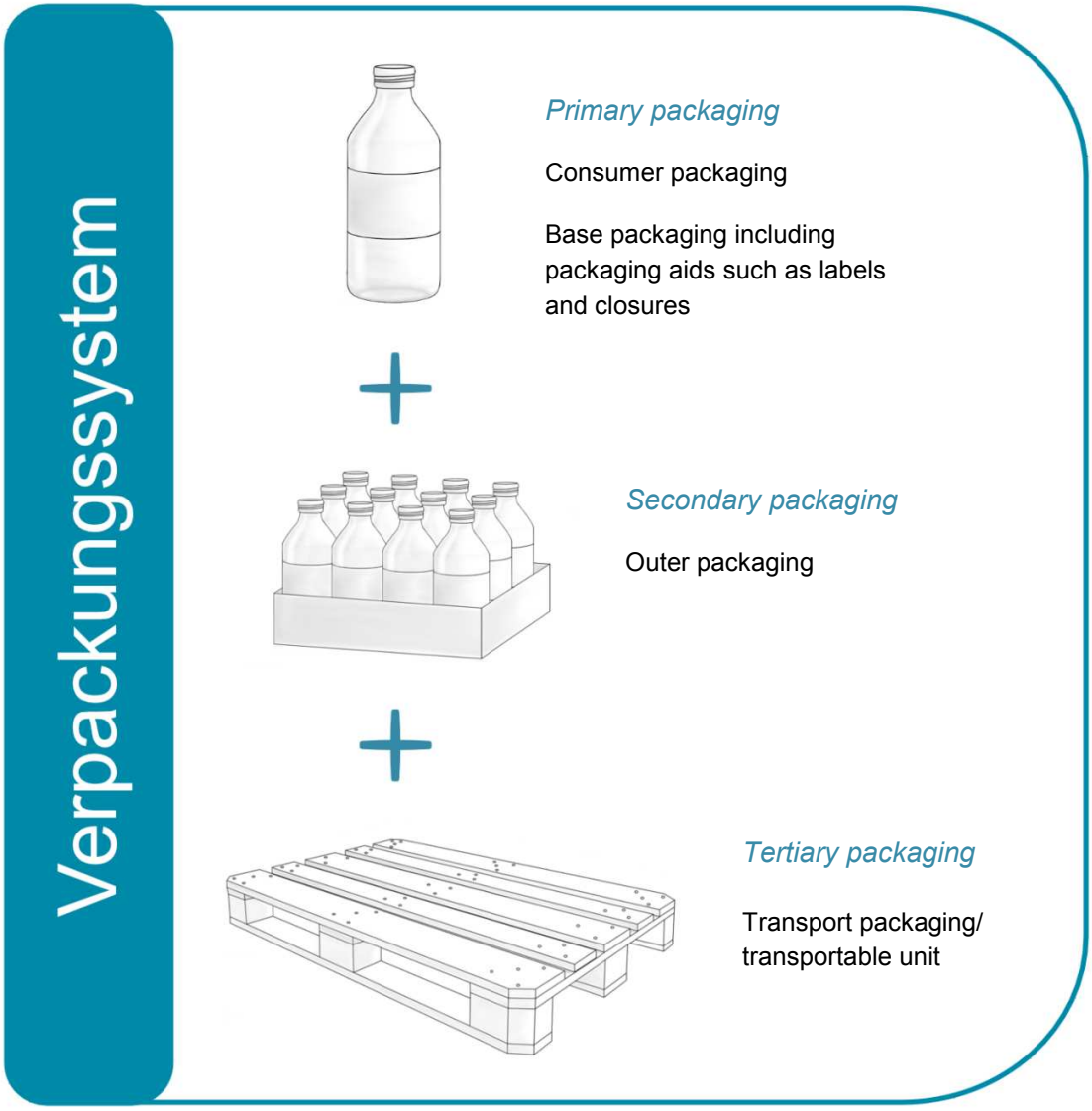
Packforce Austria:
communication and information platform for the Austrian packaging industry

GLOSSARY

Direct printing	Printing that is applied directly to the primary packaging in the course of the packing or filling process; in most cases, the batch number and the date of minimum durability are applied in this way (do not confuse with direct printing processes such as offset print, flexography, screen printing or digital printing).
Use of recycled material	Pre-consumer material: Material that has been separated from the collection stream in the manufacturing procedure. This does not include re-use of materials from re-working, regrinding or scrap produced in the course of a technical procedure and re-used in the same process (also known as PIR, post-industrial recycled content). Post-consumer material: Material from households, commercial and industrial facilities or institutes (which are the end users of the product) which can no longer be used for the intended purpose. This includes returned material from the supply chain (also known as PCR, post-consumer recycled or PCW, post-consumer waste). Definition in accordance with DIN EN ISO 14021
Flexible packaging	Packaging which significantly changes shape during its intended use, under a low load. For example pouches and bags. Definition in accordance with ÖNORM A 5405: 2009 06 15
Hollow body	Packaging with has a nominal fill volume of up to and including 5 litres, in accordance with the size criteria of Section 13 h Para. 1 Point 1 of the Austrian Waste Management Act (AWG) 2013 is designated as a hollow body for household packaging. This applies to bottles, canisters, tubs, tins, cups etc. (but not to pouches, bags, etc.)
In-mould label	A label that already carries print is placed inside the mould immediately before injection moulding, thermoforming or blow-moulding, without adding adhesion promoters. The label thus becomes an integral part of the finished product.
Littering	Littering is when small amounts of municipal waste are thrown away or left without using the existing disposal sites. Definition in accordance with the Swiss Federal Office for the Environment (BAFU)
Monomaterial/Monomaterial packaging	The components of the packaging are mainly made from one packaging material or at least from the main material of a packaging material group. One example is blister packaging, in which the thermoformed lower part and the cover film consist of polypropylene.

NIAS	Food-contact materials and food-contact products can include non-intentionally added substances (NIAS) which may migrate into the food. These are not substances which are inserted for technical reasons, but by-products, breakdown products and contamination. They can be chemical syntheses of raw materials, or also be produced during the transport or recycling of packaging.
Full emptiability	Suitability of a packaging with regard to complete removal of the filled product by the final consumer in the intended way.
Rigid packaging	Packaging which does not change shape and design under load when used as intended. For example glass bottles. Definition in accordance with ÖNORM A 5405: 2009 06 15
Material recycling	Material recycling looks to exploit material properties when recovering waste or for previously used products, and to manufacture using these secondary raw materials. This covers material (mechanical) and raw material (chemical) recycling.
Multilayer/multilayer composite/composite material	A combination of several packaging materials that cannot be separated manually with none of the materials accounting for more than 95% of the packaging mass. (Definition in accordance with the German Packaging Act)
Packaging components/packaging aids	Part of packaging that can be separated by hand or by using physical means. This includes, for instance, closures and labels. Definition in accordance with ÖNORM EN 13427:2000 12 01
Packaging system	The packaging system comprises the primary packaging (which envelops the product itself), secondary packaging (for grouping primary packaging) and tertiary packaging (transport unit).

Graphic visualisation of the packaging definitions



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