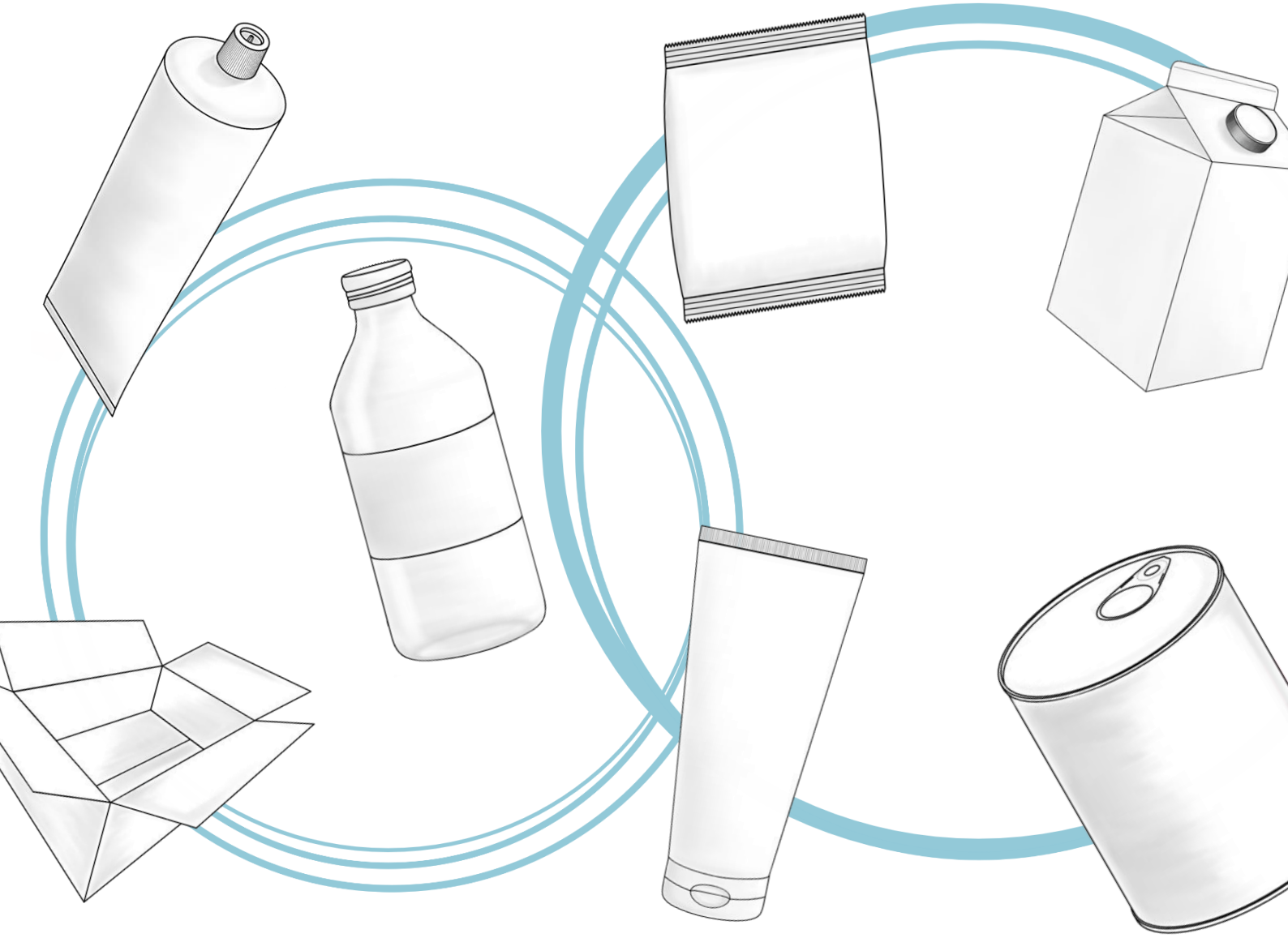
FH CAMPUS WIEN
UNIVERSITY OF APPLIED SCIENCES

CIRCULAR PACKAGING DESIGN GUIDELINE

DESIGN RECOMMENDATIONS FOR RECYCLABLE PACKAGING

Version 04, October 2021

APPLIED LIFE SCIENCES



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“Cooperation, innovation and knowledge exchange!

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)

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REVISIONS

As part of the ongoing update measures, the Circular Packaging Design Guideline Version 03 was revised in the areas mentioned and supplemented with the following essential content:

- Update of legal and structural framework conditions
- Division of recommendations for plastic packaging according to colour and type of packaging (hollow bodies/foils)
- Extension of the recommendations for plastic packaging: Polystyrene
- Extension of the design recommendations for plastic packaging: Size and packaging aids, other components
- Recommendations on recycling-ready adhesive applications and adhesive-related topics will be revised in a separate working group (Recycling-Ready Adhesives) for the time being.
- Expansion of sources
- Extension of the glossary

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)*
CEPI	*Confederation of European paper industries*
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 (except for PET-G film, inner 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*
SiO_x	*Silicon oxide*
TiO_2	*titanium dioxide*
TPE	*thermoplastic elastomer*

ACKNOWLEDGEMENT

In order to be able to make recommendations, the Guideline is continuously updated and adapted to changes in collection, sorting and recycling technology, as well as material development with the help of partners from the entire value chain. The cooperation with partners from the industry enables practical and applicable recommendations. We would, therefore, like to thank all the experts for their practical suggestions and proposals.

Special thanks also goes to the entire team of the Department of Packaging and Resource Management (Department Applied Life Sciences) at the FH Campus Wien for their contribution to the development of the guideline.

OVERVIEW AND SCOPE OF APPLICATION

Packaging fulfils many essential roles. from protection, storage and transport functions to aspects such as easier 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. 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 the European Union, in the context of the Circular Economy Package, advocates greater resource efficiency and reuse of products, as well as 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 possible uses of recyclates depend primarily on the technical requirements of the applications. For reuse in the food sector, the EFSA requirements according to EU Regulation No. 282/2008 must be met. 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 recommendations mainly refer to household packaging. For commercial packaging (volume > 5 L), they can also be applied to check minimum requirements. However, it should be noted that different, further sorting steps can be used for commercial packaging, so that the recyclability must be checked in each individual case by means of sorting tests.

This Guideline will be updated continuously and amended in response to changes in collection, sorting and recycling technologies, as well as future material developments. The present text should not be seen as an obstacle to innovations (e.g. bio-based materials, novel barriers, etc.). Novel technologies can lead to an improvement in ecological performance and must be analysed separately in each case.

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)
- Orientierungshilfe zur Bemessung der Recyclingfähigkeit von systembeteiligungspflichtigen Verpackungen (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)
- Recyclingfähigkeit von Verpackungen – Konkretisierung Untersuchungsrahmen und Kriterienkatalog (bifa Umweltinstitut) [Recyclability of packaging – definitions, investigation framework and list of criteria, bifa Environmental Institute]
- Paper and Board Packaging Recyclability Guidelines (Confederation of Paper Industries, CPI)
- Richtlinien für recyclingorientiertes Produktdesign (Design for Recycling Product Design 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)
- Design for Recycling – Kunststoffverpackungen recyclinggerecht gestalten (Der Grüne Punkt) [Design for Recycling for plastic packaging, 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 and the contents were matched according to the meaning of the European framework conditions. The 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 recyclable packaging material. Nonetheless, it is always necessary to consider the specific conditions in different countries. A comparison of country-specific registration systems 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 [EPBP]), for packaging made of polyolefins from RecyClass, and plastic packaging in general (American Association of Plastic Recyclers). There are also various software tools available for assessing recyclability, which are used as an aid for designing recyclable packaging.

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 packaging conception. Packaging must meet manifold requirements and cover a variety of functions, and combine maximum functionality and protection of goods on the one hand with 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, it can be empirically established that packaging has an influence on product loss.

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 recovery 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.

Health and 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.

Cyclic

Cyclic packaging is designed to maximise the re-use and/or recovery of materials used. This is aimed at longevity of the life cycle, full substitution for virgin materials of the same type (closed-loop recycling) or 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, to a high degree, of the raw materials to be employed as secondary raw materials, the reuse of the packaging, 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 by means of recycling.

'Design from recycling' refers to the second sub-aspect of the circular approach. Here, the focus is on use of recycling 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.

"This 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 loops. 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 Directive on landfill of waste (1999/31/EC), as well as the superordinate Waste Framework Directive (2008/98/EC). The Package also includes a specific paper on plastics A 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.
The following recycling rates should be achieved by 2030: 55 % for plastics, 80 % for ferrous metals, 60 % for aluminium, 75 % for glass and 85 % for paper and cardboard. These are shown in Table 1 (page 12) for an improved overview. 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 Directive sometimes aims to restrict the marketing of individual plastic products and has, for example, banned the use of drinking straws or cotton buds since 3 July 2021, as these are normally disposed of after a single use and are not reused or recycled. 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) – table 1. 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 applied to composite beverage packaging). This is intended to counteract the high littering potential that such closures have. 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 (see below). EPS take-out food packaging will be banned in full.

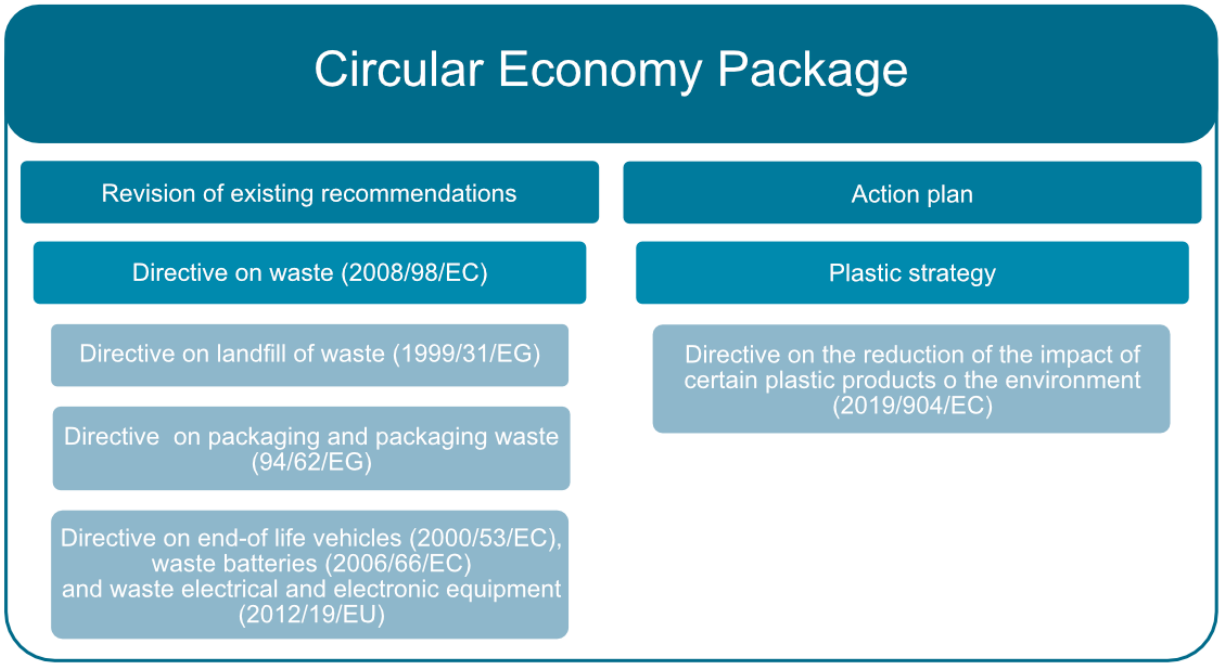
OVERVIEW OF THE RECYCLING TARGETS

		2025	2030
Recycling rates until 2030[1]	Plastic	50 %	55 %
	Ferrous metal	70 %	80 %
	Aluminium	50 %	60 %
	Glass	70 %	75 %
	Paper, cardboard and corrugated board	75 %	85 %
	Wood	25 %	30 %
Separate collection of beverage bottles up to 3L[2]		77 %	90 %
Minimum recycled content – PET bottles[2]		25 %	30 %

[1] Directive (EU) 2018/852 amending Directive 94/62/EC on packaging and packaging waste
[2] Directive (EU) 2019/904 on reducing the impact of certain plastic products on the environment

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 procedure (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 for which the losses from pre-processing steps have been taken into account (for example, for plastic any material which is directly inserted into the extruder for re-melting is counted). 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 August 2020). The Package aims to reduce waste and improve preparation for reuse and recycling.

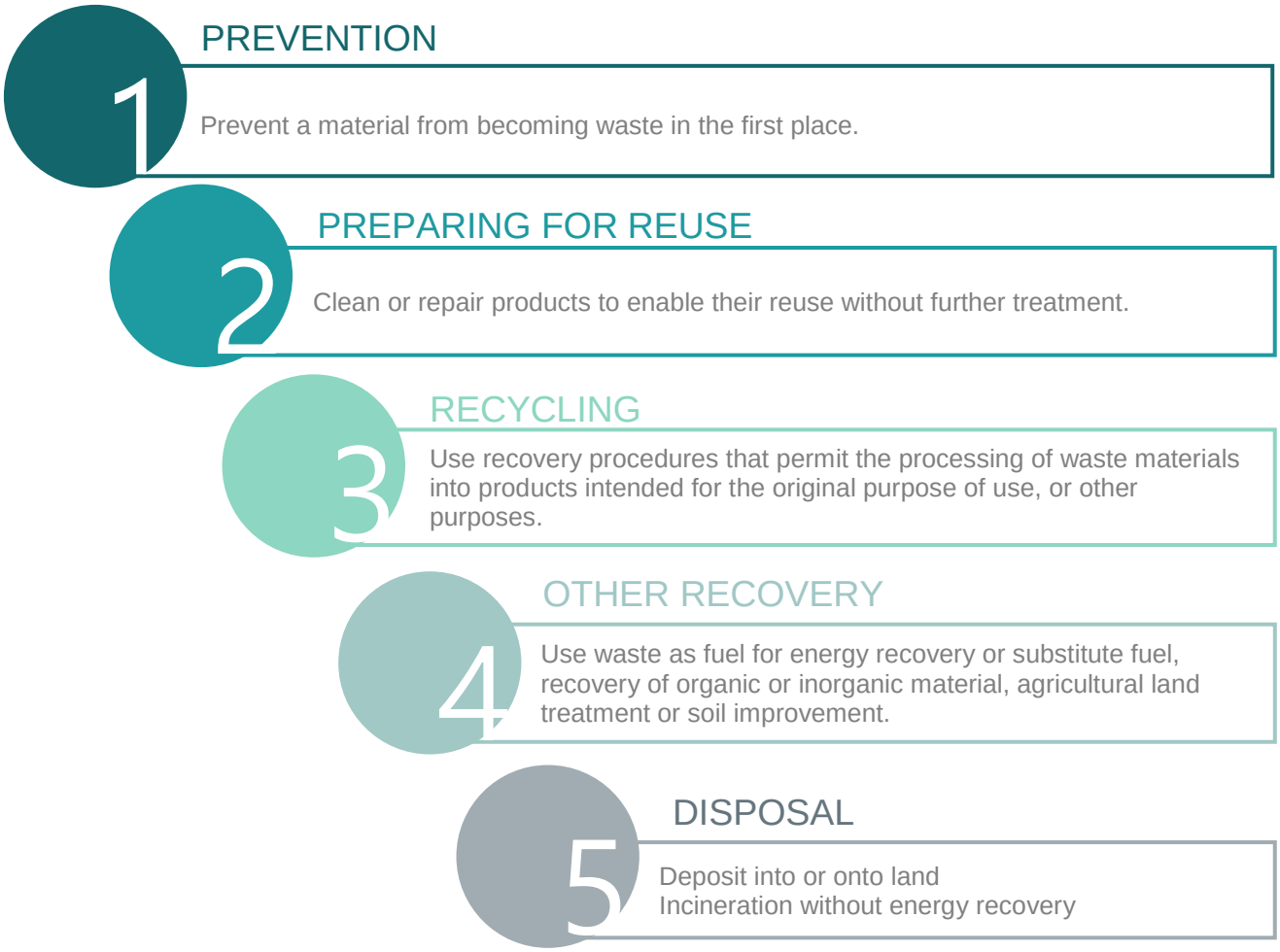


The EU Decision 2020/2053 on the European Union's own resources system, which is addressed to all EU Member States, introduced the so-called "plastic tax" from 2021. The respective Member States must pay an amount of €0.80 per kilogram of non-recycled plastic packaging waste.
The national implementation of this plastic tax is the responsibility of the EU member states and is currently still being discussed in Austria and Germany.

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, those 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 for 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. Comprehensive research is being pursued in the area of chemical recycling (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 nonrecyclable 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.	Mass fraction
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 with regard to sortability and technical recyclability:

Sortability

Sortability is considered a basic prerequisite for recyclability. It must be ensured that material-specific, state-of-the-art sorting techniques 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).

Technical 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 material streams using state of the art technology,
- as well as state-of-the-art processing technologies for the (material) recycling process
- Market potential of the resulting secondary raw materials and their full substitution for virgin material of the same type.

(Definition from the Plastics Recyclers Europe & Association of Plastic Recyclers, 2018)

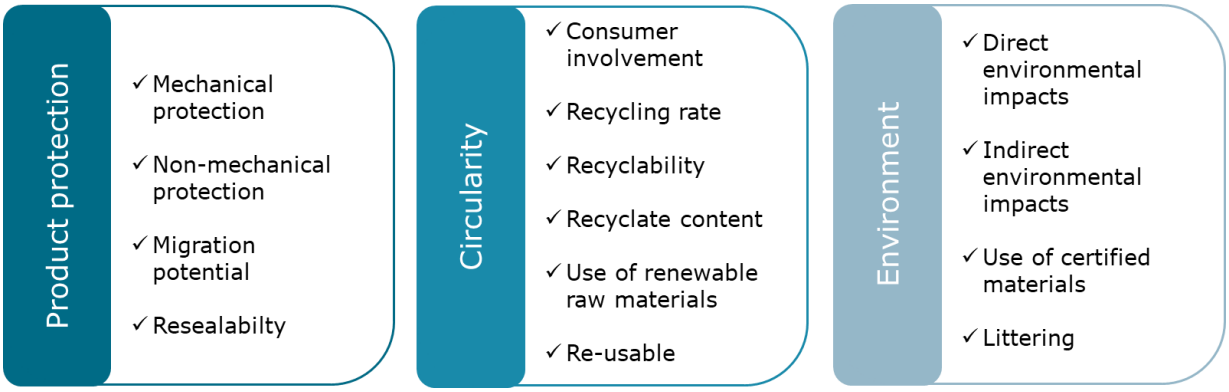
Technical recyclability is to be distinguished from the actual recycling rate (see chapter *Regulatory background*, paragraph Recycling rate).

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 v. 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 and thus negative environmental impacts.

FH Campus Wien research has led to production of model for holistic, i.e. all-encompassing sustainability assessment of packaging, based on the legal framework conditions and four basic design principles (see the *All-encompassing approach* section). This 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

The most important task of packaging is to ensure sufficient product protection. 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). In addition, the migration risk of packaging components should be kept to a minimum. In addition, the possibility of resealing the packaging should also be considered, as this can achieve additional or improved product protection.

Circularity (recyclability)

Circular packaging design aims at a long lifetime, a material-identical recycling (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 (notes on disposal and suitability for separation) should also be considered.

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 the PEF, for example, global warming potential) and indirect environmental impacts. The latter includes product losses which are caused by premature spoilage or insufficient emptying capacity. 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. But diverse packaging requirements also mean that further aspects should be considered:

- 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 provided that all relevant influencing factors are taken into account — along the entire supply chain.

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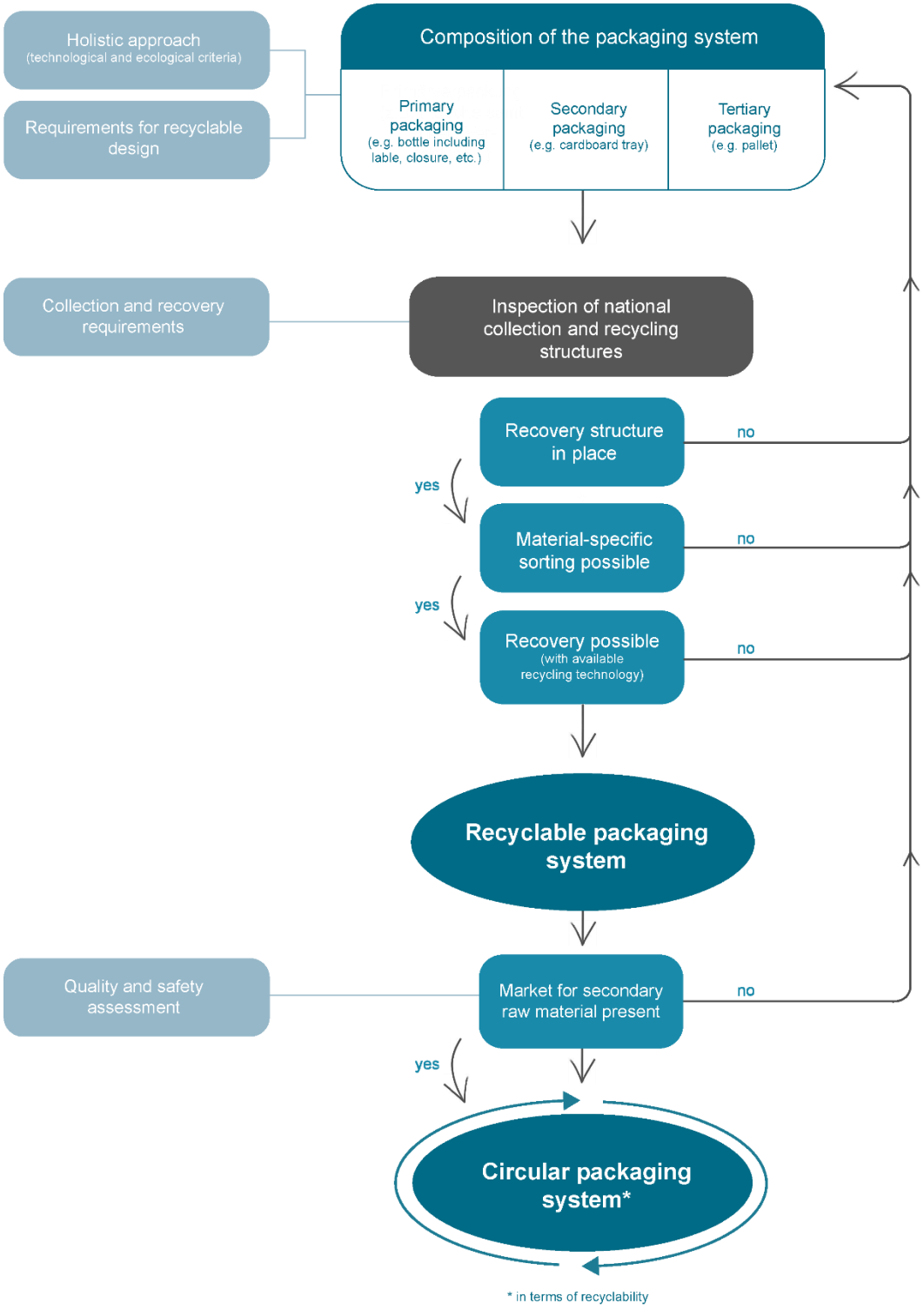
GENERAL DESIGN RECOMMENDATIONS

STEPS IN THE DESIGN PROCESS

The following diagram illustrates crucial steps in the design process of sustainable, as well as recyclable packaging (applies to disposable and reusable packaging).



In line with the waste hierarchy (see p.14), the first step is, in principle, to encourage reduction of the use of packaging material as much as possible (avoidance) 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 printed colours, decoration, closures and small parts. The suitability of packaging in relation to emptying capacity and correct sorting and separation by end consumers are also significant aspects. The following recommendations should be followed for sustainable and recyclable packaging design:

THE 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, the existence of (and access to) regional recycling streams are 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 appropriate recovery structures are available.
- Where possible, recycling material should be used in line with circular economy requirements (depending on the specific product authorisation and availability on the market)
- Additives that lead to quality problems in the recyclate during recycling processes (e.g. through potentially contaminating degradation products) should be avoided as far as possible. There is a need for further research in this area.
- If different materials are combined into multilayer composite materials, recycling is often impossible (even though 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, as a result, 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 plastics sorting, lead to incorrect classification of the material, or the material being eliminated in the sorting process. However there are black and dark dyes available that can be detected with NIR and are not carbon-black based.

PRINTING INKS AND PACKAGING COMPONENTS

- The printing inks used must be in conformity with the EuPIA Exclusion List.
- Direct printing applied by the bottling company 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 the smallest possible number of different materials or material combinations that can be easily separated.
- In addition, adhesive applications, 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 adhesive application use).

FULL EMPTYING CAPABILITY

- 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 materials, good emptiability can be difficult. Depending on the properties of the filling material, residual contents can impair recyclability. When designing packaging, particularly in the case of high-viscosity products, good emptying capacity 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 as far as possible prevents their complete removal by the end consumer for the duration of intended use. This is based on minimising littering potential (release into the environment) and compliance with Directive 2019/904/EC for beverage containers (plastic or partially plastic). This can, for instance, be achieved by integration into the resealing process (e.g. screw caps) or attachment to the packaging (e.g. stay-on closures). Whenever possible, they should be mechanically attached, 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. They should be completely removable and leave no residues (film residues, adhesive application residues, etc.) on the packaging material.

- If the packaging is sealed using an adhesive application, this should be adapted to the given sorting and recycling process (more research is needed for specific material details in the area of adhesive application use).

CONSUMER ACTION

- Correct separation of components should not be (end) consumer dependent in principle, since behaviour cannot be directly influenced. If this is not possible, measures should be taken to make correct separation as easy as possible for the end consumer. Such measures include easily readable information on the packaging, clear labelling of the material type, and visible and easy-to-use perforations for removing the decoration. If, however, the active participation of the end consumer is foreseen or required (for example, when separating cardboard wrap on a plastic cup), correct separation and disposal of the components must be proven and evidenced by empirical surveys (for example, case studies).

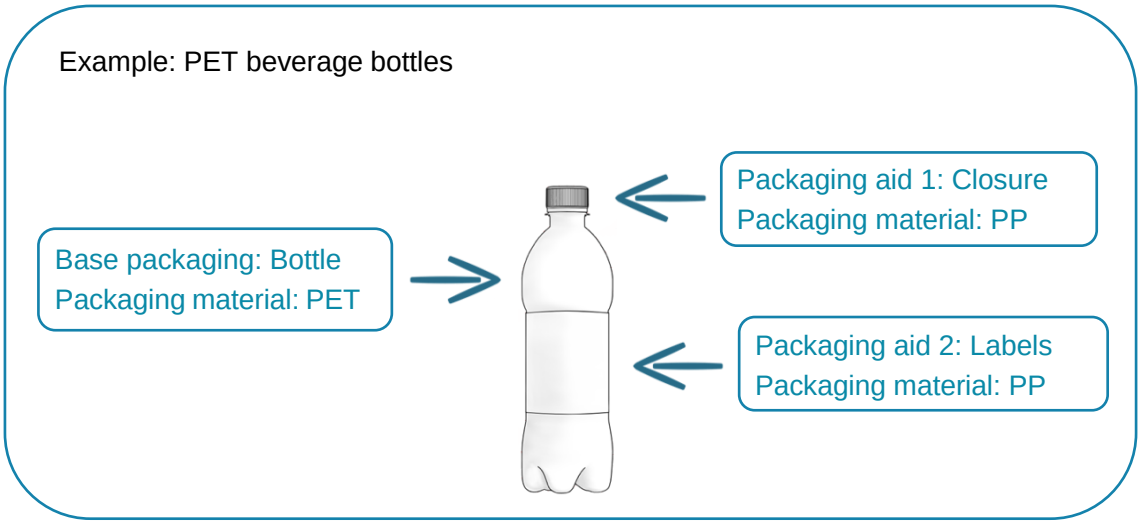
DEFINITION FOR RECYCLABILITY CLASSIFICATION

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 virgin material of the same type.

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

Depending on the packaging function, this may be sales or transport/outer packaging, and a distinction can be made between primary, secondary, and tertiary packaging, which form a packaging system (see p. 96).

Terminology and definition based on DIN 55405:2005-10



Recyclability of packaging primarily involves considering how it is disposed of and how it reaches the respective recovery stream. The material combination plays a key role in this. 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 (packaging disposal unit = bottle + label + cap), or the label can 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 proper use into account.

In addition, a distinction must be made between the extent to which the individual packaging components influence the recycling process, whereby the material composition of a packaging material (e.g.: fillers and dyes contained, barriers, etc.) must also be taken into account. The following restrictions can be distinguished:

Limitation due to individual packaging components

Individual components of the packaging cannot be recycled for technological 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 designs and components result in the packaging not being included in the intended recycling stream and thus not being recycled. However, if individual components are separated before disposal, certain 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 fundamentally redesigned to enable recycling (e.g. composite of PET and EVOH).

Just how complex it is to make a packaging more recyclable also depends on the type of restriction.

Structural restrictions due to respective country-specific collection structures are considered in relation to efforts to achieve Circular Design. However forms of packaging and materials that currently have low recycling rates (for example small PE films) should also be considered, since collection structures can be created for this packaging in the future.

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

Category	
good compatibility	The packaging component 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, or applications requiring identical material, respectively.
limited compatibility	1) The packaging component is recyclable, but affects the recyclate of the main stream in terms of quality (e.g. grey colouring due to heavy dyeing / printing of an adhering in-mould label) AND/OR: 2) Individual packaging components are separated during the recovery process and not recycled (e.g. plastic label/sleeve on glass bottle).
poor compatibility	1) The packaging component cannot be recycled in a mechanical recycling process according to the state of the art and / or there is no recycling stream. 2) One component of the disposal unit contaminates the other components in such a way that recycling is no longer possible (e.g. PA barrier in PP packaging).

FH Campus Wien
University of Applied Sciences

MATERIAL-SPECIFIC DESIGN RECOMMENDATIONS

PLASTIC PACKAGING

In view of the wide range of materials used for plastic packaging, here are a few general design-related recommendations. They 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
- Easy separability 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. In case of PET, recyclates can be used for producing high-quality products that can be used as a full substitute for virgin PET, even including closed-loop recycling, which also permits use for food-contact materials.

PET BOTTLES – TRANSPARENT AND LIGHT BLUE

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

Recyclability of PET packaging				
Component		Good	Limited	Poor
Base packaging	Material	PET		Materials with a density > 1 g/cm³, for example PVC, PS, PLA, PETG
	Dimensions			< 5 x 5 cm[1]
	Additives		UV stabilisers; AA blockers; Optical brighteners; oxygen absorbers	Nanoparticles; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers	No barrier layer; SiO_x	max. mass fraction of 5 % PA and no tie-layers; PGA multilayer PTN alloy Carbon plasma coating	EVOH; over 5 % PA by mass; Inserted barriers
	Colour	transparent, transparent – light blue/ light green		Carbon-black based colours Metallic or fluorescent colours; other transparent colours, opaque colours
Base packaging	Printing[2]	Colours comply with EuPIA Non-bleeding colours No direct printing on the packaging material No PVC-based colours		Bleeding colours Extensive direct printing on the base packaging Colours containing metal

[1] In compressed state (recommendation of FH Campus Wien)
[2] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PET packaging				
Component		Good	Limited	Poor
	Coding (batch code, best before date)	Engraving; Laser marking	The batch number and best before date 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	Closure (snap-on cap, screw cap etc.) + liners, seals and valves	PP, PE; Materials with a density < 1 g/cm³ Closure systems without liner, if necessary EVA or TPE liner; Foamed PET (density < 1g/cm³)	Silicon (density < 0.95 g/cm³)	Metals; Thermosets; not completely washable seals or silicones; Glass and metal springs in pump systems Materials with a density > 1 g/cm³ for example, POM, PET-G, PVC, PS
Packaging aid – decoration	Label material	Materials with a density < 1 g/cm³ for example, PP, PE, OPP, EPS, foamed PET, LDPET	Paper labels (wet-strength) lightly metallised labels	foamed PETG labels (also with density < 1 g/cm³); Materials with a density > 1 g/cm³ for example, PVC, PS or PET, PETG, PLA Non-wet-strength paper labels metallised labels; non-washable or welded labels
	Label adhesive[3]	*Currently being revised*	*Currently being revised*	*Currently being revised*
Packaging aid – decoration	Adhesive-free decoration (sleeve, etc.)	Materials with a density < 1 g/cm³, for example, PP, PE, OPP, EPS, foamed PET, LDPET		foamed PETG sleeves (also with density <1 g/cm³); Materials with a density > 1 g/cm³ for example, PVC, PS or PET, PETG, PLA metallised materials

[3] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

Recyclability of PET packaging				
Component		Good	Limited	Poor
	Size limitation	Decoration covered < 50 %[4] resp. 70 %[5] of the packaging surface		large-area decoration (covers > 50 % or > 70 % of the packaging surface)[6]
Packaging aids – Other	Other components	transparent PET; other components (e.g. handles) which can be shredded and separated by the float-sink method (which have a density < 1 g/cm³)		coloured PET; Materials with a density > 1 g/cm³; non-separable or welded components

[4] for bottles with a filling quantity of ≤ 500 ml
[5] for bottles with a filling quantity of > 500 ml
[6] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

PET BOTTLES - COLOURED

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

	Component	Recyclability of PET packaging Good	Limited	Poor
Base packaging	Material	PET		Materials with a density > 1 g/cm³, example PVC, PS, PLA, PETG
	Dimensions			< 5 x 5 cm[7]
	Additives		UV stabilisers; AA blockers; Optical brighteners; oxygen absorbers	PA additive (PET-A copolymer) Density-modifying materials Nanoparticles; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers[8]	No barrier layer; Carbon plasma coating SiO_x coating; PTN alloy	EVOH-Multilayer (max. 3 wt. % EVOH) and no adhesion promoters; PGA multilayer Max. 6 wt % PA and no tie-layers	EVOH multilayers with more than 3 wt. EVOH or with adhesion promoter; More than 6 wt. % PA
	Colour	transparent, light colours	transparent, dark colours; opaque colours[9]	Carbon-black based colours Metallic or fluorescent colours
	Printing[10]	Colours comply with EuPIA Non-bleeding colours No direct printing on the packaging material; no PVC-based inks		Bleeding colours metallic inks; Extensive direct printing on the base packaging

[7] In compressed state (recommendation of FH Campus Wien)
[8] Special cases such as PA-MXD6 are possible, see RecyClass: https://recyclass.eu/wp-content/uploads/2021/02/Guideline-PET-bottles-coloured-02.2021-1.pdf
[9] Valid only in Austria - in Austria opaque PET bottles are included in the recycling system (recommendation of the FH Campus Wien).
[10] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PET packaging				
Component		Good	Limited	Poor
Base packaging	Direct printing (batch printing, DMD)	Engraving; Laser marking	The batch number and best before date 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	Closures (snap-on caps, screw caps, etc.) + liners, seals and valves	PP, HDPE materials with a density of < 1 g/cm³	Silicone (density < 0.95 g/cm³)	Metals; Thermosets; not completely washable seals or silicones; Glass and metal springs in pump systems Materials with a density > 1 g/cm³ for example, POM, PET-G, PVC, PS
Packaging aid – decoration	Label material	Materials with a density < 1 g/cm³ for example, PP, PE, OPP, foamed PET (LDPET), EPS	Paper labels (wet-strength) Lightly metallised labels (density < 1 g/cm³)	Materials with a density > 1 g/cm³ for example, PVC, OPS, PET, PETG, PLA; Non-wet-strength paper labels metallised labels; foamed PETG labels (also with density < 1 g/cm³); non-washable or welded labels
	Label adhesive[11]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, etc.)	Materials with a density < 1 g/cm³, for example, PP, PE, OPP, EPS, foamed PET, LDPET		Materials with a density > 1 g/cm³ for example PVC, OPS, PET, PETG, PLA metallised materials; foamed PETG sleeves (also with density <1 g/cm³)

[11] specific requirements for adhesive applications and recommendations are currently under review in the “Focus Group Recycling-Ready Adhesives”.

Recyclability of PET packaging				
Component		Good	Limited	Poor
Packaging aid – decoration	Size restriction	Decoration covered < 50 %[12] or 70 %[13] of the packaging surface		large-area decoration (covers > 50 % resp. 70 % of the packaging surface)[14]
Packaging aids – Other	Other components	PET other components (e.g. handles) which can be crushed and separated by the float-sink method (which have a density <1 g/cm³)		Materials with a density < 1 g/cm³ non-separable or welded components made of materials other than PET

[12] for bottles with a filling quantity of ≤ 500 ml
[13] for bottles with a filling quantity of > 500 ml
[14] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

PET TRAYS - TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

		Recyclability of PET packaging		
Component		Good	Limited	Poor
Base packaging	Material	PET		PET-based multi-layer materials, including PET/PE, PLA, PVC, PS, PETG, C-PET, PET-GAG; Foamed PET (LDPET)
	Dimensions			< 5 x 5 cm[15]
	Additives	Silicone coating; Antiblocking masterbatch (max. 3 %)	UV stabilisers AA blocker Optical brighteners Antiblocking masterbatch (> 3 %); Antistatic agents; Antiblocking agents; Anti-fogging agents	Nanoparticles; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers	No barrier layer; PET-based oxygen absorbers without yellowing effect according to EPBP oven test	PET-based oxygen absorbers with low yellowing effect according to EPBP oven test	EVOH PA other barriers; other oxygen absorbers
	Colour	transparent, transparent – light blue		opaque colours; other transparent colours; Carbon-black based colours Colours containing metal
	Printing[16]	Colours comply with EuPIA Non-bleeding colours No direct printing on the packaging material; no PVC-based inks		Bleeding colours metallic inks; Extensive direct printing on the base packaging

[15] In the compressed state (recommendation of FH Campus Wien)
[16] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PET packaging				
Component		Good	Limited	Poor
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	all other types of direct printing
Packaging aids - closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PP, HDPE Materials with a density < 1 g/cm³ unprinted PET		Materials with a density < 1 g/cm³
	Flexible closures (sealing films etc.)	PP, HDPE Materials with a density < 1 g/cm³ easily removable sealing films which do not leave any residue after removal by end users; unprinted PET; PET-based foamed materials, for which the foam structure is not damaged at 90 °C SiO_x-, AlO_x-plasma as barrier		Materials with a density < 1 g/cm³
Packaging aid – decoration	Label material	Material with a density < 1 g/cm³, e.g. PP, PE, OPP	BPA-free paper labels (wet-strength)	Materials with a density > 1 g/cm³ for example PVC, OPS, PET, PETG, PLA Non-wet-strength paper labels BPA-containing paper labels; non-floating paper labels
	Label adhesive[17]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[17] specific requirements for adhesive applications and recommendations are currently under review in the “Focus Group Recycling-Ready Adhesives”.

Recyclability of PET packaging				
Component		Good	Limited	Poor
Packaging aid – decoration	Size restriction	Decoration covering max. 30% of packaging surface		Large-area decoration (covering > 30% of packaging surface)[18]
Packaging aids - Other	Other components	transparent PET; other components (e.g. handles) which can be crushed and separated in the float-sink process (which have a density <1 g/cm³); Soaker pads; Bubble pads	Paper/cardboard (wet-strength)	PVC, PS, EPS, PU, PA, PC/PMMA; Thermosets with a density > 1 g/cm³; paper/cardboard (not wet-strengthened); non-separable or welded components made of materials other than PET

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 water (potential formation of NIAS). Alternatively if the printing inks are not released during the pre-cleaning step, they can impair the transparency of the recycling stream. Instead, any printing on the decoration should be applied or the harmlessness of the inks for the recycling stream should be demonstrated.

[18] If the decoration covers more than 30% 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 applicable to particular packaging types and should be seen as an expansion of the base 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 over 1 g/cm³, as they cannot be distinguished from PET – or PETG – 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 inks primarily interfere with NIR detection. Furthermore, dark colours 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. Should PET recycling fractions be used for the production of micro-fibres, dyed granules can nevertheless be used. However, 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.

PET FILMS

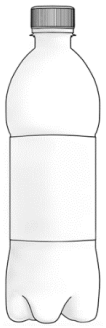
- There is currently no recovery stream for PET films
- The use of PET in multilayer film and blister packs is not advisable, as it cannot be recycled.
- Further information on multilayer materials is provided in a separate chapter.

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 with a short shelf-life. Therefore, recycling of thermoformed PET trays is promising.[19]
- In addition, improvements in NIR detection systems may, in future, enable the separation of APET and PETG or multilayer PET trays.

DESIGN EXAMPLE OF RECYCLABLE PET PACKAGING

- ✓ Bottle or tray of 100 wt% 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% or 70%, respectively, of the surface
- ✓ Batch number/DMD as laser marking



[19] As far as APET is concerned, PET from applications other than beverage bottles is also collected in the recycling system in Austria.

POLYPROPYLENE (PP)

CURRENT COLLECTION AND RECOVERY STRUCTURES

There are nationwide collection and recovery structures for polyethylene hollow articles in Austria, Germany and the Netherlands. Regarding the collection of PP packaging other than hollow articles, 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.

PP FILMS - TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Material	PP[20]; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP).	Multilayer composite with PE[21]	Other plastics (e.g. PET, PETG, PVC, PLA, PS, etc.)
	Dimensions	> A4 or > 5 x 5 cm	< A4 or ≤ 5 x 5 cm	< 5 x 5 cm[22]
	Additives	Additives if density remains < 0.97 g/ cm^3		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm^3; Foaming agents for chemical expansion; Additives that induce biodegradation/oxo/photo-degradation of the packaging
Base packaging	Barriers	SiO_x-, Al_2O_3-barrier without additional coating; barrier in the polymer matrix;	EVOH in polyolefin composite film Aluminium vapour deposition (Metallizing)[23]	PVC, PVDC, PA; Aluminium barriers[24] other barriers

[20] PP content > 90 % (recommendation of FH Campus Wien)
[21] Currently, up to 10% PE is recommended, max. 30% tolerated.
[22] in compressed state (recommendation of FH Campus Wien)
[23] 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.
[24] Deviating findings must be examined on a case-by-case basis.

Recyclability for PP packaging				
Component		Good	Limited	Poor
	Colour	transparent, uncoloured	light colours; translucent colours	black or dark colours; Carbon-black based colours
	Printing[25]	No direct printing	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours No PVC-based inks; Print covers > 50 % of the film[26]	Bleeding colours
	Coding (batch coding, best before date)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		
Packaging aids – closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PP	PE (HDPE, LDPE, LLDPE, MDPE)	Metals; Aluminium PVC Materials other than polyolefins with a density < 1 g/cm³; Seals or silicone that cannot be completely removed

[25] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.
[26] Sortability and recyclability can be influenced by the printing. This issue is currently under discussion.

Recyclability for PP packaging				
Component		Good	Limited	Poor
	Flexible closures (sealing films etc.)	PP; Sealing film should be removable by the end consumer without any residues	PE (HDPE, LDPE, LLDPE, MDPE) removable aluminium lidding film	Metals; Aluminium PVC, PET, PETG, PS, PLA, film composites materials other than polyolefins or foamed materials with a density < 1 g/cm³; sealing films or silicones that are not completely washable
Packaging aid – Decoration	Label material	PP label	PE; Paper labels (wet-strength)	metallised labels; Non-wet-strength paper labels Labels made of other materials, e.g. PET, PLA, PVC
	Label adhesive[27]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[27] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

PP FOILS – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Material	PP[28]; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP).	Multilayer composite with PE[29]	Other plastics (e.g. PET, PETG, PVC, PLA, PS, etc.)
	Dimensions	> A4 or > 5 x 5 cm	< A4 or ≤ 5 x 5 cm	< 5 x 5 cm[30]
	Additives	Additives if density remains < 0.97 g/ cm^3		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm^3; Foaming agents for chemical expansion; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers	SiO_x-, Al_2O_3-barrier without additional coating; Barrier in the polymer matrix	EVOH in polyolefinic composite film; Aluminium vapour deposition (metallisation)[31] without additional coating	PVC, PVDC, PA; Aluminium barriers[32] other barriers
	Colour	Light colours, translucent colours		Carbon-black based colours

[28] PP content > 90 % (recommendation of FH Campus Wien).
[29] Currently, up to 10% PE is recommended, max. 30% tolerated.
[30] in the compressed state
[31] 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.
[32] Deviating findings must be examined on a case-by-case basis.

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Printing[33]	No direct printing;	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours no PVC-based inks Print covers > 50 % of the film[34]	Bleeding colours
	Coding (batch coding, best before date)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type fastener etc.)	PP	PE (HDPE, LDPE, LLDPE, MDPE)	Metals; Aluminium PVC, PET, PETG, PS, PLA; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
Packaging aids – Closures	Flexible closures (sealing films etc.)	PP; Sealing film should be removable by the end consumer without any residues	PE (HDPE, LDPE, LLDPE, MDPE) removable aluminium lidding foil	Metals; Aluminium PVC, PET, PETG, PS, PLA, film composites Materials other than polyolefins with a density < 1 g/cm³;

[33] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.
[34] Sortability and recyclability can be influenced by the printing. This issue is currently under discussion.

Recyclability for PP packaging				
Component		Good	Limited	Poor
Packaging aid – Decoration	Label material	PP label	Paper labels (wet-strength) PE;	metallised labels; materials containing aluminium; Non-wet-strength paper labels Labels made of other materials, e.g. PET, PLA, PVC labels
	Label adhesive[35]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[35] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

PP CONTAINERS AND TUBES – TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Material	PP[36]; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP).	Multilayer composite with PE[37]	PS, PVC, PLA, PET, PETG
	Dimensions			< 5 x 5 cm[38]
	Additives	Additives if density remains < 0.97 g/ cm^3	Mineral fillers ($CaCO_3$, talc) if the density remains below 0.97 g/cm^3.	Additives which lead to an increase of the specific density to ≥ 1 g/cm^3; flame retardants; plasticisers; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers	EVOH[39];	EVOH[39]	EVOH[39] PVDC, PA, Aluminium barriers[40]
	Colour	Transparent	Light colours	Black, dark or opaque colours Carbon-black based colours
Base packaging	Printing[41]	EuPIA-compliant printing inks Non-bleeding colours Minimal printing no PVC-based inks		Bleeding colours

[36] PP content > 90 % (recommendation of FH Campus Wien).
[37] Currently up to 10% PE is recommended, max. 30% tolerated (recommendation of FH Campus Wien).
[38] In compressed state (recommendation of FH Campus Wien)
[39] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[40] Deviating findings must be examined on a case-by-case basis.
[41] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability for PP packaging				
Component		Good	Limited	Poor
	Direct printing (batch printing, DMD)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type fastener etc.) + Liners, seals and valves	PP; Closure systems without liners, PP or TPE-PP liners if necessary	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA	Materials other than polyolefins and foamed materials with a density < 1 g/cm³ ; Aluminium Metals; PVC Other types of TPE; Paper composite
Packaging aids – Closures	Flexible closures (sealing films etc.) + Liners, seals and valves	PP; Sealing film should be removable by the end consumer without any residues Closure systems without liners, PP or TPE-PP liners if necessary	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA	Materials other than polyolefins and foamed materials with a density < 1 g/cm³; Aluminium Metals; PVC Other types of TPE, paper laminates

Recyclability for PP packaging				
Component		Good	Limited	Poor
Packaging aid – Decoration	Label material	PP label[42]	PE; Paper labels (wet-strength) Labels made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³); Foamed polyolefin labels	Materials other than polyolefins with a density < 1 g/cm³; Non-wet-strength paper labels Aluminium metallised labels; PVC
	Label adhesive[43]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, etc.)	PP sleeve[42]	Sleeves made of PE (with a density < 1 g/cm³); Sleeves made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Materials other than polyolefins with a density < 1 g/cm³; Aluminium metallised materials; PVC
Packaging aid – Decoration	Size restriction	Decoration covered < 50 %[44] or 70 %[45] of the packaging surface		Large-area decoration (covers > 50 % resp. 70 % of the packaging surface)[46]
Packaging aids – Other	Other components	PP	PE (with a density < 1 g/cm³); PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Aluminium PVC Glass Materials other than polyolefins with a density < 1 g/cm³.

[42] provided that the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[43] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.
[44] for bottles with a filling quantity of ≤ 500 ml
[45] for bottles with a filling quantity of > 500 ml
[46] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

PP CONTAINERS AND TUBES – COLOURED AND WHITE

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Material	PP[47]; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP).	Multilayer composite with PE[48]	PS, PVC, PLA, PET, PETG
	Dimensions			< 5 x 5 cm[49]
	Additives	Additives if density remains < 0.97 g/ cm³	Mineral fillers ($CaCO_3$, talc), if the density remains < 0.97 g/cm³.	Additives which lead to an increase of the specific density to ≥ 1 g/cm³; flame retardants; plasticisers; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers	EVOH[50]	EVOH[50]	EVOH[50] PVDC, PA, Aluminium barriers
	Colour	Light colours	black inner layer; dark, NIR-detectable colours	Carbon-black based colours
	Printing[51]	EuPIA-compliant printing inks Non-bleeding colours Minimal printing no PVC-based inks		Bleeding colours

[47] PP content > 90 % (recommendation of FH Campus Wien).
[48] Currently up to 10% PE is recommended, max. 30% tolerated (recommendation of FH Campus Wien).
[49] In compressed state (recommendation of FH Campus Wien)
[50] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[51] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability for PP packaging				
Component		Good	Limited	Poor
Base packaging	Direct printing (batch printing, DMD)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type fastener etc.) + Liners, seals and valves	PP; Closure systems without liners, PP or TPE-PP liners if necessary	PE (HDPE, LDPE, LLDPE, MDPE, TPE-PE); PET, PETG, PS, PLA; Removable aluminium cap	Materials other than polyolefins or foamed materials with a density < 1 g/cm³; Aluminium Metals; PVC Other types of TPE; Paper composite
	Flexible closures (sealing films etc.) + Liners, seals and valves	PP; Sealing film should be removable by the end consumer without any residues Aluminium lidding film can be easily removed without leaving any residue; Closure systems without liners, TPE-PP liners if necessary	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA; TPE-PE	PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³.

Recyclability for PP packaging				
Component		Good	Limited	Poor
Packaging aid – Decoration	Label material	PP label[52]	PE (density < 1 g/cm³); PET, PETG, PLA, PS (all materials with a density > 1 g/cm³); Paper labels (wet-strength) Foamed polyolefin labels	Materials other than polyolefins with a density < 1 g/cm³; Non-wet-strength paper labels Aluminium metallised labels; PVC
	Label adhesive[53]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, etc.)	PP sleeve[52]	Sleeves of PE (density < 1 g/cm³); Sleeves made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Materials other than polyolefins with a density < 1 g/cm³; Aluminium metallised materials; PVC Heavily printed sleeves
	Size restriction	Decoration covers < 50 %[54] resp. 70 %[55] of the packaging surface		Large-area decoration (covers > 50 % or 70 % of the packaging surface)[56]
Packaging aids – Other	Other components	PP	PE; PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Aluminium PVC Glass Materials other than polyolefins with a density < 1 g/cm³.

[52] provided the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[53] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.
[54] for bottles with a filling quantity of ≤ 500 ml
[55] for bottles with a filling quantity of > 500 ml
[56] If the decoration covers more than 50% or 70%, respectively, 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

- For transparent PP bottles, barriers should generally be avoided. The use of EVOH is currently under review. If a barrier is required for coloured PP bottles, the use of PA should generally be avoided. An EVOH barrier is allowed up to a certain percentage in the recycling process[57]
- The bottle and its closure should be of the same material and colour where possible.
- Labels should either be made of the same material as the bottle or be water washable and cover a maximum of 50% or 70% of the packaging surface[58]. Paper labels should also be wet-strengthened.

PP FILM/BAGS

- If the use of a barrier is required, a carbon plasma coating, a SiO_X- oder Al_2O_3 barrier should be used. Use of an EVOH barrier is permitted in the recycling process up to a certain percentage[57]. 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 a sealing film (e.g. aluminium blank) is used, it must be possible to separate it completely from adhesive applications without leaving any residue.
- If barrier layers are needed, do not use PVDC or PA.
- Information should generally be placed on the lid or the sealing film, if possible, in order not to contaminate the main part of the packaging with printing or to enable a reduced packaging design without additional decorative components.
- Paper labels should be used as sparingly as possible, and whenever they are used, they should be, wet-strength grade labels which are suitable for washing off with water.

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 0.97 g/cm³ (specific value for tubes).
- Aluminium components can lead to unwanted rejection of the packaging. Tubes with an aluminium barrier (aluminium barrier laminate, ABL) with the PP/Alu/PP structure are, therefore, disadvantageous for recycling.

[57] 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/.
[58] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

DESIGN EXAMPLE OF RECYCLABLE PP PACKAGING

- ✓ PP cup with PP lid without barrier
- ✓ 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 articles in Austria, Germany and the Netherlands.

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

PE (HDPE, LDPE, LLDPE) FILMS - TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Material	PE[59] (LDPE, LLDPE, HDPE); A multilayer composite material can be used if necessary if this is based on various types of PE (for example LDPE, HDPE).	Multilayer composite with PP[60]	PS, PVC, PLA, PET, PETG
	Dimensions	> A4 or ≥ 5 x 5 cm	< A4 or ≤ 5 x 5 cm	< 5 x 5 cm[61]
	Additives	Additives if density remains < 0.97 g/ cm^3		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm^3; Foaming agents for chemical expansion; Additives that induce biodegradation/oxo/photo-degradation of the packaging

[59] PE content > 90 % (recommendation of FH Campus Wien).
[60] Currently up to 10% PP is recommended, max. 30% tolerated (recommendation of FH Campus Wien).
[61] in a compressed state

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Barriers[62]	No barrier layer; SiO_x-, Al_2O_3-barrier without additional coating; Carbon plasma coating[63]	EVOH[64]; Aluminium vapour deposition (Metallizing)[65]	EVOH[64] PVC, PVDC, PA; Aluminium barriers[66]
	Colour	transparent, uncoloured	light colours, translucent colours	black or dark colours; Carbon-black based colours
	Printing[67]	No direct printing	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours No PVC-based inks; Printing more than 50 %[68]	Bleeding colours
	Direct printing (batch printing, DMD)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		

[62] Special cases such as EcoLam High Plus and VO+LLDPE are possible, see RecyClass: https://recyclass.eu/wp-content/uploads/2021/06/Guideline-PE-films-transparent-06.2021.pdf
[63] If the base packaging is transparent, it may become discoloured
[64] Current limits for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[65] 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.
[66] Deviating findings must be examined on a case-by-case basis.
[67] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.
[68] Sortability and recyclability can be influenced by the printing. This issue is currently under discussion.

Recyclability of PE packaging				
Component		Good	Limited	Poor
Packaging aids – closures	Rigid closures (snap-on lid, screw-type fastener etc.) + Liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liner, if necessary PE liner	PP; Removable aluminium closure	Metals; Aluminium PVC, PET, PETG, PS, PLA; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
	Flexible closures (sealing films etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues	PP; removable aluminium lidding film	Metals; Aluminium PVC, PET, PETG, PS, PLA, film composites Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
Packaging aid – decoration	Label material	PE (HDPE, LDPE, LLDPE, MDPE)	Paper labels (wet-strength) PP	metallised labels; Labels made of other materials, e.g. PET, PVC, PLA or non-wet-strength paper labels
	Label adhesive[69]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[69] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

PE (HDPE, LDPE, LLDPE) FILMS – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Material	PE[70] (LDPE, LLDPE, HDPE); A multilayer composite material can be used if necessary if this is based on various types of PE (for example LDPE, HDPE).	Multilayer composite with PP[71]	PS, PVC, PLA, PET, PETG
	Dimensions	> A4 or ≥ 5 x 5 cm	< A4 or ≤ 5 x 5 cm	< 5 x 5 cm[72]
	Additives	Additives if density remains < 0.97 g/ cm³		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm³ (lime, glass, etc.); Foaming agents for chemical expansion; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers[73]	SiO_x-, Al_2O_3-barrier without additional coating; barrier in the polymer matrix; carbon plasma coating[74]	EVOH[75] Aluminium vapour deposition (Metallizing)	EVOH[75] PVC, PVDC, PA; Aluminium barriers
	Colour	transparent, uncoloured	light colours, translucent colours	black or dark colours; Carbon-black based colours

[70] PE content > 90 % (recommendation of FH Campus Wien).
[71] Currently, up to 10% PP is recommended, max. 30% tolerated.
[72] in a compressed state
[73] Special cases such as EcoLam High Plus and VO+LLDPE are possible, see RecyClass: https://recyclass.eu/wp-content/uploads/2021/02/Guideline-PE-films-transparent-02.2021-1.pdf
[74] If the base packaging is transparent, it may become discoloured
[75] Current limits for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Printing[76]	No direct printing;	EuPIA-compliant printing inks Non-bleeding colours Light or translucent colours no PVC-based inks Printing more than 50 %[77];	Bleeding colours
	Coding (batch coding, best before date)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		
Packaging aids – closures	Rigid closures (snap-on lid, screw-type fastener etc.) + Liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE)	PP; Removable aluminium closure	Metals; Aluminium PVC, PET, PETG, PS, PLA; Materials other than polyolefins or foamed materials with a density <1 g/cm³.
	Flexible closures (sealing films etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues	PP; removable aluminium lidding foil	Metals; Aluminium PVC, PET, PETG, PS, PLA, film composites Materials other than polyolefins or foamed materials with a density < 1 g/cm³.

[76] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.
[77] Sortability and recyclability can be influenced by the printing. This issue is currently under discussion.

Recyclability of PE packaging				
Component		Good	Limited	Poor
Packaging aid – decoration	Label material	PE (HDPE, LDPE, LLDPE, MDPE)	PP; Paper labels (wet-strength)	metallised labels; Labels made of other materials, e.g. PET, PVC, PLA; Non-wet-strength paper labels
	Label adhesive[78]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[78] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

PE (HDPE) CONTAINERS AND TUBES – TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Material	HDPE[79]; A multilayer composite material can be used if necessary if this is based on various types of PE (for example LDPE, HDPE).	Multilayer composite with PP[80]	PS, PVC, PLA, PET, PETG
	Dimensions			< 5 x 5 cm[81]
	Additives	Additives if density remains < 0.97 g/ cm^3	Mineral fillers ($CaCO_3$, talc), if density remains < 0.97 g/ cm^3.	Additives which lead to an increase of the specific density to ≥ 1 g/cm^3; flame retardants; plasticisers; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers[82]	EVOH[83]	EVOH[83]; aluminium vapour deposition (metallisation)[84]	EVOH[83] PVDC, PA, Aluminium barriers[85]
	Colour	transparent, clear	Light colours	black inner layer; Black, dark or opaque colours Carbon-black based colours

[79] PE content > 90 % (recommendation of FH Campus Wien).
[80] Currently, up to 10% PP is recommended, max. 30% tolerated.
[81] In compressed state (recommendation of FH Campus Wien).
[82] Certain EVOH barriers such as PE-g-MAH with up to 6 % EVOH and MAH > 0.1 % mass fraction and the ratio of EVOH to compound layers ≤ 2 as well as encases (fluorination) permitted – confirmation of composition necessary (Recyclass).
[83] Current limits for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[84] 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.
[85] Deviating findings must be examined on a case-by-case basis.

Recyclability of PE packaging				
Component		Good	Limited	Poor
Base packaging	Printing[86]	EuPIA-compliant printing inks Non-bleeding colours Minimal printing Light or translucent colours no PVC-based inks		Bleeding colours
	Direct printing (batch printing, DMD)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		Direct printing
Packaging aids – closures	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liners, TPE-PE liners if necessary	PP; PS, PET, PETG, PLA (all materials with a density > 1 g/cm³); removable aluminium lid; removable silicone with a density > 1g/cm³; TPE-PP	Aluminium Metals; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³; Other types of TPE
Packaging aids – closures	Flexible closures (sealing films etc.) + Liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues Closure systems without liner, if necessary or TPE-PE liner.	PP; PS, PET, PETG, PLA (materials with a density > 1 g/cm³); removable aluminium lidding foil; removable silicone with a density > 1g/cm³; TPE-PP	PVC materials other than polyolefins or foamed materials with a density < 1 g/cm³; Other types of TPE

[86] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PE packaging				
Component		Good	Limited	Poor
Packaging aid – decoration	Label material	PE (HDPE, LDPE, LLDPE, MDPE) [87]	Paper labels (wet-strength) PP; PET, PETG, PLA, PS (all with a density > 1 g/cm³; Foamed polyolefin labels	Materials other than polyolefins with a density < 1 g/cm³; metallised labels; aluminium-containing labels; Non-wet-strength paper labels PVC label
	Label adhesive[88]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, etc.)	HDPE, LDPE, LLDPE, MDPE[87]	PP / OPP (with a density < 1 g/cm³) PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Materials other than polyolefins with a density < 1 g/cm³; Heavily printed sleeves; metallised materials; materials containing aluminium; PVC
Packaging aid – decoration	Size restriction	Decoration covered < 50 %[89] or 70 %[90] of the packaging surface		large-area decoration (covers > 50 % resp. 70 % of the packaging surface)[91]
Packaging aids – Other	Other components	HDPE, LDPE, LLDPE, MDPE	PP; PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Aluminium PVC Glass Materials other than polyolefins with a density < 1 g/cm³.

[87] provided that the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR
[88] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.
[89] for bottles with a filling quantity of ≤ 500 ml
[90] for bottles with a filling quantity of > 500 ml
[91] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable.

PE (HDPE) CONTAINERS AND TUBES – COLOURED AND WHITE

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

		Recyclability of PE packaging		
Component		Good	Limited	Poor
Base packaging	Material	HDPE[92]; A multilayer composite material can be used if necessary if this is based on various types of PE (for example LDPE, HDPE).	Multilayer composite with PP[93]	PS, PVC, PLA, PET, PETG
	Dimensions			< 5 x 5 cm[94]
	Additives	Additives if density remains < 0.97 g/ cm³	Mineral fillers ($CaCO_3$, talc), if density remains < 0.97 g/ cm³.	Additives which lead to an increase of the specific density to ≥ 1 g/cm³; flame retardants; plasticisers; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers[95]	EVOH[96]	Aluminium vapour deposition (Metallizing)[97] EVOH[96]	EVOH[96] PVDC, PA; aluminium barriers[98]
	Colour	all colours, white	black inner layer and black, not carbon black based colours	Carbon-black based colours
Base packaging	Printing[99]	EuPIA-compliant printing inks Non-bleeding colours no PVC-based inks		Bleeding colours

[92] PE content > 90 % (recommendation of FH Campus Wien).
[93] Currently, up to 10% PP is recommended, max. 30% tolerated.
[94] In compressed state (recommendation of FH Campus Wien)
[95] Certain EVOH barriers such as PE-g-MAH with up to 6 % EVOH and MAH > 0.1 % mass fraction and the ratio of EVOH to compound layers ≤ 2 as well as encase (fluorination) permitted – Confirmation of composition necessary.
[96] Current limits for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[97] 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.
[98] possible exceptions must be tested in each individual case
[99] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PE packaging				
Component		Good	Limited	Poor
	Coding (batch coding, best before date)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be done by a minimal direct print, provided that food-compatible inks are used.		Direct printing
Packaging aids – closures	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liners, TPE-PE liners if necessary	PP; PS, PET, PETG, PLA (all materials with a density > 1 g/cm³); removable silicone with a density > 1g/cm³; TPE-PP	Aluminium Metals; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³; Other types of TPE
	Flexible closures (sealing films etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues	PP; PS, PET; PETG, PLA (all materials with a density > 1 g/cm³); removable aluminium lidding foil; removable silicone with a density > 1g/cm³; TPE-PP	Aluminium Metals; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³; Other types of TPE
Packaging aid – decoration	Label material	PE (HDPE, LDPE, LLDPE, MDPE) [100]	Paper labels (wet-strength) PP; PET, PETG, PLA, PS (all with a density > 1 g/cm³; Foamed polyolefin labels	Materials other than polyolefins with a density < 1 g/cm³; metallised labels; aluminium-containing labels; Non-wet-strength paper labels PVC label

[100] provided the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.

Recyclability of PE packaging				
Component		Good	Limited	Poor
	Label adhesive[101]	*Currently being revised*	*Currently being revised*	*Currently being revised*
	Adhesive-free decoration (sleeve, etc.)	HDPE, LDPE, LLDPE, MDPE[100]	PP / OPP (with a density < 1 g/cm³) PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Sleeves made of materials other than polyolefins with a density < 1 g/cm³; Heavily printed sleeves; metallised materials; materials containing aluminium; PVC
	Size restriction	Decoration covered < 50 %[102] or 70 %[103] of the packaging surface		Large-area decoration (covers > 50 % or 70 % of the packaging surface)[104]
Packaging aids - Other	Other components	HDPE, LDPE, LLDPE, MDPE	PP; PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	Aluminium PVC Glass Materials other than polyolefins with a density < 1 g/cm³.

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[105].

[101] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.
[102] for bottles with a filling quantity of ≤ 500 ml
[103] for bottles with a filling quantity of > 500 ml
[104] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable
[105] Currently, up to 10 % PP is recommended, max. 30 % tolerated.

- Plastic labels should be of the same material as the bottle body. If paper labels are used, they should be of wet-strength grade.

PE FILM/BAGS

- If the use of a barrier is required, a carbon plasma coating, a SiO_X- oder Al_2O_3 barrier should be used. Use of an EVOH barrier is permitted in the recycling process up to a certain percentage[106]. 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 over ≥ 0.97 g/cm³.
- If PE film is combined with other types of plastics by means of co-extrusion, please take care that PE polymers are used whenever possible. LDPE, LLDPE, MDPE and HDPE combinations can be used.

PE TRAYS/CUPS

- If a sealing film (e.g. aluminium blank) is used, it must be possible to remove it completely without leaving any residue from adhesive applications.
- Information should generally be placed on the lid or the sealing film, if possible, in order not to contaminate the main part of the packaging with printing or to enable a reduced packaging design without additional decorative components.
- Paper labels should be used as sparingly as possible, and whenever they are used, they should be, wet-strength grade labels which are suitable for washing off with water.

PE TUBES

- Avoid the use of fillers such as chalk (filled polyolefin/FPO) if this results is a density of over 0.97 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 components can lead to unwanted rejection of the packaging. Tubes with an aluminium barrier (aluminium barrier laminate, ABL) with the PE/Alu/PE structure are, therefore, disadvantageous for recycling.

[106] 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 wt% LDPE, without a barrier
- ✓ White pigment colour
- ✓ HDPE closure
- ✓ Minimal printing with coloured inks in conformity with EuPIA
- ✓ Batch number/DMD as laser marking

- ✓ Pouch packaging made of 100 % LDPE with SiO_x barrier
- ✓ Transparent or white pigment
- ✓ Sealed closure
- ✓ Minimal printing with coloured 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 system that allows the bottle to be turned upside down (optimisation of residual emptying)

POLYSTYRENE

CURRENT COLLECTION AND RECOVERY STRUCTURES

In Austria and Germany, collection and recycling structures for hollow polystyrene containers exist. For the Netherlands, no collection structures can be assumed at present.

PS CONTAINERS

RECOMMENDATIONS FOR RECYCLABLE PS PACKAGING

Component		Recyclability of PS packaging		
		Good	Limited	Poor
Base packaging	Material	PS		Foamed PS with a density < 1g/cm³; Multilayer composites
	Dimensions			< 5 x 5 cm[107]
	Additives	Additives, if the density remains between 1.0 and 1.07 g/m³.	Mineral fillers ($CaCO_3$, talc) which do not increase the density above 1.07 g/cm³.	additives which increase the density to above 1.07 g/m³; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers		EVOH	PVDC, PA,
	Colour	Light colours	Dark colours	Carbon-black based colours
	Printing[108]	EuPIA-compliant printing inks Non-bleeding colours no PVC-based inks		Bleeding colours

[107] In compressed state (recommendation of FH Campus Wien)
[108] Printing on the main body should generally be avoided or minimised as it can lead to deterioration of the recyclate quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PS packaging				
Component		Good	Limited	Poor
Base packaging	Direct printing (batch printing, DMD)	Engraving; Laser marking The batch coding and indication of the best-before date can, if necessary, also be carried out by means of minimal direct printing, provided that food-compatible inks are used.	Minimal printing	
Packaging aids – closures	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PS	PE, PP; EVA;	PET, PETG, PVC, PLA; PVC; Aluminium Metals, Materials other than polyolefins or foamed materials with a density < 1 g/cm³;
	Flexible closures (sealing films etc.)		PE, PP; Removable aluminium lidding film; Wet-strength paper labels	Aluminium film Non-wet-strength paper labels Multi-layer composite of PET/paper or PET/PS; Other materials with a density > 1 g/cm³
Packaging aid – decoration	Label material	PS[109]	PP, PE; Wet-strength paper labels; In-mould labels in PS	PET, PETG, PVC, PLA; Non-wet-strength paper labels Aluminium Metallised labels
Packaging aid	Label adhesive[110]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[109] if the pressure/barrier of the decoration does not negatively influence the detection of the packaging material by the NIR
[110] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

Recyclability of PS packaging				
Component		Good	Limited	Poor
	Adhesive-free decoration (sleeve, etc.)	PS[111]	PP, PE	PET, PETG, PVC, PLA; Aluminium Metallised labels; Heavily printed labels
	Size restriction	Decoration covers < 50 %[112] resp. 70 %[113] of the packaging surface		Large-area decoration (covers > 50 % or 70 % of the packaging surface)[114]
Packaging aids - Other	Other components	PS	PP; PE; Wet-strength paper	PET; PETG; PVC; PLA; metals, metal foils, Other materials with a density > 1 g/cm³

[111] if the pressure/barrier of the decoration does not negatively influence the detection of the packaging material by the NIR
[112] for bottles with a filling quantity of ≤ 500 ml
[113] for bottles with a filling quantity of > 500 ml
[114] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable

RECOMMENDATIONS FOR PACKAGING AIDS - AN OVERVIEW

The following list provides an overview of advisable packaging components or component combinations which, in the current state of the art, do not have negative impacts on the recycling process. Additionally, it includes 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 wholly or partially plastic beverage containers up to three litres 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 closures which contain metal on plastic packaging since they may lead to them being removed instead of retained during sorting.
- In general, Sealing films (including lids) should be removable by the consumer without any residues.
- In general, separable small parts such as fully 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 ideally be made of the same material as the packaging (except PET). In addition, sleeves should generally be printed as little as possible and/or cover as small an area of the packaging as possible.
- In general, Sleeves can also be made of a different material than the packaging if separation is possible through different densities. However, these should cover a maximum of 50% or 70% of the packaging surface in order to avoid incorrect sorting.
- 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 them being removed instead of retained during sorting.

If sleeves printed over the entire surface cover more than 50 % or 70%, respectively, of the packaging surface and/or consist of a different material to the base packaging, they affect its 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 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 never cover more than 50 % or 70%, respectively, of the packaging[115].
- 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 they can be separated in the specific recycling process[116].
- 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 which contain metal since these parts may lead to them 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. However, printing should be carried out as sparingly as possible, as the firmly bonded in-mould label is recycled together with the packaging material and excessive printing leads to a reduction in recyclate quality. 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).

[115] If the decoration covers more than 50% or 70%, respectively, of the packaging surface, the sortability of the base packaging must be proven in sorting trials for it to be considered recyclable
[116] Adhesive application requirements and recommendations are currently being developed in the Recycling-ready Adhesives Focus Group.

Additional labels

Recommendations for self-adhesive labels (labels coated with pressure-sensitive adhesives), labels applied with the aid of hot-melt adhesive applications and general recommendations for the use of recyclable adhesive applications are currently under revision.[116]

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 (e.g. PE insert in PE bowl) or is easy to mechanically separate 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, the recycling infrastructure in Austria, Germany and the Netherlands has been adapted to the most frequently used materials. In the case of materials that are seldom used on the market, no appropriate recovery streams 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 frequently used materials. The rare materials that should not be used include polycarbonate (PC) and polyvinyl chloride (PVC).

COMPOSTABLE PLASTICS

Bio-based plastics (e.g. bio-PE, bio-PP or bio-PET) must 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 to the recycling process 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 noncompostable 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 worthwhile (e.g. coffee capsules, fresh meat packaging) in future. However, evidence of industrial composting must be provided and communicated to the final consumers.

It is specially advised not to use oxo-degradable plastics, i.e. 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 have, in any case, been banned under the Single Use Plastics Directive of the EU (2019/904, Article 5) since 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 film with a good barrier function and thus 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

Composite beverage cartons (CBCs) usually consist of a single or double-sided LDPE-coated carton and, if necessary, an intermediate aluminium layer (for longer-lasting products). 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 beverage composite cartons. For this reason, sorting problems can occur if the outer layers are not made of PE and cardboard as usual.[117] 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 then takes place in special pulpers, in which the fibre content of the shredded packaging materials is separated and its use in new paper-based products is made possible. 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 current developments aim to increase material recovery of BCs, and polyethylene and aluminium components in particular. Therefore, 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.

RECOMMENDATIONS FOR RECYCLABLE BEVERAGE CARTONS

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

Recyclability of composite beverage cartons				
Component		Good	Limited	Poor
Base packaging	Origin of fibres	Conifers and deciduous trees	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 and seam sealants	One-sided plastic coating or plastic laminate (PE) Two-sided plastic coating or plastic laminate (PE)		Metallized surfaces or coatings which impair NIR detection
	Printing	Colours comply with EuPIA		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/PAPERBOARD/CARDBOARD

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 can the waste paper types (according to EN643) be provided, which can then 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 *Multilayer Materials with Plastic Content*).

RECOMMENDATIONS FOR RECYCLABLE PAPER/PAPERBOARD PACKAGING

Recyclability of paper / board / cardboard packaging				
	Component	Good	Limited	Poor
Base packaging	Origin of fibres	Conifers and deciduous trees	Non-woody plants such as hemp, grass, cotton etc.	
	Coatings[118]	Without coating; One-sided plastic coating or plastic laminate if fibre content > 95%	One-sided plastic coating or plastic laminate if fibre content is 85 to 95% Metallised paper if metallization is less than 60% of the surface	Plastic coating on both sides[119] One-sided plastic coating or plastic laminate if fibre content < 85% Wax coating Silicone papers
	Adhesive applications[120]	*Currently being revised*	*Currently being revised*	*Currently being revised*

[118] The stated minimum fibre content limits are current recommendations which may be adapted after publication of the CEPI guideline.
[119] Composite cartons are an exception to this.
[120] Specific requirements for adhesive applications and recommendations are currently being worked on in the "Focus Group Recycling-Ready Adhesives".

Recyclability of paper / board / cardboard packaging				
Component		Good	Limited	Poor
Base packaging	Additives	Mineral fillers such as kaolin, talk and calcium carbonate Titanium dioxide (white pigment) Starch (filler)		Wets-strength fibre content[121]
	Printing	EuPIA-compliant colours[122]		Colours containing mineral oil
Designs		Minimal printing without combination with non fibre-based materials Adhesive tapes with cellulose substrates that can be easily defibrated and easily removable adhesive tapes or adhesive applications	Adhesive tapes or adhesive applications that are not easy to separate; 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 currently under revision[123].

Additive

Some speciality 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.

[121] Possible exceptions must be tested in each individual case
[122] 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.
[123] Specific requirements for adhesive applications and recommendations are currently under review in the "Focus Group Recycling-Ready Adhesives".

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. There is also a risk of fibres sticking to the plastic residues, 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.

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 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 (e.g. inclusion of coloured dots) since they are difficult to remove in the conventional deinking process. This is particularly relevant for the recycling of graphic paper but should also be taken into account for packaging.

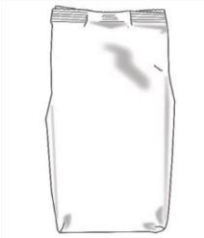
The use of mineral oil-containing inks is problematic as these substances can migrate into the packaged product. In the recycling process, mineral oil residues cannot be completely removed, which is why there are restrictions on the use of recycled paper-based packaging for food.

Special fibres

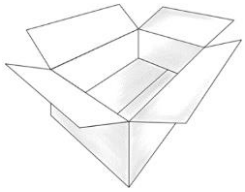
It is not completely clear how paper from non-woody (e.g. grass, hemp, cotton, etc.) fibres affects the paper recycling process. However, a small portion of non-timber fibres in the waste paper stream is considered unproblematic. Sources of application potential in this area need to be further investigated.

DESIGN EXAMPLE FOR RECYCLABLE PAPER/PAPERBOARD PACKAGING

- ✓ Undyed paper/cardboard
- ✓ Plastic coating on one side less than 5 % of the total mass
- ✓ Printing with coloured inks in conformity with the EuPIA guideline



- ✓ Undyed corrugated board
- ✓ Minimal printing with coloured inks in conformity with EuPIA
- ✓ Dividers also made of paperboard



GLASS PACKAGING

CURRENT COLLECTION AND RECOVERY STRUCTURES

Glass can be recycled almost infinitely while retaining its 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 low cullet yields. Ferromagnetic metals and aluminium can be eliminated in the sorting process.

RECOMMENDATIONS FOR RECYCLABLE GLASS PACKAGING

Recyclability of glass packaging				
	Component	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		No packaging glass such as heat-resistant glass (e.g. borosilicate glass); Lead glass; Cryolite glass; Enamel constituents
Base packaging	Colour	Green, brown, white/transparent and similar hues	Opaque colours and metallic colours	Black, dark blue
Base packaging	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
Packaging aids	Decoration	Engraving Paper labels (wet-strength)	Permanently attached plastic labels	Permanently attached and extensive 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
- ✓ Labels that can be detached in the sorting process

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, this packaging is sent to shredders or sorting plants where it is sorted out by hand or separated from other metal packaging with the help of magnetic separators.

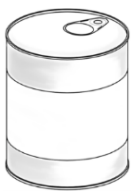
Tin plate cans thus have almost unlimited recyclability, without a loss of quality. Aerosol cans (spray dispensers with propellant) with residues of highly flammable liquid can lead to accidents in recycling plants. Therefore, this packaging must be free of product residues and propellant gas or removed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

RECOMMENDATIONS FOR RECYCLABLE TIN PLATE PACKAGING

Recyclability of tinplate packaging				
Component		Good	Limited	Poor
Base packaging	Material and additives	Ferromagnetic metals (alloys)		
Base packaging	Printing/direct printing by filler	Lacquer finish 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 wraps 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 then transported to shredding plants or sorting facilities, 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 of aluminium packaging				
Component		Good	Limited	Poor
Base packaging	Material and additives	Non-ferrous metal parts		Multilayer material[124]
Base packaging	Printing/direct printing by filler	Lacquer finish Aluminium with direct printing EuPIA-compliant coatings and printing inks		Non-compliant colours
Packaging aids	Closures	Aluminium screw-cap	Plastic closures and valve caps, if these can be separated before disposal or during the sorting process.	
Packaging aids	Decoration	Engraving		PVC label
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

[124] Possible exceptions must be tested in each individual case

EXAMPLES/ SPECIFIC APPLICATION 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 often collected separately and used as fuel for energy recovery due to the above-mentioned safety problems. Part 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 atomiser can be used and no aerosol system needs to be used.

ALUMIUM TUBES

- Aluminium tubes are usually made from 1000-series aluminium alloy. In general, design the walls of the aluminium tube to be as thin as possible to permit better flexibility, simple removal of the product and emptying of residue, and 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 to separate and dispose of separately by consumers.

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 cannot or is not recycled[125]. To prevent this, aluminium foil should be compressed before disposal by the user and pressed together to guarantee that it can be selected and to avoid oxidation in the melting furnace.

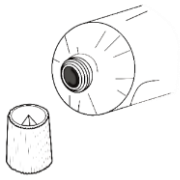
ALUMINIUM CLOSURES

- 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 EXAMPLE OF 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



[125] Possible exceptions can be tested in each individual case

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COUNTRY-SPECIFIC COLLECTION STRUCTURES

Internationalisation of design recommendations

A system for acquiring (collecting and recovering) packaging waste which is as harmonised as much as possible is the foundation for a cross-country circular economy. The considerations in the packaging design process should therefore also take the recycling structures available at international level into account. Conversely, the recycling structure of the individual country should also be matched to the materials and products on the market. Uniform packaging design and well-established recovery 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 recovery structures in individual countries. Systems also vary greatly within Europe. This is why there are also different design recommendations for recyclable packaging design. Therefore aim is to have a structure which is as harmonised as possible, in turn resulting in uniform design recommendations. Packaging producers currently face the tough challenge of meeting the various criteria for a global market.

FH Campus Wien is surveying differences in specific national design criteria, from which harmonisation efforts can be derived in the future.

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 it can be assumed that they have similar waste management systems. Despite the similar structures, there are differences in these countries due to technical or structural circumstances.

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. Technical possibilities are also not fully exploited for economic reasons. The recovery of thermoformed PET bowls 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 structures of Austria, Germany and the Netherlands.

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

Verpackungsabfallstrom		Österreich	Deutschland	Niederlande
Getränkeverbundkarton		Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
Papier		Erfassungsstruktur vorhanden (gilt auch für einseitig beschichtetes Papier)	Erfassungsstruktur vorhanden (gilt auch für einseitig beschichtetes Papier)	Erfassungsstruktur vorhanden (gilt auch für einseitig beschichtetes Papier)
Aluminium		Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
Weißblech		Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
Glas		Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
PS	starr	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden
	flexibel	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden
PVC	starr	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden
	flexibel	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden
PE	starr	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
	flexibel	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
PP	starr	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
	flexibel	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
PET	streckblasgeformt	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden	Erfassungsstruktur vorhanden
	thermogeformt	Recycling eingeschränkt möglich	keine separate Erfassungsstruktur vorhanden	Recycling ist möglich
	flexibel	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden	keine separate Erfassungsstruktur vorhanden

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 being 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 with regard to its recyclability 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

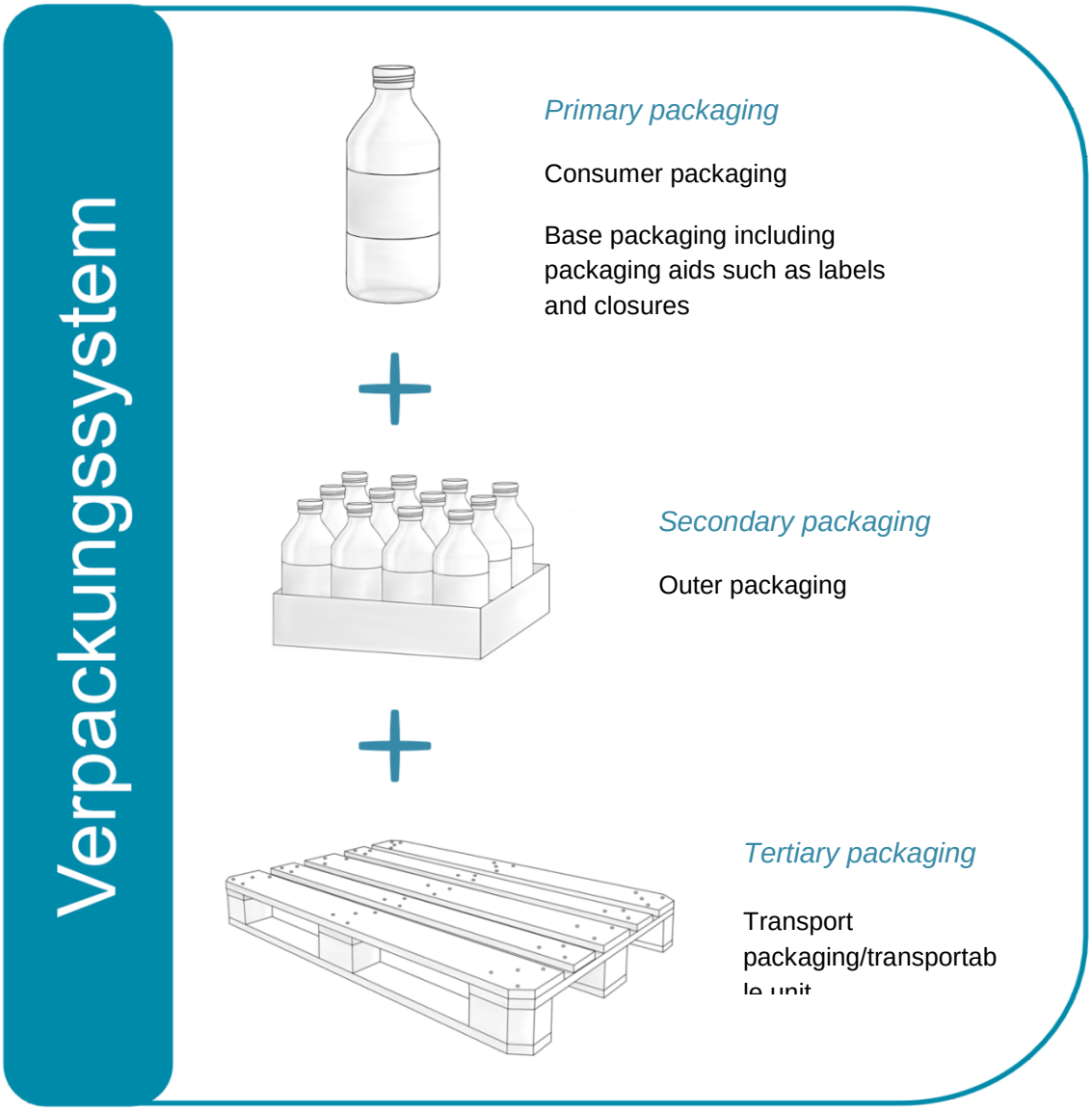
Packforce Austria:
communication and information platform for the Austrian packaging industry

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 articles	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 article 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.
Wet strength	Wet strength is a quantitative property and can be described with tensile strength and wet strength retention (ISO 3781). Whether a paper is wet strength or not is a property of the paper itself. If the paper does not fray in water, it is wet strength. It does not matter whether the paper is still adherent, shredded or not.
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.
Composite material / multilayer / multi-layer composite /	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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