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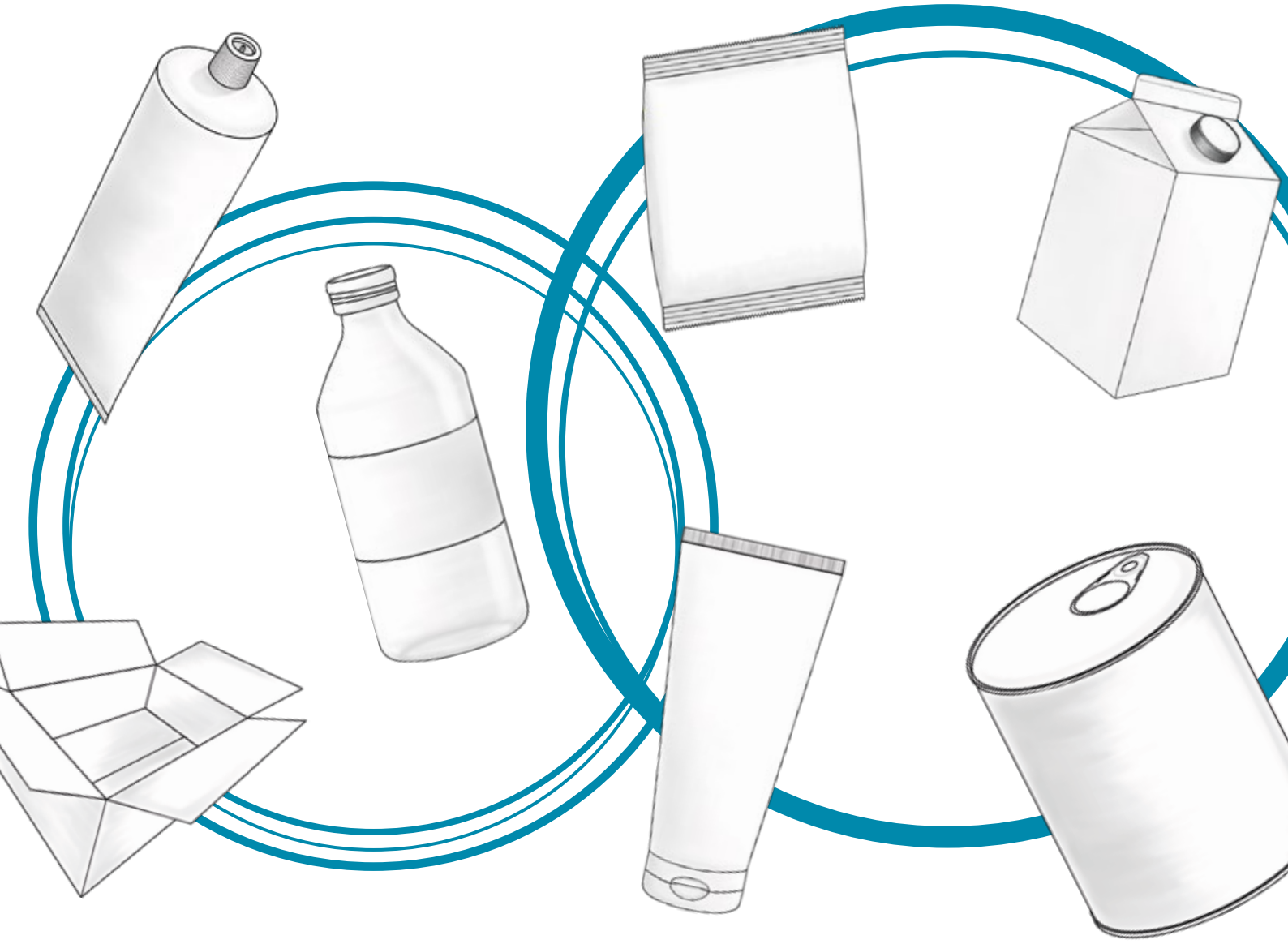
Circular Packaging Design Guideline

Design Recommendations for Recyclable Packaging

Version 06, September 2024

APPLIED LIFE SCIENCES



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CIRCULAR ANALYTICS

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Altstoff Recycling Austria

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Media owner and publisher:
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Circular Analytics TK GmbH, Canovagasse 7/1/14, 1010 Vienna, Austria
Published by: FH-Prof.in Dr.in Silvia Apprich und Univ. Doz. Dr. Manfred Tacker
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Vienna, September 2024

“Cooperation, innovation and knowledge exchange!

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

Johannes Bergmair, General Secretary World Packaging Organisation (WPO)

CONTENTS

REVISIONS

As part of the ongoing update measures, the *Circular Packaging Design Guideline* in version 05 was revised in the areas mentioned or supplemented with the following essential content:

- Update of legal and structural framework conditions
- Update of the recommendations for plastic packaging
- Update of the recommendations for composite beverage cartons
- Update of the recommendations for paper / paperboard / cardboard
- Expansion of sources
- Extension of the glossary
- Update of the images (e.g. Circular Economy Package)

LIST OF ABBREVIATIONS

AA-Blocker	*acetaldehyde blocker*
Al_xOx	*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*
DMD	*minimum durability date*
EPBP	*European PET Bottle Platform*
EPRC	*European Paper Recycling Council*
EPS	*expanded polystyrene*
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*
NIAS	*non-intentionally added substances*
NIR	*near-infrared (spectrometer)*
OPET	*oriented polyethylene terephthalate*
OPP	*oriented polypropylene*
PA	*polyamide*
PBT	*polybutylene terephthalate*
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*
TPO	*polyolefin elastomer*
TPS	*styrene block copolymer*

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LIST OF TABLES

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 involvement of industry partners enables practical and applicable recommendations. Therefore, we would like to thank all the experts for their practical suggestions and proposals.

Special thanks also go 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.

DISCLAIMER

This guideline summarises the current state of knowledge and understanding. It is expressly pointed out that materials which are classified as “less good” in this guideline can be well recyclable in their own right. Further research is needed for this. This requires and enables further experimental investigations without meeting a minimum standard.

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 contribute significantly 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 and 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, is advocating for 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 recycled materials 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 recycled PET 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 in 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, in order 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 new material of the same type.

The *Circular Packaging Design Guideline* aims to provide recommendations for the recyclable design of packaging and addresses all players along the entire value chain. The recommendations mainly refer to household packaging. For commercial packaging (volume > 5 L), these recommendations 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 innovation (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.

When using the term bioplastics, it is important to differentiate between bio-based and bio-degradable plastics. Bio-plastics can have one of the two properties or both. Bio-based plastics, so-called drop-in polymers (e.g.: bio-PE), are already increasingly being used and do not pose a problem in the recycling process due to their chemical structure. In contrast, there is no functioning

recycling system for biodegradable plastics. The materials are only biodegradable under certain conditions and are, therefore, undesirable in industrial composting. Their chemical structure also differs from that of conventional plastics and drop-in solutions and is, therefore, not suitable for the same recycling stream. As there is no separate waste stream for bio-degradable plastics at the moment, the majority of them are incinerated.

Information from the following sources was used as a basis for the preparation of this Guideline in the currently valid version:

- APR Design Guide for Plastics Recyclability (The Association of Plastics Recyclers)
- Circularity by Design Guideline for Fibre-based Packaging (4evergreen)
- Design for Recycling Guidelines (Plastics Recyclers Europe)
- Design for Recycling – for packaging and paper in South Africa (Packaging SA)
- 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)
- Guidelines to facilitate the recycling of packaging (CONAI)
- KIDV Recycle Check (Netherlands Institute for Sustainable Packaging)
  Minimum Standard for determining the recyclability of packaging subject to system participation pursuant to section 21 (3) VerpackG - German Central Agency Packaging Register)
- Paper and Board Packaging Recyclability Guidelines (Confederation of Paper Industries, CPI)
- PET Bottles Design Guidelines (European PET Bottle Platform)
- Verification and examination of recyclability (cyclos-HTP)
- Quickstart Guide to Designing for Recyclability (APCO)
- Recyclability by Design (Recycling of Used Plastics Limited: RECOUP)
- Recyclability of plastic packaging - Improving Recycling Through Eco-design (Cotrep)
- Guidance on the Improved Collection and Sorting of Fire-based Packaging for Recycling (4evergreen)
- Recyclingfähigkeit von Verpackungen – Konkretisierung Untersuchungsrahmen und Kriterienkatalog (bifa Umweltinstitut) [Recyclability of packaging – definitions, investigation framework and list of criteria, bifa Environmental Institute]
- Richtlinien für recyclingorientiertes Produktdesign (Design for Recycling Product Design Guidelines, RecyClass)

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 of recyclable packaging material. Nevertheless, 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 (page 95).

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 achieve an increase in recyclability, it is not only necessary to have a “circular design” that is adapted to current structures and technologies, but also to continuously develop sorting, separating and recycling technologies. 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:

Figure 1 Structure Circular Packaging Design Guideline

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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 in order to combine maximum functionality and protection of goods on the one hand and 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

The packaging must not pose a health or safety risk to humans or the ecosystem at any stage of the 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.

Circularity

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 new 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".

Mainly due to legal requirements in particular, the focus of ecological sustainability in the packaging industry is currently on closing material and product cycles. The EU Circular Economy Package, which came into force in July 2018, contains requirements to promote the EU-wide recycling of raw materials. In 2018, the package led to modifications of the EU Directive on packaging and packaging waste (94/62/EC), in combination with the Landfill Directive (1999/31/EC), as well as the superordinate Waste Framework Directive (2008/98/EC).

The package is accompanied by a specific strategy paper for plastics (A European Strategy for Plastics in a Circular Economy, or EU Plastics Strategy). This focus is increasingly on the recycling rates for all packaging materials and on intensifying extended producer responsibility schemes. By 2030, all plastic packaging placed on the market in the EU should be reusable or recyclable in a cost-effective manner. In addition, 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 8) for an improved overview. Producers of plastic packaging, in particular, are thus faced with a major challenge, as an increase in recycling rates from the current 22.5% to 55% by 2030 is planned (2018/852/EC amending Directive 94/62/EC). The new Single Use Plastics Directive (2019/904/EC) also contains regulations on single-use products made entirely or partly of plastic.

The directive 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 generally disposed of after a single use and are not reused or recycled. Also, disposable expanded polystyrene food packaging intended to be consumed on site or taken away as take-away meals will be banned. Article 9 of the Directive additionally requires the separate collection of beverage bottles up to three litres (including their tops) at a rate of 77% (by 2025) and 90% (by 2029) (Table 1). Similarly, from 3 July 2024 (in accordance with Article 6), only beverage containers of up to three litres made wholly or partly of plastic may be placed on the market if their closures or lids remain attached to the container for the duration of their intended use (this also applies to composite beverage containers).

This is intended to counteract the high littering potential that such closures have. In addition, the directive sets new targets for the minimum recycled content: A new minimum content of 25% by

2025 applies to PET bottles and 30% by 2030 to plastic beverage bottles up to three litres (see below).

OVERVIEW OF THE RECYCLING TARGETS

		2025	2030
Recycling rates until 2030[1]	Plastic	50%	55%
	Ferrous metals	70%	80%
	Aluminium	50%	60%
	Glass	70%	75%
	Paper, cardboard, paperboard 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%

Table 1 Overview of the recycling targets

[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

In order to increase the collection rates for beverage bottles, Austria is focusing on the introduction of a one-way deposit system for beverage bottles. According to the Waste Management Act (AWG) amendment to the circular economy package (December 2021), this is to be organised by manufacturers and trade. In order to avoid greenhouse gases, the amendment to the AWG also stipulates that transports of waste over ten tonnes should be transferred by trail in the future.

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 amend 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). Therefore, the recycling rate can be differentiated from technical recyclability.

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

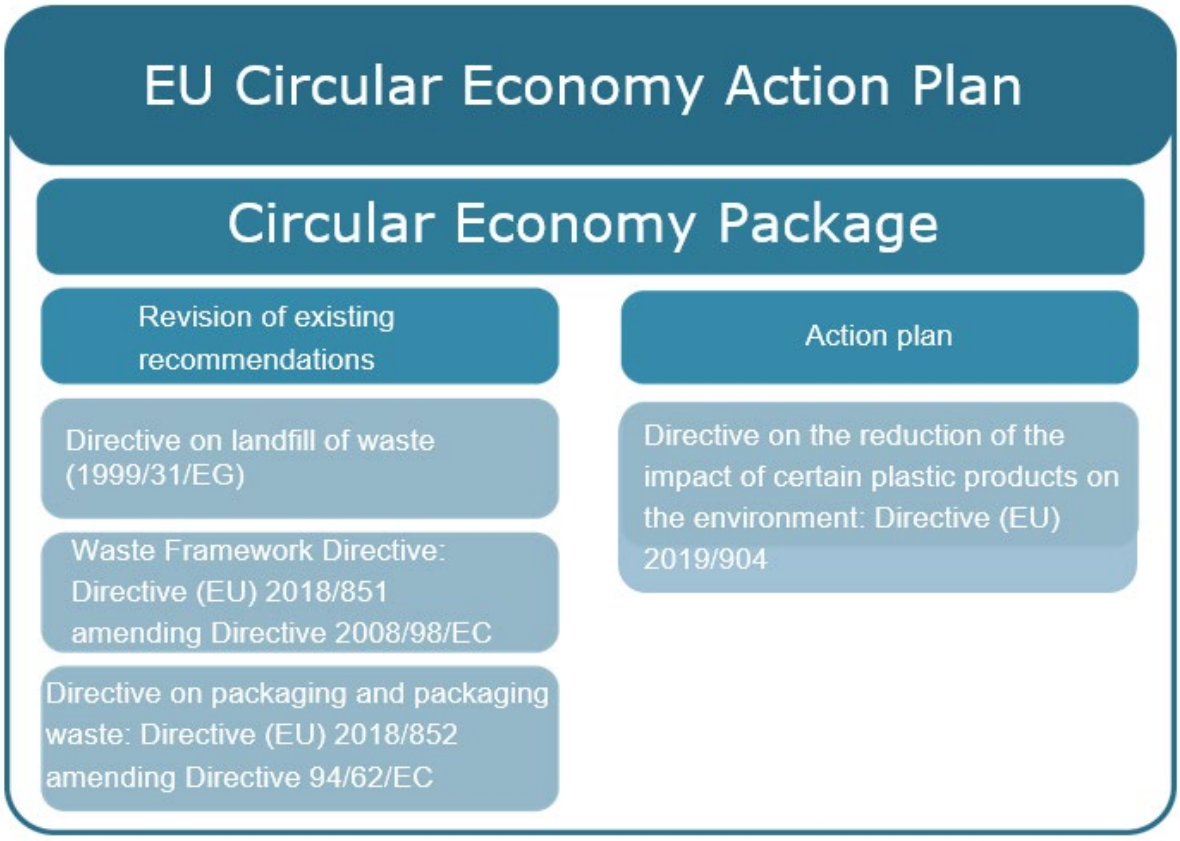

Figure 2 EU Cicular Economy Action Plan

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 €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. In both countries, the levies are to be passed on to the manufacturers and distributors in order to achieve a steering effect. In Austria, the introduction of eco-modulation is currently still in the planning stage. The licence tariffs reflect the costs for collection, sorting and recycling. In contrast, eco-modulation is intended to create financial incentives to bring recyclable products onto the market – this is, therefore, to be organisationally separate and not covered by the "licence tariffs". In Austria and Germany, concrete regulations are still pending.

With the "Sustainable Product Initiative", the EU took a step towards the circular economy in March 2022. In this bill, the requirements for eco-design, the introduction of a digital product passport and the prohibition of destruction of unsold consumer products are announced. In particular, durability, reliability, reusability, retrofitting capability, repairability, possibility of maintenance and overhaul,

energy and resource efficiency, recycled content and the presence of substances of concern are addressed here.

In addition, a strategy for sustainable and recyclable textiles, a strategy for a revised Construction Products Regulation and a proposal to empower consumers to go green were also published in March 2022.

On 30 November 2022, the second package of measures was published as part of the New Circular Economy Action Plan. On the one hand, this contains the EU's policy framework for the procurement, labelling and use of bio-based plastics and the use of biodegradable and compostable plastics. On the other hand, the second package contains the draft for a packaging and packaging waste regulation. With this publication the European Commission's endeavours to regulate packaging in the coming decades became tangible for the first time. The ambitious recycling targets for all materials by 2025 and 2030, which are already known from the Packaging and Packaging Waste Directive (Directive (EU) 2018/852), remain in place. In addition, all packaging on the European market must be recyclable by 2030. The draft provides for the introduction of recyclability levels (see Figure 3), which must be used to categorise all packaging.

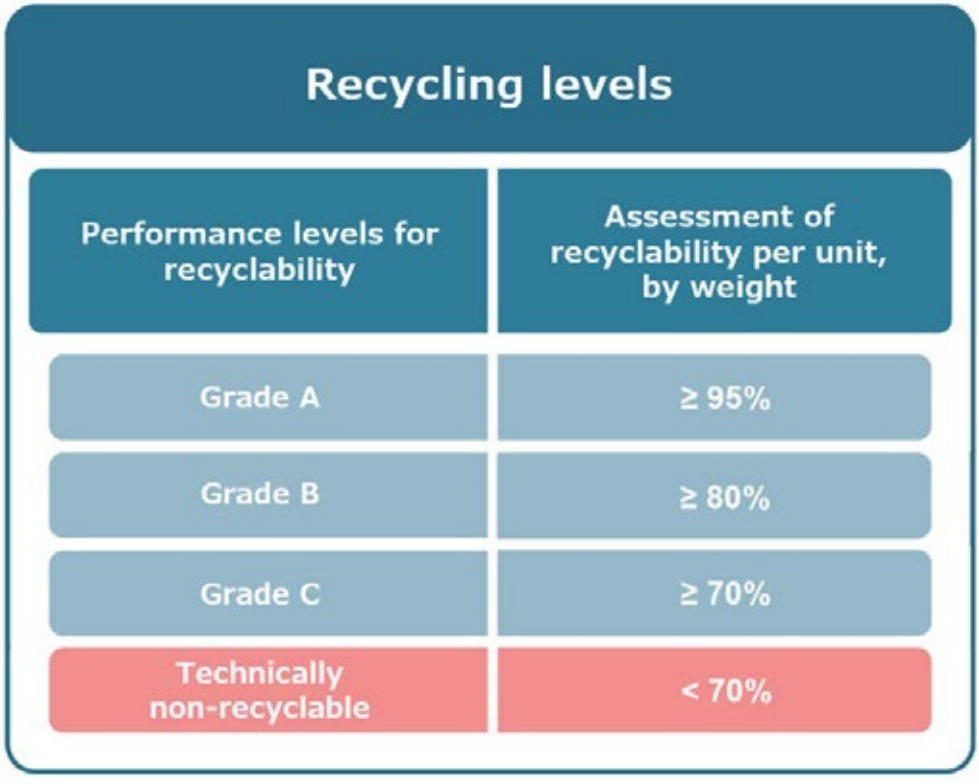

Figure 3 Recycling levels PPWR

If packaging has a recyclability of <70%, it may no longer be placed on the European market by 2030. From (provisionally) 2030, packaging must continue to fulfil design for recycling criteria to be defined by the Commission in delegated acts. From (provisionally) 2035, packaging must be ‘recycled at scale’ to be considered recyclable.

In addition, plastic packaging must contain a minimum proportion of post-consumer recyclate and reuse targets must be met for all packaging, by 2030. As part of this, waste reduction targets will be prescribed for the member states to reduce waste volumes and promote reuse and refilling. In addition, certain packaging formats (particularly in the HORECA sector) will be banned when the regulation comes into force.

In March 2023, the proposal for a directive on green claims and a proposal to promote the repair of goods were published as part of the third package of measures of the New Circular Economy Action Plan. In the course of 2023, the revision of the Waste Framework Directive (with a focus on textiles) and the initiative to reduce the impact of microplastics were also presented.

As part of the European legislative process, the Ecodesign Directive and the Packaging and Packaging Waste Regulation were adopted by the European Parliament at the first reading in April 2024 and the Green Claims Directive in March 2024.

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.

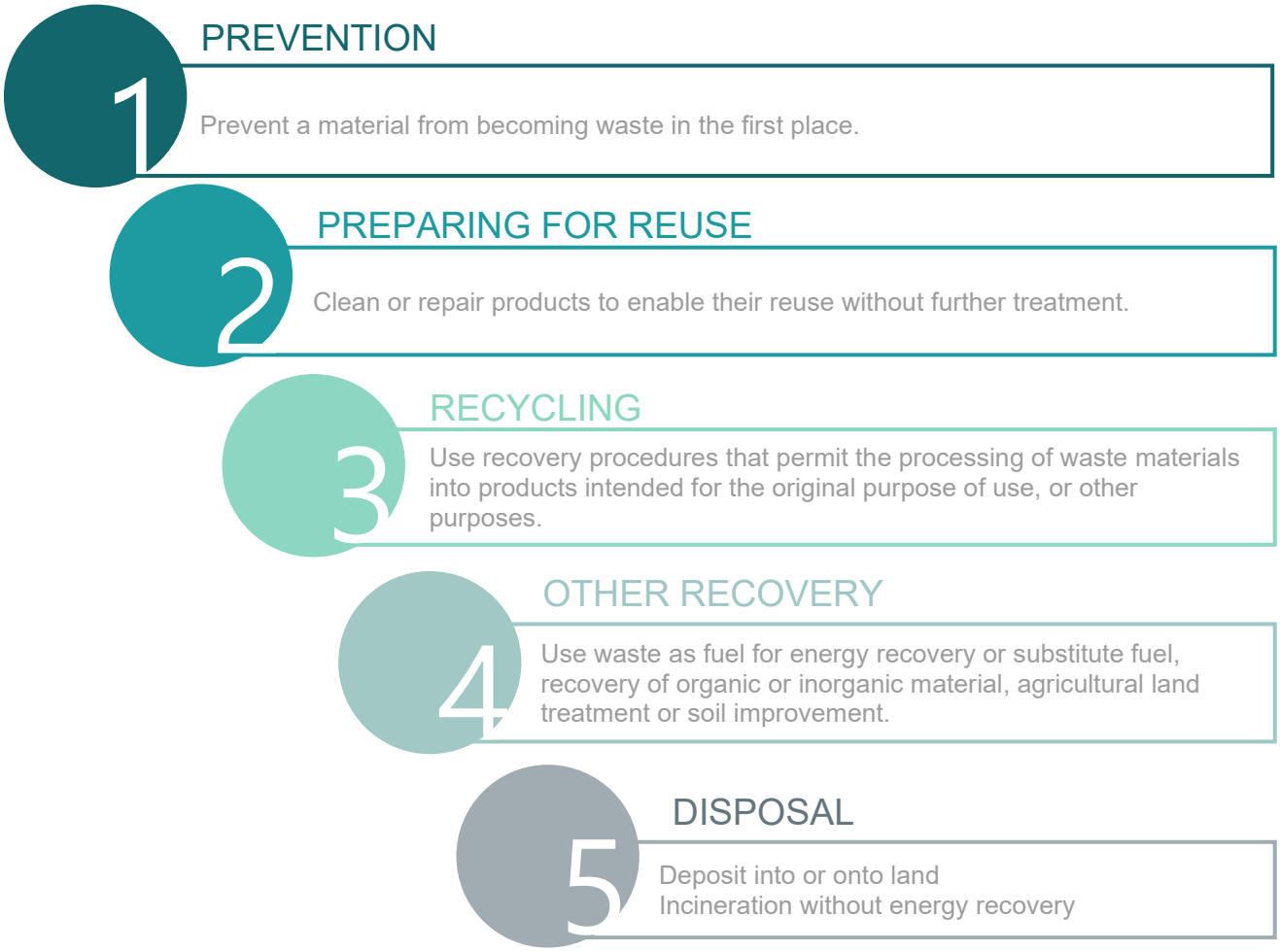

Figure 4 waste hierarchy

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 recycled materials) so that recycled polyolefin materials (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 new material of the same type, i.e. the secondary material must meet the quality and safety standards that permit its replacement of the 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 new material of the same type.	Mass fraction
Qualitative	Questionnaire-based assessment methods that survey product properties such as material composition, colour or the ability to empty the product	Scale□ (e.g. from A to F; or categories such as very good/good/limited/no recyclability)

Table 2 Current methods of recyclability assessment

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 sorting capability and technical recyclability:

Sorting capability

Sorting capability is considered a basic prerequisite for recyclability. It must be ensured that material-specific, state-of-the-art sorting techniques can be used. Sorting capability depends on both detectability and correct identification (for example, material is detected by a specific near-infrared spectrum) and also the orting capability 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 according to the state-of-the-art technology available on the market in the respective country,
- as well as state-of-the-art processing technologies for the (material) recycling process;
- and the secondary raw materials obtained from them have market potential to be recycled as substitute new materials.

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

The technical recyclability must be distinguished from the actual recycling rate (see chapter *Regulatory Background*, paragraph Recycling rate).

Recycling rate

The recycling rate refers to the proportion of recyclable materials actually recycled from waste in relation to the market quantity placed on the market. The recycling rate depends on the collection, sorting and recovery rates. In contrast to the recovery rate, the energy recovery of recyclable materials from waste (e.g.: incineration) is not included; therefore, the two terms must not be used as synonyms. Accordingly, the recovery rate is always greater than the 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. However, this poses the risk of premature spoilage and thus negative environmental impacts.

FH Campus Wien research has led to the production of a 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

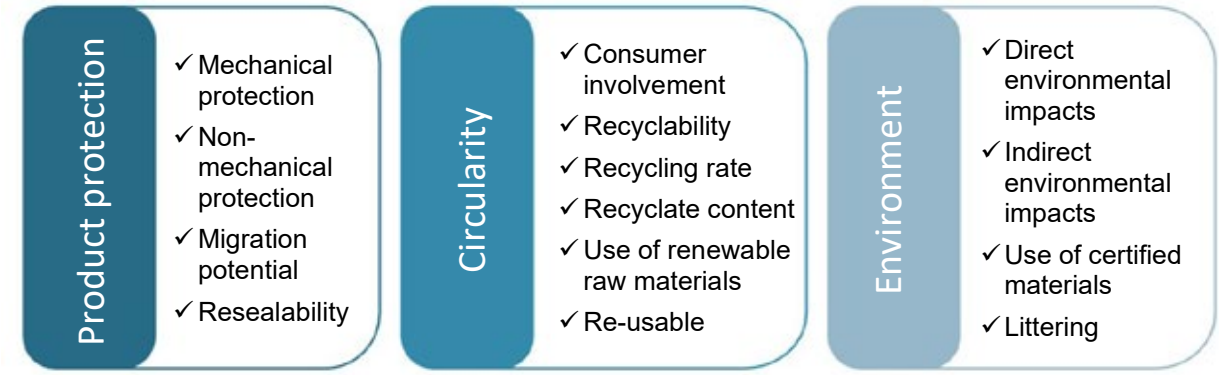

Figure 5 Model for holistic sustainability assessments of packaging

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. The possibility of resealing the packaging should be considered, as this can provide 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, recycled material 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 the ability to empty the product fully. 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).

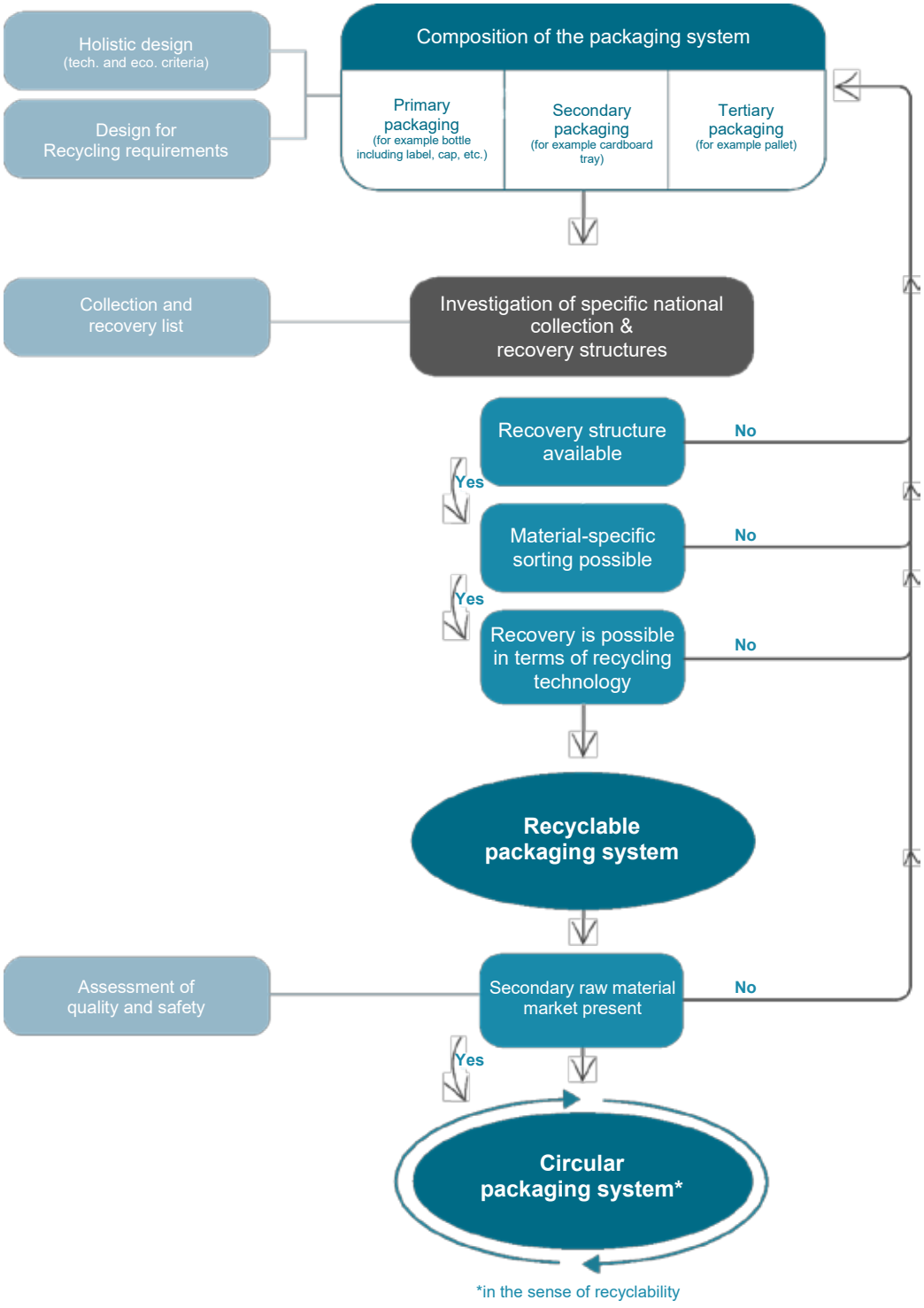


Figure 6 Steps in the design process

In the sense of the waste hierarchy (see Figure 6), the first step should be to reduce the use of packaging material as much as possible (avoidance) or to enable the reuse of packaging (reusable). 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. If different materials are combined in a multi-layer composite, material recycling cannot be carried out in many cases (however, new barrier and also recycling technologies are constantly being worked on, which must also be taken into account).
- 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 recycled material 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.

MATERIAL COLOUR

- In general, avoid or minimise dyeing of packaging materials. Strongly coloured materials can lead to a reduction in the material value of the recycled material in the case of paper or plastic. It is also important to use standard colours for glass packaging.
- In addition, dyes based on carbon black can lead to non-detection and thus rejection of the material during NIR detection in the plastic sorting process. However, black and dark dyes are already available that are not based on carbon black and do not negatively affect NIR detection.

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.
- New research results (Lisiecki, 2024) (not yet published) show that some of the pigments used in printing inks in the packaging sector are not designed for the temperatures used in mechanical recycling.
- Likewise, some NC-based printing inks are not heat resistant and are unsuitable for mechanical recycling (EuPIA 2021).
- 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, the ability to empty the product fully can be difficult. Depending on the properties of the filling material, residues may 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 justified by the minimisation of littering potential (input into the environment) and by compliance with Directive 2019/904/EC for beverage containers (wholly or partly made of plastic). For example, screw caps, which are integrated into the reclosure process, or stay-on closures, which adhere to the packaging, can be used. At best, the connection should be made mechanically to allow for later detachment in the sorting process. For all beverage containers with a volume of up to 3 litres, the closures on the main body must remain in place from July 2024 (Directive (EU) 2019/904).
- 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 if possible (film residues, adhesive application residues, etc.) on the packaging material.
- If the packaging is sealed using adhesives, the adhesive application should be adapted to the given recycling processes (research is required for further material-specific details in the area of the adhesive applications used).

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. However, if an active participation of the final consumer is foreseen or assumed (e.g. when separating a cardboard wrap around a plastic cup), the correct separation and disposal of the components must be proven and documented by empirical surveys (e.g. case study).

DEFINITION FOR ASSIGNMENT TO RECYCLABILITY CATEGORIES

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 base packaging 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. These include staples, seals, adhesive tapes, labels, tape, sleeves, closures, pull-on 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

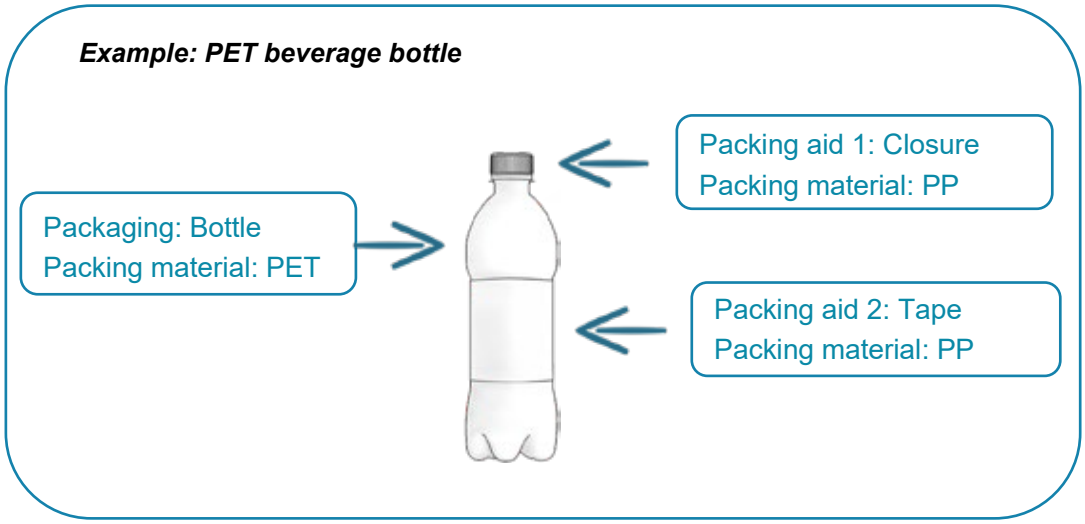


Figure 7 example: PET bottle - terminology

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 either be disposed of with the tape and cap attached (disposal unit = bottle + band + cap), or the tape can be detached in advance (disposal unit 1 = bottle + cap / disposal unit 2 = band).

In general, it is advantageous if the disposal unit consists of one type of material (example: bottle and attached closure are both made of PP) or if it is adapted to the structural conditions of the sorting and recycling process (e.g. bottle and closure are made 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 technical and / or structural reasons, but have no negative impact on the recyclability of the packaging (e.g. detachable label on PET beverage bottle made of non-recyclable material).

Restrictions due to insufficient sorting capability

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 of packaging components	
Good compatibility	1) The packaging component can be collected, sorted and the material can be recovered with state-of-the art mechanical recycling processes. 2) An industrial-scale recovery stream is available, and the recycled material can be used for high-quality applications, or applications requiring identical material, respectively.
Limited compatibility	1) The packaging component is recyclable, but affects the recycled material 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. PETG in PET beverage bottle)

Figure 8 Classification of recyclability

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 separation of the individual components from different materials in the sorting or recycling process
- Colours should be used as little as possible
- Avoid using small parts that can be removed by the consumer
- Currently, packaging components that do not correspond to a minimum size of 5x5 cm are rejected in the sorting process. The most recent Austrian systems can detect packaging components with a minimum size of 2x2 cm
- Use of sortable and recyclable packaging aids in coordination with the material of the packaging (for details see chapter *Packaging aid recommendations at a glance*).
- An assessment of recyclability on the basis of individual packaging components is permissible if these must be irrevocably separated for use and consumption, or if components of combination packaging separate independently during collection and sorting due to the mechanical stresses that occur and are therefore loaded individually in the sorting process. (e.g. self-separating plastic/carton sleeve; snap-on lid for yoghurt pots).

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, recycled materials can be used for producing high-quality products that can be used as a full substitute for new 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 bottles – transparent and light blue				
		Good	Limited	Poor
Base packaging	Material	PET		Materials with a density > 1 g/cm³, for example PVC, PS, PLA, PETG,PBT,PC
	Additives		UV stabilisers AA blocker Optical brighteners Oxygen absorber	Nanoparticles; Additives that induce biodegradation/oxo/photo-degradation of the packaging
	Barriers[1]	No barrier layer; SiO_x	Carbon plasma coating PTN alloy PGA multilayer	EVOH
	Colour	transparent; transparent - light blue/ light green		Carbon-black based colours metallic pigments; Bleeding colours fluorescent pigments; other transparent colours; opaque colours

[1] Special cases, such as PA-MXD6 with a max. 5 wt. % PA-MXD6 or with bonding layers; monolayer PA-MXD6 blend are possible, see RecyClass: https://recyclass.eu/guidelines/clear-pet-bottles/ and https://www.epbp.org/.

Recyclability of PET bottles – transparent and light blue				
		Good	Limited	Poor
Base packaging	Printing[2]	EuPIA-compliant printing inks Non-bleeding colours no direct printing	PVC-based colours	extensive direct printing
	Coding (batch code, best before date)	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-compliant inks 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 liner; foamed PET (density < 1g/cm³); fixed closures[3]	Silicone (density < 0.95 g/cm³); unattached closings[3]	Metals; Thermosets; not completely washable seals or silicones; Glass and metal springs in pump systems Non-separable or separated materials with a density > 1 g/cm³ e.g. POM, PET-G, PVC, PS

[2] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[3] For all beverage containers with a volume of up to 3 litres, the closures on the main body must remain in place from July 2024 (Directive (EU) 2019/904).

Recyclability of PET bottles – transparent and light blue				
		Good	Limited	Poor
Packaging aid – decoration	Label material	Materials with a density < 1 g/cm³ [4], for example, PP, PE, OPP, EPS, foamed PET, LDPET	Paper labels removable under cold wash conditions; lightly metallised labels	metallised labels; Paper labels not removable under cold wash conditions; 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-washable or welded labels
Packaging aid – decoration	Label adhesive	in caustic soda solution – hot wash removable adhesive applications (at 60 - 80°C)		not in caustic soda solution – hot wash removable adhesive applications (at 60 - 80°C)
	Adhesive-free decoration (sleeve, etc.)	Materials with a density < 1 g/cm³, for example, PP, PE, OPP, EPS, foamed PET, LDPET		metallised materials; foamed PETG sleeves (also with density <1 g/cm³); Materials with a density > 1 g/cm³, e.g. PVC, PS or PET, PETG, PLA
	Size limitation	Decoration covers < 50%[5] or 70%[6] of the packaging surface		Decoration covers > 50% resp. > 70% of the packaging surface[7]
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] Materials with a density < 1 g/cm³ must not exceed this target value after printing. The density properties must not shift into the negative range during the recycling process (density change possible due to shrinkage)
[5] For bottles with a filling quantity of ≤ 500 ml
[6] For bottles with a filling quantity of > 500 ml
[7] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test in order to be considered recyclable.

PET BOTTLES - COLOURED

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

Recyclability of PET bottles - coloured		Good	Limited	Poor
Base packaging	Material	PET		Materials with a density > 1 g/cm³, for example PVC, PS, PLA, PETG
Base packaging	Additives		UV stabilisers AA blocker Optical brighteners Oxygen absorber	PA additive (PET-A copolymer) Density-modifying materials Nanoparticles; Additives that induce biodegradation/oxo/photo-degradation of the packaging
Base packaging	Barriers[8]	No barrier layer; Carbon plasma coating SiOx; PTN alloy	EVOH-Multilayer (max. 3 wt. % EVOH) and no adhesion promoters; PGA multilayer	EVOH multilayers with more than 3 wt. % EVOH or with adhesion promoter
Base packaging	Colour	transparent, light colours	transparent, dark colours[9]; opaque colours[10]	Carbon-black based colours metallic pigments; fluorescent pigments
Base packaging	Printing[11]	EuPIA-compliant printing inks minimal direct printing	PVC-based colours	Bleeding colours extensive direct printing
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-compliant inks are used.	

[8] Special cases such as PA-MXD6 with max. 6 wt. % PA-MXD6 are possible, see RecyClass: https://recyclass.eu/guidelines/coloured-pet-bottles/.
[9] Provided that the detectability by means of NIR is not affected.
[10] Valid only in Austria – in Austria, opaque PET bottles are included in the recycling system (recommendation of FH Campus Wien).
[11] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PET bottles - coloured				
		Good	Limited	Poor
Packaging aids – closures	Closures (snap-on caps, screw caps, etc.) + liners, seals and valves	PP, HDPE Materials with a density < 1 g/cm³ fixed closures[12]	Silicone (density < 0.95 g/cm³); non-fixed closures[12]	Metals; Thermosets; not completely washable seals or silicones; Glass and metal springs in pump systems Non-separable or separated 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 removable under cold wash conditions; Lightly metallised labels (density < 1 g/cm³)	metallised labels; Paper labels not removable under cold wash conditions; foamed PETG labels (also with density < 1 g/cm³); Materials with a density > 1 g/cm³ for example, PVC, OPS, PET, PETG, PLA; non-washable or welded labels
	Label adhesive	in caustic soda solution – hot wash removable adhesive applications (at 60 - 80°C)		not in caustic soda solution – hot wash removable adhesive applications (at 60 - 80°C)

[12] For all beverage containers with a volume of up to 3 litres, the closures on the main body must remain in place from July 2024 (Directive (EU) 2019/904).

Recyclability of PET bottles - coloured				
		Good	Limited	Poor
Packaging aid – decoration	Adhesive-free decoration (sleeve, etc.)	Materials with a density < 1 g/cm³ [13], for example, PP, PE, OPP, EPS, foamed PET, LDPET		metallised materials; foamed PETG sleeves (also with density <1 g/cm³); Materials with a density > 1 g/cm³, e.g. PVC, OPS, PET, PETG, PLA
	Size restriction	Decoration covers < 50% [14] or 70% [15] of the packaging surface		Decoration covers > 50% or 70% of the packaging surface [16]
Packaging aids - Other	Other components	PET other components (e.g. handles) which can be crushed and separated in the float-sink process (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

[13] Materials with a density < 1 g/cm³ must not exceed this target value after printing. The density properties must not shift into the negative range during the recycling process (density change possible due to shrinkage)
[14] For bottles with a filling quantity of ≤ 500 ml
[15] For bottles with a filling quantity of > 500 ml
[16] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

PET TRAYS - TRANSPARENT

RECOMMENDATIONS FOR RECYCLABLE PET PACKAGING

Recyclability of PET trays - transparent				
		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)
	Additives	Silicone coating; Antiblocking masterbatch (max. 3%)	UV stabilisers AA blocker Optical brighteners Antiblocking masterbatch (> 3%); Antistatic agents; Antiblocking agents; Antifogging 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 oxygen absorbers
	Colour	transparent; transparent – light blue	opaque colours[17]; other transparent colours[17]	Carbon-black based colours metallic pigments; fluorescent pigments
	Printing[18]	EuPIA-compliant printing inks minimal direct printing	PVC-based colours	Bleeding colours extensive direct printing

[17] Provided that the detectability by means of NIR is not affected.
[18] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PET trays - transparent				
		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-compliant inks are used.	all other types of direct printing
Packaging aids - closures	Rigid closures (snap-on lid, screw-type closure 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 films in which the foam structure is not destroyed at 90°C; SiOx, AlOx plasma as barrier		Non-separable or separated materials with a density > 1 g/cm³
Packaging aid – decoration	Label material	Material with a density □ < 1 g/cm³ [19], e.g. PP, PE, OPP	Paper labels removable under cold wash conditions;	Materials with a density > 1 g/cm³ for example PVC, OPS, PET, PETG, PLA Paper labels not removable under cold wash conditions; non-floating paper labels
	Label adhesive	hot wash removable adhesive applications (at 60 - 80°C)		adhesive applications that cannot be removed in a hot wash (at 60 - 80°C)

[19] Materials with a density < 1 g/cm³ must not exceed this target value after printing. The density properties must not shift into the negative range during the recycling process (density change possible due to shrinkage)

Recyclability of PET trays - transparent				
		Good	Limited	Poor
Packaging aid – decoration	Size restriction	Decoration covers ≤ 30% of the packaging surface		Decoration covers > 30% of the packaging surface[20]
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	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 recycled material.

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.

[20] If the decoration covers more than 30% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test in order 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 basic recommendations mentioned in the table above.

PET BOTTLES

- Avoid contaminants that can lead to the formation of acidic compounds in the extrusion process, as this can reduce intrinsic viscosity. This primarily applies to PVC and EVOH.
- Avoid polymers with a similar density or a density 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 they have a density above 1 g/m³ and thus cannot be distinguished from the PET bottle material. There is a risk of colour contamination and quality limitations from recycled PET.

PET FILMS

- There is currently no recycling stream for PET film.
- 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 recycled material.
- 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, the recycling of thermoformed PET trays is promising.[21]
- In addition, improvements in NIR detection systems may, in future, enable the separation of APET and PETG or multilayer PET trays.
- Plastic and cardboard sleeves that separate themselves from the main body under mechanical pressure do not interfere with the recyclability of the main body.

EXAMPLE OF A RECYCLABLE PET PACKAGE

- ✓ 100% PET bottle or tray 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% of the area
- ✓ Batch number/DMD as laser marking

[21] If it is APET, PET from applications other than beverage bottles is also recorded 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 films - transparent				
		Good	Limited	Poor
Base packaging	Material	PP; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP).	Multilayer composite PP/PE with PE ≤ 10 wt.%[22]	Other polymers Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Additives	Additives if density remains < 0.97 g/ cm³		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm³; 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[23] with adhesion promoters; Aluminium vapour deposition (metallisation)[24] without additional coating	EVOH[23] with adhesion promoters; PVC, PVDC, PA; Aluminium foils[25]; other barriers

[22] The value applies to injection moulding (reference process) and is unsuitable for blow moulding
[23]Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[24] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallisation has been applied to the inside of a film bag.
[25] Deviating findings must be examined on a case-by-case basis.

Recyclability for PP films - transparent				
		Good	Limited	Poor
Base packaging	Colour	transparent, uncoloured	light colours; translucent colours	black or dark colours; Carbon-black based colours
	Printing[26]	EuPIA-compliant not bleeding printing inks minimal direct printing; laser printing;	Print covers < 50% of the film[27]	Non EuPIA-compliant colours bleeding inks; Print coverage >50 %
	Coding (batch coding, best before date)	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-compliant inks are used.		
	Laminating adhesives	PU ≤ 2.3 %	PU > 2.3 % < 4.5 %	Aliphatic polyurethanes > 4.5 %; Aromatic PU; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance;

[26] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[27] The recycled material's quality can be influenced by the printing.

Recyclability for PP films - transparent				
		Good	Limited	Poor
Packing aids – Closures	Rigid closures (snap-on lid, screw-type closure etc.)	PP; Closure systems without liner, if necessary PP liner	PE (HDPE, LDPE, LLDPE, MDPE)	Metals; Aluminium PVC, PET, PETG, PS, PLA Materials other than polyolefins with a density < 1 g/cm³; Seals or silicone that cannot be completely removed
Packing aids – Closures	Flexible closures (sealing films etc.)	PP; Sealing film; which leaves no residue after removal by the end consumer	PE (HDPE, LDPE, LLDPE, MDPE) removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS; Film composites; materials other than polyolefins or foamed materials with a density < 1 g/cm³; sealing films or silicones that are not completely washable
Packing aids – Decoration [28]	Label material	PP	PE; Paper labels removable under cold wash conditions;	metallised labels; Paper labels not removable under cold wash conditions; Labels made of other materials, e.g. PET, PLA, PVC
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	Not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[28] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

PP FILMS – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP films - coloured				
		Good	Limited	Poor
Base packaging	Material	PP; 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 ≤ 10 %	Other polymers Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Additives	Additives if density remains < 0.97 g/ cm³	PBT solvent < 5%	Additives which lead to an increase of the specific density to ≥ 0.97 g/cm³; 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 [29] with adhesion promoters; Aluminium vapour deposition (metallisation)[30] without additional coating	EVOH [30] with adhesion promoters; PVC, PVDC, PA; Aluminium foils[31]; other barriers
	Colour	light colours; translucent colours		Dark and not NIR detectable colours

[29]Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[30] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallisation has been applied to the inside of a film bag.
[31] Deviating findings must be examined on a case-by-case basis.

Recyclability for PP films - coloured				
		Good	Limited	Poor
Base packaging	Printing[32]	EuPIA-compliant printing inks minimal direct printing (< 50 % of the film); laser printing;	Print covers > 50% of the film[33]	Non EuPIA-compliant colours; Bleeding colours PVC-based 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 carried out by means of minimal direct printing, provided that food-compliant inks are used.		
	Laminating adhesives	PU ≤ 2.3 %	PU > 2.3 % < 4.5 %	Aliphatic polyurethanes > 4.5 %; Aromatic PU; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance;

[32] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[33] The recycled material's quality can be influenced by the printing.

Recyclability for PP films - coloured				
		Good	Limited	Poor
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type closure etc.)	PP; Closure systems without liner, if necessary, PP liner	PE (HDPE, LDPE, LLDPE, MDPE) removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e .g. PET, PETG, PVC, PLA, PS; 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 closure	Metals; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS; Film composites; Materials other than polyolefins with a density < 1 g/cm³.
Packing aids - Decoration [34]	Label material	PP	Paper labels removable under cold wash conditions; ; PE	metallised labels; materials containing aluminium; Paper labels not removable under cold wash conditions; Labels made of other materials, e.g. PET, PLA, PVC labels
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	Not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[34] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

PP CONTAINERS AND TUBES – NOT COLOURED AND WHITE

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP containers and tubes – not coloured and white				
		Good	Limited	Poor
Base packaging	Material	PP; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP). Multi-layer composite material with max. 5% PE	Multi-layer composite with max. 10% PE	Multilayer composite with PE > 10%; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Additives	Unavoidable additives if density remains < 0.97 g/ cm³	mineral fillers ($CaCO_3$, talc), if the density remains below 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[35]	EVOH[35] with adhesion promoters;	EVOH[35] with various binding layers and adhesion promoters PVDC, PA, Aluminium foils[36] Metallisation
	Colour	Transparent	Light colours	Black, dark or opaque colours Carbon-black based colours

[35] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[36] Deviating findings must be examined on a case-by-case basis.

Recyclability for PP containers and tubes – not coloured and white				
		Good	Limited	Poor
Base packaging	Printing[37]	EuPIA-compliant printing inks minimal direct printing	Other direct printing	Bleeding colours PVC-based colours
	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-compliant inks are used.		
	Laminating adhesives	Aliphatic PU ≤ 2.3 %	Aliphatic PU > 2.3 % < 4.5 %	Aliphatic polyurethanes > 4.5 %; Aromatic PU; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance;
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type closure etc.) + Liners, seals and valves	PP; Closure systems without liner, if necessary PP or TPE[39] Liner	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA (density > 1 g/cm3) TPO und TPS[38]	Metals; Aluminium PVC Paper compound; materials other than polyolefins and foamed materials with a density < 1 g/cm³.

[37] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[38] Deviating determinations must be examined on a case-by-case basis

Recyclability for PP containers and tubes – not coloured and white				
		Good	Limited	Poor
	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 liner, if necessary PP or TPE[39] Liner	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA TPO und TPS[40]	Metals; Aluminium PVC Paper compound; materials other than polyolefins and foamed materials with a density < 1 g/cm³.
Packing aids – Decoration [41]	Label material	PP[42]	PE; Paper labels removable under cold wash conditions; Labels made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³); Removable silicones with a density > 1 g/cm³; foamed polyolefin labels	metallised labels; Aluminium PVC Paper labels not removable under cold wash conditions; Materials other than polyolefins with a density < 1 g/cm³.
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[39] Certification required
[40] Deviating determinations must be examined on a case-by-case basis
[41] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).
[42] Provided the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.

Recyclability for PP containers and tubes – not coloured and white				
		Good	Limited	Poor
	Adhesive-free decoration (sleeve, etc.)	PO sleeve with a density < 1 g/cm³[42]	Removable sleeves/labels made of PE (with a density < 1 g/cm³); Sleeves made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³) Removeable PO foamed labels	metallised materials; PVC Aluminium Materials other than polyolefins with a density < 1 g/cm³; cardboard sleeves (not separable)
	Size restriction	Decoration covers < 50%[43] or 70%[44] of the packaging surface		Decoration covers > 50% resp. > 70% of the packaging surface[45]
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.

[43] For bottles with a filling quantity of ≤ 500 ml
[44] For bottles with a filling quantity of > 500 ml
[45] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

PP CONTAINERS AND TUBES – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PP PACKAGING

Recyclability for PP containers and tubes - coloured				
		Good	Limited	Poor
Base packaging	Material	PP; A multilayer composite material can be used if necessary if this is based on various types of PP (for example OPP, BOPP). Multi-layer composite material with max. 5% PE	Multilayer composite with max. 10% PE	Multilayer composite with PE > 10%; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Additives	Unavoidable 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[46]	EVOH[46] with adhesion promoters;	EVOH[46] with different adhesion promoters; PVDC, PA, Aluminium foils[47]
	Colour	All colours	black inner layer; dark, NIR-detectable colours	Non NIR-detectable colours; Carbon-black based colours
Base packaging	Printing[48]	EuPIA-compliant printing inks Non-bleeding colours minimal direct printing; No PVC-based colours	Other direct printing	Bleeding colour; PVC based colours

[46] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[47] Deviating findings must be examined on a case-by-case basis.
[48] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability for PP containers and tubes - coloured				
		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 carried out by means of minimal direct printing, provided that food-compliant inks are used.		
	Laminating adhesives	PU < 3 wt.%; lamination adhesives that have been tested with other barriers	PU between 3 and 4.5 wt.%; lamination adhesives tested with other barriers	PU > 4.5 wt.% ; To be tested: Acrylates; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance;
Packaging aids – Closures	Rigid closures (snap-on lid, screw-type closure etc.) + Liners, seals and valves	PP; Closure systems without liner, if necessary PP or TPE[49] Liner	PE (HDPE, LDPE, LLDPE, MDPE); TPO and TPS[50] PET, PETG, PS, PLA (density > 1g/cm3); removable aluminium closure	Metals; Aluminium PVC Paper compound; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
	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 liner, if necessary PP or TPE[51] Liner	PE (HDPE, LDPE, LLDPE, MDPE) PET, PETG, PS, PLA TPO and TPS[50]	PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³.

[49] Certification required
[50] Deviating determinations must be examined on a case-by-case basis
[51] Certification required

Recyclability for PP containers and tubes - coloured				
		Good	Limited	Poor
Packing aids – Decoration [52]	Label material	PP[53]; In-mould label made of PP	PE (density < 1 g/cm³); PET, PETG, PLA, PS (all materials with a density > 1 g/cm³); Paper labels removable under cold wash conditions; foamed polyolefin labels	metallised labels; Aluminium PVC Paper labels not removable under cold wash conditions; Materials other than polyolefins with a density < 1 g/cm³.
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)
	Adhesive-free decoration (sleeve, etc.)	PP sleeve[53]	Sleeves of PE (density < 1 g/cm³); Sleeves made of PET, PETG, PLA, PS (all materials with a density > 1 g/cm³)	metallised materials; Aluminium PVC; Cardboard sleeves (not separable) Materials other than polyolefins with a density < 1 g/cm³; heavily printed sleeves
Packaging aid – Decoration	Size restriction	Decoration covers < 50%[54] or 70%[55] of the packaging surface		Decoration covers > 50% resp. > 70% of the packaging surface[56]

[52] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).
[53] Provided the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[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% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test in order to be considered recyclable.

Recyclability for PP containers and tubes - coloured				
		Good	Limited	Poor
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.

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 peel off from the packaging when washed at up to 40°C in cold water.

PP FILM/BAGS

- If the use of a barrier is required, a carbon plasma coating, a SiO_X- or 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 metallisation 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 only be used to a limited extent and if they are, they should have water-washable (removable with cold washing up to 40°C) properties.

[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/de/uber-recyclass/richtlinien-fuer-recyclingorientiertes-produktdesign/.
[58] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

- Plastic and cardboard sleeves that separate themselves from the main body under mechanical pressure do not interfere with the recyclability of the main body.

PP TUBES

- The tube itself and its shoulder, closure and label should preferably be made of the same material. If HDPE is used for the closure or the label, the proportion of HDPE should be as small as possible
- Printing over the entire surface is admissible if in conformity with the EuPIA Exclusion List.
- Avoid the use of fillers such as chalk (filled polyolefin/FPO) if this results in a density of over 0.97 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.

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 minimal decoration with minimally printed PP in-mould label
- ✓ Batch number/DMD as laser marking on lid

POLYETHYLENE (HDPE, LDPE, LLDPE)

CURRENT COLLECTION AND RECOVERY STRUCTURES

Collection and recycling structures for hollow polyethylene packaging exist in almost all EU member states.

Europe-wide harmonisation of the design-for-recycling criteria for plastic packaging is being driven forward within the framework of the European Committee for Standardisation; publication of the standards is planned for 2025.

PE (HDPE, LDPE, LLDPE) FILMS – UNCOLOURED

RECOMMENDATIONS FOR RECYCLABLE PACKAGING MADE OF PE

Recyclability of PE films – uncoloured				
		Good	Limited	Poor
Base packaging	Material	Oriented and non-oriented LDPE, LLDPE (incl. PE plastomers), HDPE; A multi-layer composite can be used if necessary, if it is made up of different PE types (e.g. LDPE, HDPE). (Multilayer composite) EVA, EBA, EEA, EMA copolymers with vinyl acetate and acrylic monomers with ≤ 5 wt.% PP; EMAA, EAA copolymers and ionomers with ≤ 20 %	Multilayer composite with ≤ 5 wt.% PP	Multilayer composite with PP > 5 wt.% (PET, PETG, PVC, PLA, PS)
	Additives	Additives if density remains < 0.97 g/ cm³		Additives which lead to an increase of the specific density to ≥ 0.97 g/cm³; Foaming agents for chemical expansion; Additives that induce biodegradation/oxo/photo-degradation of the packaging

Recyclability of PE films – uncoloured				
		Good	Limited	Poor
	Laminating adhesives		Aliphatic PU ≤ 2.5 wt.-%	Aliphatic polyurethanes > 2.5 wt %; Aromatic PU and water based acrylates; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance; Other laminating adhesives (e.g.Epoxy)
	Barriers[59]	No barrier layer; SiO_X-, Al_2O_3-barrier without additional coating;	EVOH[60] with adhesion promoters; ≤ 15% PA 6/66 copolymer with melting temperature < 192 °C and incorporating	EVOH[600] with adhesion promoters; Any other PA; Metallisation[61]; PVC, PVDC barrier layer; AlOx coating with PVOH primer; any other barrier layer; aluminium[62]
Base packaging	Colour	transparent, uncoloured	light colours; translucent colours	black or dark colours; Carbon-black based colours
	Printing[63]	EuPIA-compliant printing inks; PU based colours minimal direct printing	Non-bleeding colours minimal direct printing; Light or translucent colours no PVC-based inks; Print covers > 50% of the film [64]	Non EuPIA-compliant colours; Printing covers > 50 % of the foil

[59] 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, see also https://www.verpackungsregister.org/fileadmin/files/Mindeststandard/Mindeststandard_VerpackG_Ausgabe_2022.pdf

[60] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.

[61] If the material-specific sorting is not affected. For example, sorting is not affected if the metalisation is applied in the intermediate layer of a film bag.

[62] Deviating findings must be examined on a case-by-case basis.

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

[64] Sorting capability and recyclability can be influenced by the printing.

Recyclability of PE films – uncoloured				
		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 carried out by means of minimal direct printing, provided that food-compliant inks are used.		
	Rigid closures (snap-on lid, screw-type closure etc.) + Liners, seals and valves	PE (HDPE, MDPE LDPE, LLDPE (incl. PE plastomers)); Closure systems without liner, if necessary PE liner	PP; removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e .g. PET, PETG, PVC, PLA, PS; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
Packaging aids – closures	Flexible closures (sealing films etc.)	PE (HDPE, MDPE LDPE, LLDPE (incl. PE plastomers)); Sealing film should be removable by the end consumer without any residues	PP; removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e .g. PET, PETG, PVC, PLA, PS; Film composites; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
	Label material	PE (HDPE, LDPE, LLDPE, MDPE)	PP; Paper labels removable under cold wash conditions;	metallised labels; Paper labels not removable under cold wash conditions; Labels made of other materials, e.g. PET, PVC, PLA;

Recyclability of PE films – uncoloured				
		Good	Limited	Poor
packing aids - Decoration[65]	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[65] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

PE (HDPE, LDPE, LLDPE) FILMS – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PACKAGING MADE OF PE

Recyclability of PE films - coloured				
		Good	Limited	Poor
Base packaging	Material	PE; Oriented and non-oriented LDPE, LLDPE (incl. PE plastomers), HDPE; A multi-layer composite can be used if necessary, if it is made up of different PE types (e.g. LDPE, HDPE). (Multilayer composites) EVA, EBA, EEA, EMA copolymers with vinyl acetate and acrylic monomers with ≤ 5 wt.% PP; EMAA, EAA copolymers and ionomers with ≤ 20 %	Multilayer composite with ≤ 5 wt.% PP	Multilayer composite with PP > 5 wt.% (PET, PETG, PVC, PLA, PS)
	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

Recyclability of PE films - coloured				
		Good	Limited	Poor
	Barriers[66]	SiO_X-, Al_2O_3-barrier without additional coating; barrier in the polymer matrix; carbon plasma coating[67]	EVOH[68] with adhesion promoters;; ≤ 15% PA 6/66 copolymer with melting temperature < 192 °C and incorporating Aluminium vapour deposition (metallisation)[69] without additional coating PVOH ≤ 1 %	EVOH[68] with adhesion promoters;; Any other PA; Metallisation[70]; PVC, PVDC barrier layer; AlOx coating with PVOH primer; any other barrier layer; aluminium[71]
	Laminating adhesives	PU and water bases acrylates ≤ 3 wt.%;	PU and water bases acrylates 3 - 5 wt.%;	PU and water bases acrylates > 5 wt.%; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance; Other laminating adhesives (e.g. Epoxy)
	Colour	light colours; translucent colours	NIR detected dark colours	Non NIR detected black or dark colours; Carbon-black based colours

[66] 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., see also https://www.verpackungsregister.org/fileadmin/files/Mindeststandard/Mindeststandard_VerpackG_Ausgabe_2022.pdf
[67] In the case of transparent base material, discolouration may occur.
[68] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[69] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallisation has been applied to the inside of a film bag.
[70] If the material-specific sorting is not affected. For example, sorting is not affected if the metalisation is applied in the intermediate layer of a film bag.
[71] Deviating findings must be examined on a case-by-case basis.

Recyclability of PE films - coloured				
		Good	Limited	Poor
Base packaging	Printing[72]	EuPIA-compliant printing inks minimal direct printing; PU based colours; Printing covers < 50 % of the film	≤ 0.8 wt% NC binder; Print covers > 50% of the film [73]	> 0.8 wt% NC binder; Bleeding colours; PVC binder
	Coding (batch coding, best before date)	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-compliant inks are used.		
Packaging aids – closures	Rigid closures (snap-on lid, screw-type closure etc.) + Liners, seals and valves	PE (HDPE, MDPE LDPE, LLDPE (incl. PE plastomers); Closure system without liner, if necessary PE liner	PP; removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e .g. PET, PETG, PVC, PLA, PS; materials other than polyolefins or foamed materials with a density <1 g/cm³.
	Flexible closures (sealing films etc.)	PE (HDPE, MDPE LDPE, LLDPE (incl. PE plastomers); Sealing film should be removable by the end consumer without any residues	PP; removable aluminium closure	Metals; Aluminium Materials with a density > 1 g/cm³, e .g. PET, PETG, PVC, PLA, PS; Film paper composites; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.

[72] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[73] Sorting capability and recyclability can be influenced by the printing.

Recyclability of PE films - coloured				
		Good	Limited	Poor
Packing aids – Decoration[74]	Label material	PE (HDPE, LDPE, LLDPE, MDPE)	PP; Paper labels removable under cold wash conditions	metallised labels; Paper labels not removable under cold wash conditions Labels made from other materials, e.g. PET, PVC, PLA
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[74] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

PE (HDPE) CONTAINERS AND TUBES – UNCOLOURED AND WHITE

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Recyclability of PE containers and tubes – uncoloured and white				
		Good	Limited	Poor
Base packaging	Material	HDPE; A multi-layer composite can be used if necessary, if it is made up of different PE types (e.g. LDPE, HDPE). TPO with ≤ 10% PP	Multilayer composite with ≤. 10% PP	Multilayer composite with PP > 10%; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Additives	Additives if density remains < 0.97 g/ cm³	mineral fillers ($CaC1O_3$, 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[75]	EVOH[76] In-mould fluorination; SiOx Plasma coating; AlxOx	EVOH[76] with adhesion promoters;	EVOH[76] with adhesion promoters; PVDC, PA; Plasma fluorination; metalisation Aluminium foils[77]

[75] 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 Enkase (fluorination) permissible – confirmation of composition necessary (Recyclass).
[76] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[77] Deviating findings must be examined on a case-by-case basis.

Recyclability of PE containers and tubes – uncoloured and white				
		Good	Limited	Poor
	Laminating adhesives		Aliphatic PU < 2.5 wt.%;	PU and water-based acrylates > 2.5 wt.%; Aromatised PU and water-based acrylates; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance; Other laminating adhesives (e.g. Epoxy)
	Colour	transparent, clear	Light colours	black inner layer; Black, dark or opaque colours Carbon-black based colours
	Printing[78]	EuPIA-compliant printing inks Non-bleeding colours minimal direct printing; Light or translucent colours No PVC-based colours		Bleeding colours; PVC binder
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-compliant inks are used.		Direct printing

[78] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PE containers and tubes – uncoloured and white				
		Good	Limited	Poor
Packaging aids – closures	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liner, if necessary PP or TPE[79] Liner	PP; TPO and TPS[80] Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS; detachable aluminium closure; removable silicone with a density > 1g/cm³	Aluminium Metals; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
	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 PP or TPE[81] Liner	PP; TPO and TPS[80] Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS; removable silicone with a density > 1g/cm³; foamed PO ≤ 1 wt.%	Other TPE; Foiled paper; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
	Label material	PE (HDPE, LDPE, LLDPE, MDPE)[82]; In-mould labels that can be removed in the recycling process,	Paper labels removable under cold wash conditions PP; Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS; Removable foamed polyolefin labels	metallised labels; aluminium-containing labels; PVC labels; Paper labels not removable under cold wash conditions Materials other than polyolefins with a density < 1 g/cm³.
Packing aids – Decoration[83]	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[79] Certification required
[80] Deviating determinations must be examined on a case-by-case basis
[81] Certification required
[82] Provided the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[83] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

Recyclability of PE containers and tubes – uncoloured and white				
		Good	Limited	Poor
	Adhesive-free decoration (sleeve, etc.)	HDPE, LDPE, LLDPE, MDPE[82]	PP / OPP (with a density < 1 g/cm³) Materials with a density > 1 g/cm³, e.g. PET, PETG, PET-C, PVC, PLA, PS; Removable wet-strength paper labels; Removable foamed polyolefin labels	metallised materials; materials containing aluminium; PVC Materials other than polyolefins with a density < 1 g/cm³; Cardboard sleeves (not separable) heavily printed sleeves
	Size restriction	Decoration covers < 50%[84] or 70%[85] of the packaging surface		Decoration covers > 50% or 70% of the packaging surface[86]
Packing aids – Decoration[87]	Other decoration technologies		Electroplating on attachments (with density > 1 g/cm³)	Electroplating on attachments (with density < 1 g/cm³)
Packaging aids - Other	Other components	HDPE, LDPE, LLDPE, MDPE	PP; Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS	Aluminium PVC Glass Materials other than polyolefins with a density < 1 g/cm³.

[84] For bottles with a filling quantity of ≤ 500 ml.
[85] For bottles with a filling volume of > 500 ml.
[86] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.
[87] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

PE (HDPE) CONTAINERS AND TUBES – COLOURED

RECOMMENDATIONS FOR RECYCLABLE PE PACKAGING

Recyclability of PE containers and tubes - coloured				
		Good	Limited	Poor
Base packaging	Material	HDPE; A multi-layer composite can be used if necessary if it is made up of different PE types (e.g. LDPE, HDPE). Multilayer composite with max. 5% PP	Multilayer composite with max. 10% PP	Multilayer composite with PP > 10%; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA, PS
	Size[88]	at least two dimensions ≥ 5 cm		at least two dimensions < 5 cm [89]
	Additives	Unavoidable aditives 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[90]	EVOH[91] with adhesion promoters; In-mould fluorination; SiOx plasma coating; AlxOx	EVOH[91]; with adhesion promoters; Fluorinated plasma Aluminium vapour deposition (metallisation)[92] without additional coating; PVOH ≤ 1 wt.%	EVOH[91] with adhesion promoters; PVDC, PA, Aluminium foils[93] PVOH > 1 wt.%

[88] Size limit valid for Austria, country-specific size limits must be observed.
[89] In the compressed state
[90] 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.
[91] Current limit values for EVOH can be found at https://recyclass.eu/recyclass/design-for-recycling-guidelines/.
[92] As long as it does not impair the material-specific sorting process. As long as it does not impair the sorting process, i.e. if the metallisation has been applied to the inside of a film bag.
[93] Deviating findings must be examined on a case-by-case basis.

Recyclability of PE containers and tubes - coloured				
		Good	Limited	Poor
Base packaging	Laminating adhesives	PU and water-based acrylates ≤ 3 wt%; Laminating adhesives that have been tested with other barriers	PU and water-based acrylates 3 - 5 wt%; Laminating adhesives that have been tested with other barriers	PU and water-based acrylates > 5 wt%; Laminating adhesives specifically developed for high thermal applications above boiling and/or for high chemical resistance; Other laminating adhesives (e.g. Epoxy)
	Colour	all colours; White	black inner layer; dark, NIR-detectable colours	Carbon-black based colours
	Printing[94]	EuPIA-compliant printing inks Non-bleeding colours No PVC-based colours		PVC based colours; 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 carried out by means of minimal direct printing (< 1 wt.%), provided that food-compliant inks are used.	Any other direct printing; Cold transfer and hot stamping techniques that do not affect the detectability of the underlying PE polymer	
Packaging aids – closures	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PE (HDPE, LDPE, LLDPE, MDPE) Closure systems without liner, if necessary PE or TPE[95] Liner	PP; TPO and TPS[96] Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS; removable silicone with a density > 1g/cm³; detachable aluminium closure;	Aluminium Metals; PVC Materials other than polyolefins or foamed materials with a density < 1 g/cm³.

[94] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.
[95] Certification required
[96] Deviating determinations must be examined on a case-by-case basis

Recyclability of PE containers and tubes - coloured				
		Good	Limited	Poor
	Flexible closures (sealing films etc.)	PE (HDPE, LDPE, LLDPE, MDPE) Sealing film should be removable by the end consumer without any residues Closure systems without liner, if necessary PE or TPE[95] Liner	PP; TPO and TPS[97] Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS; removable silicone with a density > 1g/cm³; PO with a density > 1g/cm³;	Other TPE, Aluminium Metals; PVC; foiled paper; Materials other than polyolefins or foamed materials with a density < 1 g/cm³.
Packing aids - Decoration[98]	Label material	PE (HDPE, LDPE, LLDPE, MDPE) [99] In-mould labels made of PE printed with < 1wt.% of the entire packaging (excluding dark colours and bleeding inks)	Paper labels removable under cold wash conditions; PP; Materials with a density > 1 g/cm³, e.g. PET, PETG, PLA, PS; foamed polyolefin labels other In-mould labels made of PE printed with > 1wt.%	metallised labels; aluminium-containing labels; PVC labels; Paper labels not removable under cold wash conditions; Carton and paper in-mould labels; Materials other than polyolefins with a density < 1 g/cm³.
	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[97] Deviating determinations must be examined on a case-by-case basis

[98] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

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

Recyclability of PE containers and tubes - coloured				
		Good	Limited	Poor
	Adhesive-free decoration (sleeve, etc.)	HDPE, LDPE, LLDPE, MDPE[99]	PP / OPP (with a density < 1 g/cm³) Materials with a density > 1 g/cm³, e.g. PET, PETG, PLA, PS	Heavily printed sleeves; metallised materials; materials containing aluminium; PVC; Carton sleeves (not separable) Sleeves made of materials other than polyolefins with a density < 1 g/cm³.
	Size restriction	Decoration covers < 50%[100] or 70%[101] of the packaging surface		Decoration covers > 50% resp. > 70% of the packaging surface[102]
Packaging aids - Other	Other components	HDPE, LDPE, LLDPE, MDPE	PP; Materials with a density > 1 g/cm³, e .g. PET, PETG, PLA, PS	Aluminium PVC Glass Foamed 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[103].
- Plastic labels should be of the same material as the bottle body. If paper labels are used, they should peel off from the packaging in a cold wash up to 40°C.

[100] For bottles with a filling quantity of ≤ 500 ml.
[101] For bottles with a filling volume of > 500 ml.
[102] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.
[103] Currently, up to 10% PP is recommended; max. 30% is tolerated.

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[104]. Avoid PVDC, PA and PE-X barriers.
- If metallisation 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 only be used to a limited extent and if they are, they should have water-washable properties.
- Plastic and cardboard sleeves that separate themselves from the main body under mechanical pressure do not interfere with the recyclability of the main body.

[104] 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/de/uber-recyclass/richtlinien-fuer-recyclingorientiertes-produktdesign/.

PE TUBES

- Avoid the use of fillers such as chalk (filled polyolefin/FPO) if this results in 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.

DESIGN EXAMPLES OF RECYCLABLE PE PACKAGING

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

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

- ✓ Bottle made from 100% HDPE
- ✓ 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 - COLOURED

RECOMMENDATIONS FOR RECYCLABLE PACKAGING MADE OF PS

Recyclability of PS containers - coloured				
		Good	Limited	Poor
Base packaging	Material	PS[105]		Foamed PS with a density < 1g/cm³; Multilayer composites
	Additives	Additives, if the density remains between 1.0 and 1.07 g/m³.	mineral fillers ($CaCO_3$, talc) that 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 ≤ 5 wt. %	EVOH > 5 wt. % with adhesion promoters;	PVDC, PA,
	Colour	Light colours	Dark colours (NIR detectable)	Non NIR detectable colours
	Printing[106]	EuPIA-compliant printing inks Non-bleeding colours No PVC-based colours		Bleeding colours PVC binder

[105] PS share > 90%
[106] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PS containers - coloured				
		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 carried out by means of minimal direct printing, provided that food-compatible inks are used.	Minimal printing	
Base packaging	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PS	PE, PP; EVA; TPE[107]	Metals; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; materials other than polyolefins or foamed materials with a density > 1 g/cm³
Packaging aids – closures	Flexible closures (sealing films etc.)	PS	PE, PP; detachable aluminium closure; Paper labels removable under cold wash conditions	Aluminium foils[108]; PVC Paper labels not removable under cold wash conditions Multi-layer composite of PET/paper or PET/PS; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA

[107] Certification required
[108] Deviating findings must be examined on a case-by-case basis.

Recyclability of PS containers - coloured				
		Good	Limited	Poor
	Label material	PS[109]	PP, PE with density < 1g/cm3; Paper labels (wet-strength and removable in cold wash up to 40°C)	metallised labels; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Paper labels (not wet-strength)
Packing aids – Decoration[110]	Label adhesive		adhesive application does allow cellulose-based labels to be removed in cold wash (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)
	Adhesive-free decoration (sleeve, etc.)	PS[111]	PP, PE with density < 1g/cm³; Cardboard sleeves	metallised labels; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Cardboard sleeves (not wet-strengthened); heavily printed labels
	Size restriction	Decoration covers < 50%[112] or 70%[113] of the packaging surface		Decoration covers > 50% or 70% of the packaging surface[114]
Packaging aids - Other	Other components	PS	PP; PE; Paper	Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Metals, metal foils

[109] If the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[110] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).
[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 volume of > 500 ml.
[114] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

PS CONTAINERS – NATURAL AND WHITE

RECOMMENDATIONS FOR RECYCLABLE PACKAGING MADE OF PS

Recyclability of PS containers – natural and white				
		Good	Limited	Poor
Base packaging	Material	PS[115]		Foamed PS with a density < 1g/cm³; Multilayer composites
	Additives	Additives, if the density remains between 1.0 and 1.07 g/m³.	mineral fillers ($CaCO_3$, talc) that 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 ≤ 5 wt. %	EVOH > 5 wt. % with adhesion promoters;	PVDC, PA,
	Colour	Natural, white		Other colours
	Printing[116]	EuPIA-compliant printing inks; No printing (with the exception of batch coding); Non-bleeding colours No PVC-based colours		Bleeding colours PVC binder
	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	

[115] PS share > 90%
[116] Printing on the main body should generally be avoided or minimised, as it can lead to deterioration of the recycled material's quality. The recommendations given apply if printing cannot be avoided.

Recyclability of PS containers – natural and white				
		Good	Limited	Poor
Base packaging	Rigid closure (snap-on cap, screw cap etc.) + liners, seals and valves	PS	PE, PP; EVA; TPE[117]	Metals; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; materials other than polyolefins or foamed materials with a density > 1 g/cm³
Packaging aids – closures	Flexible closures (sealing films etc.)	PS	PE, PP; detachable aluminium closure; Paper labels	Aluminium foils[118]; PVC Paper labels (not wet-strengthened); Multi-layer composite of PET/paper or PET/PS; Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA
	Label material	PS[119]	PP, PE with density < 1g/cm3; Paper labels removable under cold wash conditions	metallised labels; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Paper labels not removable under cold wash conditions
Packing aids – Decoration[120]	Label adhesive	adhesive application removable in cold wash (up to 40°C)	not completely removable adhesive applications (up to 40°C)	adhesive application does not allow cellulose-based labels to be removed in cold wash (up to 40°C)

[117] Certification required
[118] Deviating findings must be examined on a case-by-case basis.
[119] If the pressure/barrier of the decoration does not negatively affect the detection of the packaging material by the NIR.
[120] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

Recyclability of PS containers – natural and white				
		Good	Limited	Poor
	Adhesive-free decoration (sleeve, etc.)	PS[121]	PP, PE with density < 1g/cm³; Cardboard sleeves	metallised labels; Aluminium Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Cardboard sleeves (not wet-strengthened); heavily printed labels
	Size restriction	Decoration covers < 50%[122] or 70%[123] of the packaging surface		Decoration covers > 50% or 70% of the packaging surface[124]
Packaging aids - Other	Other components	PS	PP; PE; Paper	Materials with a density > 1 g/cm³, e.g. PET, PETG, PVC, PLA; Metals, metal foils

- Plastic and cardboard sleeves that separate themselves from the main body under mechanical pressure do not interfere with the recyclability of the main body.

[121] If the pressure/barrier of the decoration does not negatively influence the detection of the packaging material by the NIR
[122] For bottles with a filling quantity of ≤ 500 ml.
[123] For bottles with a filling volume of > 500 ml.
[124] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

RECOMMENDATIONS FOR PACKAGING AIDS - AN OVERVIEW

The following compilation provides an overview of recommended packaging components or combinations which are currently not classified as interfering in the plastics recycling process. Additionally, it includes knockout criteria for certain components. A continuous update is also planned for this list.

CLOSURES

- As a general point, from the year 2024, closures will have to remain attached to wholly or partially plastic beverage containers of 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 of a different material than the packaging material, it should be separable in the recycling process (e.g. by coarse shredding etc.).
- General: It is generally important to avoid metal and metal-containing closures on plastic packaging, as these can lead to unwanted sorting.
- General: Sealing foils (including sealing plates) should be removable by consumers without leaving residues.
- General: Detachable small parts, such as completely removable pull-on straps, should be avoided due to the high littering potential.
- In the case of PE or PP packaging, use closures of the same material whenever possible
- Closures for packaging made of PET: materials with a density < 1 g/cm³

SLEEVES (ADHESIVE-FREE DECORATION)

- General: Sleeves should ideally be made of the same material as the packaging material (exception PET). In addition, sleeves should generally be printed as little as possible and/or cover as small an area of the packaging as possible.
- General: Sleeves can also be made of a different material than the packaging material 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 for packaging made of PET: materials with a density < 1 g/cm³.
- General: It is generally important to avoid decorations containing metal, as these can lead to unwanted rejection.

If fully printed sleeves take up more than 50% or 70% of the packaging surface and/or are made of a different material than the packaging material, sorting capability can be adversely affected. 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

- General: If a label is not made of the same material as the packaging, a maximum of 50% or 70% of the packaging should be covered[125].
- General: Labels should be made of the same type of material as the packaging material (exception PET). If this is not the case, label adhesives should be designed in such a way that they can be separated in the specific recycling process. Adhesive applications and label materials are also available for specific recycling processes that can be recycled along with the packaging[126].
- General: In-mould labels and packaging material should be identical
- Plastic labels for packaging made of PET: materials with a density < 1 g/cm³.
- paper labels on plastic packaging should be wet-strength
- General: It is generally important to avoid decorations containing metal, as these can lead to unwanted rejection.

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 made out 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 the recycled material's 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).

[125] If the decoration covers more than 50% or 70% of the packaging surface, the sorting capability of the packaging must be proven by means of a sorting test in order to be considered recyclable
[126] Labels and adhesives can also remain on the packaging and be recycled along with the main body, provided the impact on the recycled material's quality has been tested and certified (certification required; see e.g. https://recyclass.eu/recyclability/approvals/).

Additional labels

Recommendations for self-adhesive labels (labels coated with pressure-sensitive adhesives), labels applied with the aid of hot-melt adhesive applications, as well as general recommendations for the use of recyclable adhesive applications are currently being revised

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. However, compostable plastics (in accordance with DIN EN 13432) do 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.

COMPOSITE MATERIALS WITH PLASTIC CONTENT

Composite materials or multilayers, i.e. materials made of two or more different materials, can combine the best properties of the respective materials. 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 recognise 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.[127] 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 mass proportion of the components is approximately 80% cardboard and 20% PE.	The mass percentage of the components is approximately 75% cardboard, 20% PE and 5% aluminium.

Processing then takes place in special pulpers, which separate the fibre components of the shredded packaging materials and enable them to be used in new paper-based products, while LDPE and aluminium are usually recycled for energy. In the last 18 months, plants have been commissioned in Europe (e.g. in Germany, the Netherlands and the Czech Republic) with the particular aim of increasing the recycling of polyethylene and aluminium components. The breakdown process does not allow for the complete recovery of the fibres, as a small proportion remains bonded to the plastic coating and ends up in the reject. 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.

[127] However, the sorting process may differ depending on the plant.

RECOMMENDATIONS FOR RECYCLABLE BEVERAGE CARTONS

Recyclability of composite beverage cartons				
		Good	Limited	Poor
Base packaging	Origin of fibres	Conifers and deciduous trees	non-woody plants such as hemp, grass, cotton, etc.[128]	
	Additives	Mineral fillers such as kaolin, talk and calcium carbonate in the paper part; Titanium dioxide (white pigment) Starch (filler)		
	Coatings and seam sealants	One-sided plastic coating or plastic laminate (PE) Two-sided plastic coating or plastic laminate (PE)		metallised surfaces or coatings that interfere with NIR detection;
	Printing	Colours comply with EuPIA	colours containing mineral oil[129]	
Packaging aids – closures		HDPE; PP with easy separability in the pulper from the other packaging components	unattached closures[130]	
Designs		according to specific packaging material composition (standard structure)		Designs which deviate from the standard structure

[128]When using non-woody fibres, it must be ensured that the materials can be processed in standard recycling plants.
[129] https://www.eupia.org/fileadmin/FilesAndTradExtx_edm/2018-08-02_Printing_Ink_Industry_Contribution_to_Mineral_Oil_Reduction_in_Paper_and_Board.pdf
[130] For all beverage containers with a volume of up to 3 litres, the closures on the main body must remain in place from July 2024 (Directive (EU) 2019/904).

- ✓ 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, 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 relate to the recyclability of paper packaging in a standard paper mill: some of the recommendations are based on the specifications of 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				
		Good	Limited	Poor
Base packaging	Origin of fibres	Conifers and deciduous trees	non-woody plants such as hemp, grass, cotton, etc.[131]	
	Coatings	Without coating; one-sided plastic coating or plastic laminate, if fibre content > 95%	one-sided plastic coating or plastic laminate, if fibre content 85 to 95%; metallised paper, if the metallisation takes up less than 60% of the surface area	Plastic coating on both sides[132] one-sided plastic coating or plastic laminate, if fibre content < 85%; Wax coating Silicone papers
	Adhesive applications	water-soluble adhesives; Hotmelt application of 2 mm x 2 mm[133]	Pressure-sensitive adhesives[133]	

[131] When using non-woody fibres, it must be ensured that the materials can be processed in standard recycling plants.
[132] Composite cartons are an exception to this rule.
[133] Applies to adhesives with a melting point > 68°C. The compatibility of adhesives with the recycling process should be checked against the EPRC Scorecard. See https://www.paperforrecycling.eu/wp-content/uploads/dlm_uploads/2018/03/EPRC_Scorecard_removability_of_adhesive.pdf

Recyclability of paper / board / cardboard packaging				
		Good	Limited	Poor
Base packaging	Additives	Mineral fillers such as kaolin, talk and calcium carbonate Titanium dioxide (white pigment) Starch (filler) Wet strength agent: Polyacrylamide (GPAM) [134]	Wet strength agent[135]: Polyamidoamine epichlorohydrin (PAEE)	
	Printing	EuPIA-compliant printing inks[136]	inks containing mineral oil[137]	
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 cannot be easily removed; 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

When using non-water-soluble adhesives, the formation of non-soluble adhesive accumulations, so called “cumulative adhesives”, can occur during the recycling process – “stickies”. The mechanical recycling process aims to remove these stickies during screening.

A 2018 study by the European Paper Recycling Council, conducted according to INGEDE Method 12, concluded that macro-stickies with a particle size of more than 2,000 µm can be completely removed in standard recycling processes. The smaller the sticky particles, the greater the risk of stickies remaining in the fibre suspension and reducing the quality of the recycled fibres.

[134] Deviating findings must be examined on a case-by-case basis.
[135] Deviating findings must be examined on a case-by-case basis
[136] Restrictions may apply to the use of UV-cured inks, as there is a risk of reducing the quality of the secondary material (this applies, above all, in the recycling process of the graphic paper industry).
[137] https://www.eupia.org/fileadmin/FilesAndTradExtx_edm/2018-08-02_Printing_Ink_Industry_Contribution_to_Mineral_Oil_Reduction_in_Paper_and_Board.pdf

Additive

Some speciality paper packaging contains moisture-proofing additives that can also cause issues in the recycling process. These so-called wet strength agents prevent the fibres from coming loose during recycling. Decisive for the influence on the recycling process are the quantity, as well as the type of wet solids and the individual equipment of the paper processing plant. Typically, temporary wet strength agents (PAM, GPAM, APAM) are easier to process than permanent wet strength agents (PAE, PAAE etc.) A recyclability test is recommended on a case-by-case basis when using wet strength agents.

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, specialised 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. (There are currently efforts in Europe to recycle packaging based on white substrate in recycling plants with a de-inking process).

The use of printing inks containing mineral oil is problematic for safety reasons, 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.

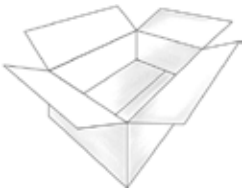
Special fibres

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% by mass of the total mass
- ✓ Printing with coloured inks in conformity with the EuPIA

- ✓ 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. Across the whole of Austria, Germany and the Netherlands, glass packaging is collected in a uniform system, with separate bins for white glass and coloured glass. The production of glass is energy-intensive, but the use of secondary material can reduce this energy input by 2 - 3% per 10% cullet content. 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, resulting in the glass being eliminated from the recycling process. Affixed labels can also impair the breaking process and lead to low cullet yields. Ferromagnetic metals, aluminium and plastics can be eliminated in the sorting process.

RECOMMENDATIONS FOR RECYCLABLE GLASS PACKAGING

		Recyclability of glass packaging		
		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
	Colour	Green, brown, white/transparent and similar hues		Opaque coloured glass; Black, dark blue
	Printing/direct printing by filler	Direct printing EuPIA-compliant coatings and printing inks	Glass container is colour-coated over the whole area	
Packaging aids	Closures	Ferromagnetic metals (alloys) Plastic Aluminium		Ceramic Flip-top caps with a ceramic/porcelain component
	Decoration	Engraving; matting Paper labels	Permanently attached plastic labels	permanently adhesive and large-area plastic labels; full-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				
		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		Composite material[138]
	Printing/direct printing by filler	Lacquer finish Aluminium with direct printing EuPIA-compliant coatings and printing inks		Non-compliant colours
	Closures	Aluminium screw-cap	Plastic closures and valve caps, if these can be separated before disposal or during the sorting process.	
	Decoration	Engraving		PVC label
Designs		Mono-material packaging (all components made of aluminium and joined together)	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 contents; loose small parts made of aluminium

[138] Deviating findings must be examined on a case-by-case basis.

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.
- Composites with ferromagnetic metals should be avoided, as this leads to a loss of aluminium in the sorting and recycling process.
- 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.

ALUMINIUM BOTTLES

- Aluminium cans are usually made from a single piece of aluminium and are, therefore, also easily recyclable.
- Closures are made of different materials, such as tinplate or plastic. In order to be fully recycled, the consumer is responsible for disposing of the cap separately from the bottle.
- 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.

ALUMIUM TUBES

- Aluminium tubes are usually made from 1000-series aluminium alloy. In general, it is important to 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[139]. To prevent this, aluminium foil should be compressed and squeezed by users before disposal to ensure its selectability 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

[139] Deviating findings may be examined on a case-by-case basis.

RESEARCH AT THE FH CAMPUS WIEN

Current research results at University of Applied Science - FH Campus Wien

PET 2 PACK

DEVELOPMENT OF A CLOSED-LOOP SYSTEM FOR PET FORMED PACKAGING IN AUSTRIA IN THE FOOD AND NON-FOOD SECTORS

Research period: 01.07.2020 - 31.12.2023

As part of this project, a new closed-loop system (comparable to that for PET beverage bottles) for PET rigid packaging from the food and non-food sectors was to be developed across the entire value chain in Austria in the spirit of the circular economy. This involved researching the safety-related fundamentals of these materials as well as analysing current sorting techniques in detail and investigating recycling options. This provided the basis for the development of PET rigid recyclates developed to be authorised for use and thus make a significant contribution to resource conservation and the circular economy.

Outcomes: In the course of the project, value chains were carried out on a laboratory and technical scale. In both cases, it was shown that the mechanical properties can match those of virgin material if good processing is carried out first. In terms of volume, the collection of recyclable packaging has a high potential for processing PET trays and PET bottles from the non-food sector. It is evident that D4R criteria are being applied. However, not all of them are used to the same extent; for example, there are still many multilayer trays in circulation. It is pleasing to note that a high proportion of transparent PET packaging can be found on the Austrian market. Multilayers have been a disruptive factor in recycling. However, we were able to prove that it is possible to recycle Austrian post-consumer PET goods under defined conditions. The safety assessment did not show any worrying results. The LCA shows that the use of recycled PET can make an important contribution to climate protection and resource conservation.

Funding organisation: FFG Collective Research

Cooperation partners: Packforce (consortium leader), TCKT - Transfercenter für Kunststofftechnik GmbH, TU Vienna, OFI - Austrian Research Institute for Chemistry and Technology

PACK2THE LOOP

CLOSING THE CIRCLE OF POLYOLEFIN PACKAGING

Research period: 1.4.2021 – 30.6.2024

The project aims to develop quality-assured recyclates from post-consumer materials and thus contribute to the development of a closed cycle for rigid packaging made of polypropylene, polyethylene and polystyrene. In this context, the entire packaging value chain is considered. This is done on the basis of specific use cases:

- Hollow bodies made from polypropylene or high-density polyethylene for non-food applications
- Cups made of polystyrene or polypropylene for food applications

The first step is to take stock of the volume of waste in Austria, followed by sorting, shredding and processing the material. Flakes are mechanically recycled and processed into primary products. The tests are accompanied by a safety assessment. Based on the test results, recommendations for a recycling-friendly packaging design (Design4Recycling) are derived.

Outcomes: Tests have shown that clean input material has a significant influence on the quality of the recyclates. Various impurities, such as foreign polymers and packaging aids, make it difficult to close a loop.

Funded by: FFG Collective Research

Project coordination: Ecoplus plastics cluster

Research consortium: University of Applied Science FH Campus Wien, TU Wien, OFI - Austrian Research Institute for Chemistry and Technology, Montanuniversität – University of Leoben

REFLEX

INDUSTRY PROJECT: RECYCLABLE FOOD PACKAGING

Research period: 08.2020 – 12.2023

The interdisciplinary research field of food packaging is facing considerable challenges, as innovative and recyclable packaging solutions are required in accordance with the EU Circular Economy Package and the European Strategy for Plastics. In particular, flexible multi-layer packaging, which consists of combined material layers (mainly polymers, paper and aluminium), offers optimum product protection but significantly affects recyclability.

In order to maintain both product protection and low packaging weight while improving recyclability, the development of innovative coatings on mono-polyolefin films is being pursued. A central research objective is the development of recyclable polyolefin-based food packaging films in three oxygen barrier categories. In addition, the aim is to label the films to enable high-quality recycling through improved sorting.

The Reflex industry project investigated the effectiveness of coatings such as ORMOCER®, Michem® Flex barrier coating and polyvinyl alcohol on various polypropylene-based films, such as cPP and SiOx- and AlOx-coated PP films.

Outcomes: The combination of SiOx and AlOx with ORMOCER®, Michem® Flex and PVOH resulted in high oxygen barrier properties for PP/SiOx and OPP/AlOx films. The deposition of a single ORMOCER® layer was able to improve the oxygen barrier properties of cPP and reduced the oxygen permeability by a factor of 88, from 1516 cm^3/m^2-d-bar to 17.41 cm^3/m^2-d-bar. The Michem® Flex coating led to a significant reduction in oxygen permeability and was able to reduce the OTR value of cPP by 551 times, from 1516 cm^3/m^2-d-bar to 2.75 cm^3/m^2-d-bar.

Funding organisation: FFG

Cooperation partners: Packforce Austria (consortium leader), OFI - Austrian Research Institute for Chemistry and Technology

CARDBOX "GREEN CARTONS"

Research period: 01.12.2020 - 30.11.2024

In order to increase the sustainability of food packaging, the use of materials made from renewable raw materials such as cardboard is becoming increasingly important. However, cardboard does not have the same barrier properties as plastic packaging. For example, untreated cardboard has a

lower barrier against water, water vapour, oxygen and fats and therefore often offers less product protection. For this reason, cardboard is usually extrusion-coated with plastics for use as food packaging. To reduce the amount of plastic applied and improve recyclability compared to extrusion coating, water-based dispersion coatings are used in the 'Green Cartons' project. Dispersion-coated cardboard fulfils many barrier requirements as well as sealability. As part of the project, the recyclability and suitability as a food contact material is also being investigated by means of a migration test.

Outcomes: Effective barrier properties against water vapour, oxygen and fats can be achieved with dispersion varnishes. This indicates that cartonboard coated with dispersion varnish has considerable potential for use as a packaging material in various product categories. Sealability has also been demonstrated. Initial tests also showed improved recyclability compared to PE-coated cardboard. The migration tests mentioned above have yet to be carried out.

Funding organisation: FFG:Collective Research
Cooperation partners: Cardbox Packaging Wolfsberg GmbH (project management)

PACKAGING COCKPIT – PACO (FFOQSI)

Research period: 01.07.2020 - 31.12.2023

To achieve the specified targets of EU Directive 94/62/EC on packaging and packaging waste from 2018, it must be determined which of the available packaging is considered recyclable and which must be changed. These requirements pose a major challenge for packaging manufacturers and distributors. In Austria, a number of methods are employed to assess the recyclability of materials, but the results of these assessment tools are not always consistent and the process is time-consuming and costly. It is therefore necessary to create an Austrian standard and thus a basis for the assessment of recyclability, which will help to support the industry in achieving the EU requirements.
In addition to the objective of recyclability of packaging, an important aspect, namely the ecological impact, should not be ignored. Recyclability alone is not enough to make a statement about the environmental impact of individual packaging. In addition to the assessment of recyclability, an overview life cycle assessment must also be conducted.
Therefore, the aim of this work package in a first step is to develop a packaging assessment cockpit (Packaging Cockpit) for sustainable food packaging. In a second step, specific food packaging with a high level of sustainability will be developed for different food categories.

Outcomes: The development of the packaging cockpit includes the automation of the sustainability assessment, which includes recyclability on the one hand and a streamlined LCA of packaging for different EU member states on the other.

Funding body: FFG:Basic Programme - Collective Research - COMET, K1, 4th call COMET Centre (K1), 2nd FP (2020), FFG
Cooperation partners: Circular Analytics TK, MCP GmbH

FH Campus Wien
University of Applied Sciences

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. Therefore, the considerations in the packaging design process should also take the recycling structures available at an 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 to be 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, the 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

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

APPENDIX

OUR SERVICES

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

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

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

The *Packaging Cockpit* project will work on providing a software-supported assessment of packaging 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

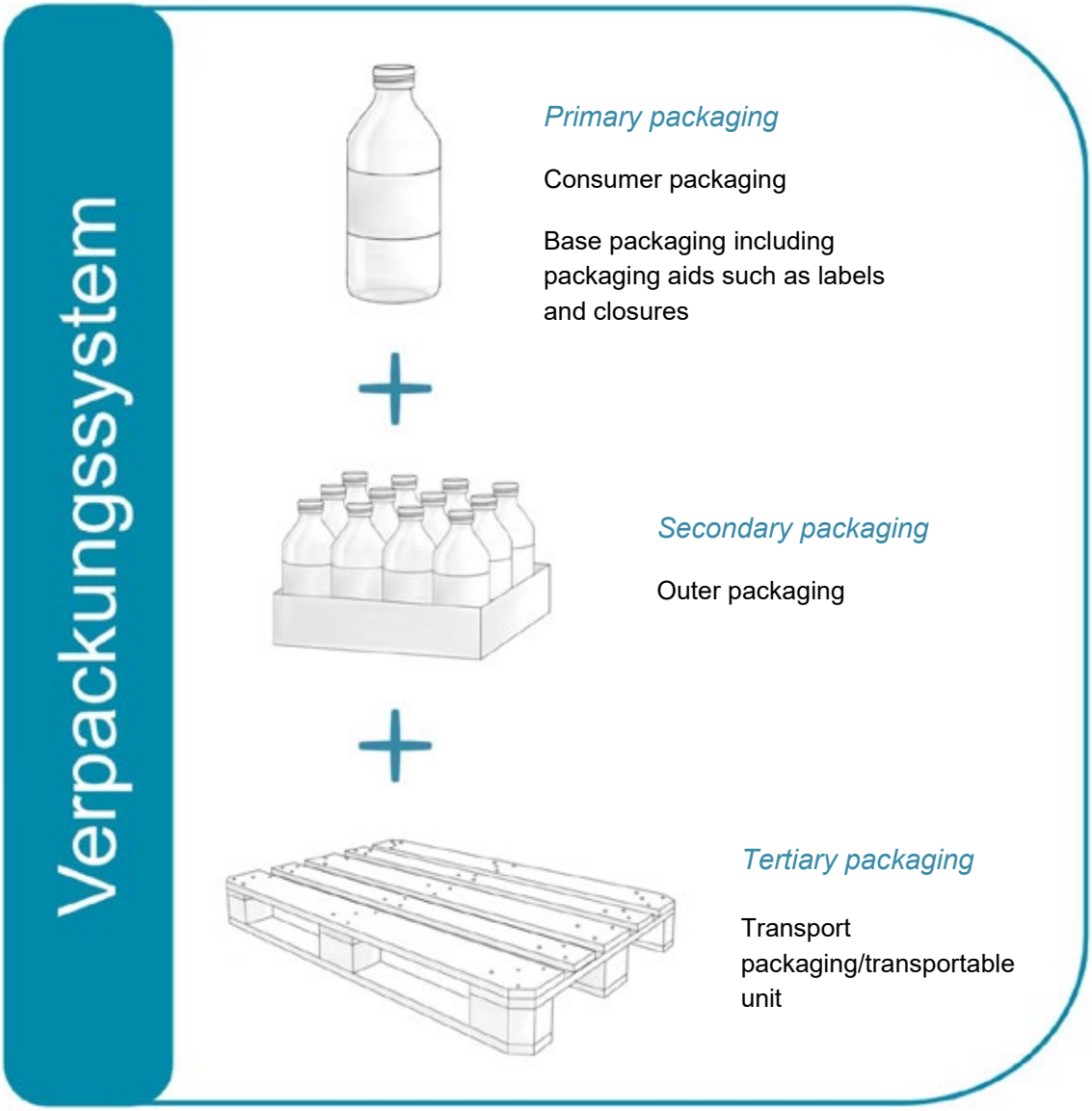
Packforce Austria the Austrian Packaging Forum: Communication and information platform for the Austrian packaging industry

GLOSSARY

Coding	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 (waste before use): Material separated from the collection stream during the manufacturing process. This does not include the 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 (waste after use): Material from households, commercial and industrial facilities or institutes (who are the final consumers of the product) that can no longer be used for its 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 according to ÖNORM A 5405: 2009 06 15
Hollow body	Hollow bodies for household packaging are packaging with a nominal filling volume of up to (and including) 5 litres in accordance with the size criteria pursuant to Section 13 h (1) Item 1 AWG 2013. 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 emptying capability	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 according to 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	Combination of several packaging materials which cannot be separated by hand and none of which exceeds a mass percentage of 95%. Definition according to 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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DOI: 10.34895/fhcw.0002.v6

Illustration: Vivienne Nieuwenhuizen, Judith Romberger