Recyclability by Design

Guidelines for Plastic Packaging

Supporting the design of recyclable plastic packaging within a circular economy.



- Support Recyclability
- Reduce Complexity
- Minimise Environmental Impact
- Drive a Circular Economy



RECOUP

CELEBRATING

20 YEARS

OF RECYCLABILITY BY DESIGN

Recyclability By Design
Version 12: Updated 2026

This work has been published by RECOUP in consultation with experts in the plastic packaging industry and the recycling industry.

The information contained within this document is for guidance only. Any details given are intended as a general recommendation based on the best of our knowledge at the time of publication.

The guidance in this document does not imply any endorsement of the recyclability of any given polymer or packaging format. Guidance does not necessarily guarantee compliance with the different recycling schemes. Users are advised to contact RECOUP to check for specific up-to-date information.

While every effort has been made to ensure the accuracy of the contents of this publication, RECOUP cannot accept any responsibility or liability for any errors or omissions. Opinions expressed by external contributors may not reflect RECOUP positions. Recommendations provided herein are offered for the purpose of guidance only and should not be considered legal advice.

1 Metro Centre, Welbeck Way, Woodston, Peterborough, UK, PE2 7UH
T:+ 44 (0)1733 390021 E:enquiry@recoup.org W:www.recoup.org

RECOUP, founded in 1990, is the UK's leading independent authority and trusted voice on plastics resource efficiency and recycling.

RECOUP works to maximise plastic packaging recycling through stimulating the development of sustainable plastics waste management, including the improvement of plastics collection and sorting activities across the UK, undertaking research and analysis to identify good practices and remove barriers to the adoption of efficient recycling systems.

The contents of this guide may be copied without modification but must include source referencing to RECOUP. All information contained in this report is the subject of copyright. Please ensure that you are working from the most recent version.
To access the most recent copies go to: www.recoup.org

Contents

Introduction 4
General Guidelines 7
Material Specific Guidelines 11
- PET 12
- HDPE 17
- PP 21

Guidelines - Other Plastic Packaging 24
Film Recycling 26
Recycling of Plastic Packaging 27

Appendix - Polymer Densities 30
Recyclability By Design Versions 31
Glossary of Terms 32
Useful Organisations 33

Introduction

Climate change, resource efficiency and sustainable development are important considerations in the design and development of packaging. Reducing environmental impacts requires consideration of packaging throughout its life cycle, including the materials and resources used, its performance in use, and what happens to it after use.

Packaging should be designed to meet its required technical, brand and customer functions while minimising environmental impact. This includes using resources efficiently and designing packaging so that, once it has fulfilled its purpose, materials can be effectively recovered and recycled wherever practicable.

These guidelines focus specifically on the design of plastic packaging for recycling. They are intended to help designers make informed material and design choices that maximise the opportunity for packaging to be successfully collected, sorted and reprocessed through established recycling systems.

Background

This publication is intended as a definitive general guidance document that has wide international agreement. It will provide plastic packaging designers, in particular, with a better understanding of the environmental implications of their design decisions, thus promoting good environmental practices but without unnecessarily restricting choice. Designers can be reassured that through following these recommendations, their plastic packaging should not cause recycling issues in any European country and be acceptable internationally.

This document is intended to address the issues in a way that will encourage packaging designers and specifiers to follow agreed good practice.

The advice contained in the document has been provided both to help users maintain the value of the post-used material resulting from the mechanical recycling of their packaging and to avoid significant interference with established recycling processes and material streams. The chapter “Recycling of Plastic Packaging” summarises the key aspects concerning the recycling of plastics.

Scope

This document provides practical guidance to address common questions faced by designers and specifiers of plastic packaging. The recommendations are broadly applicable and reflect international guidance and practice at the time of publication.

This document focuses specifically on designing plastic packaging for recyclability and does not provide a comprehensive assessment of plastic packaging sustainability. Recyclability is one consideration within a broader environmental and operational context, which also includes the overall impacts of different packaging systems and the effectiveness of collection, sorting, recycling and recovery systems.

Addressing these evolving challenges will require continued collaboration between packaging designers, manufacturers, waste and resource management professionals, governments and other relevant stakeholders.

Packaging design, materials and recycling technologies continue to evolve. Consequently, the recyclability of packaging components, including labels, adhesives and sealing layers, may change as new evidence, technologies and industry practices emerge. Regulatory requirements and recognised good practice may also develop over time, and recyclability guidance should be reviewed accordingly.

Aims

The aim of this document is to encourage designers to consider recyclability during packaging design, provide guidance on making packaging more recyclable, and help prevent packaging components from inadvertently interfering with existing plastics recycling streams.

Pursuit of these aims must be proportionate; the

guiding principle for any packaging design should be “fitness for purpose”. Thus the goal of improving the recyclability of the packaging cannot compromise product safety, functionality or general consumer acceptance and should positively contribute to an overall reduction in the environmental impact of the total product offering.

As the recycling industry has grown, collection rates and recycling rates improved, recyclability is the most environmentally sound option. Energy recovery or composting are other options to be considered, depending on the nature of packaging and the local solid waste management infrastructure. These recovery routes are complementary and their relative use needs to be optimised to meet local conditions, thereby providing an integrated and sustainable approach to packaging waste management.

Is this document relevant to me?

This guidance is intended primarily for those responsible for specifying and designing plastic packaging, but is also relevant to packaging technologists, manufacturers, buyers, retailers and others across the packaging value chain.

The guidance focuses principally on plastic packaging entering domestic waste and recycling streams, although many of the principles may also be applicable to commercial and industrial packaging.

It brings together knowledge and experience from across the packaging and waste management sectors, alongside relevant European guidance, to support good practice in plastic packaging design for recyclability. Following the guidance should help specifiers identify and avoid design features that may adversely affect the collection, sorting and recycling of plastic packaging.

Designing packaging with recycling in mind can support regulatory compliance, resource efficiency and wider sustainability objectives. As policy, recycling infrastructure and technologies continue to evolve, businesses should consider recyclability as an integral part of packaging design and specification rather than as a consideration at the end of the design process.

Protecting Your Freedom of Material Choice

Plastic packaging manufacturers understand the demonstrable benefits of plastics as a packaging material. Its lightweight nature is of particular benefit due to transport cost minimisation. In addition, plastic is often the most appropriate material to meet consumer demands of ensured freshness, safety and product visibility.

Companies involved in the packaging supply chain can safeguard their freedom of material choice by engaging with the recycling industry to provide support for the development of effective plastics recycling within the UK. Developing packaging that can easily be recycled by incorporating recyclability into the product development stage, combined with involvement in the development of the recycling industry, will help to protect both the public and political profile of plastic packaging and reduce the risk of material choice restriction via political intervention.

Genuine efforts to minimise environmental impact and maximise environmental benefit through the introduction of efficient plastics recycling programmes both protects and enhances the public image so vital to maintaining competitive advantage.

Following these guidelines will at a minimum, provide an important contribution to help you ensure that your packaging is compliant with relevant legislation /agreements, that recycling costs are minimised and that societal expectations and your company practices are matched in the area of plastic packaging recycling.

The document however is designed to go beyond being a simple aid to legal compliance; it provides up-to-date guidelines that can be used to support a process of continuous environmental improvement, a key element of both Sustainable Development and Corporate Social Responsibility.

Are guidelines still important?

Recyclability and circularity guidelines help packaging designers maximise the potential for packaging to be mechanically recycled, while minimising interference with established recycling processes and material streams.

Considering these guidelines early in the design process can help identify potential recyclability issues before a packaging design is finalised, avoiding unnecessary redesign, delays and associated costs.

Design for recyclability is also increasingly linked to regulatory and financial requirements. In the UK, the RAM assesses packaging against the existing recycling system, including collection, sortation, reprocessing and application. The resulting recyclability assessment can affect the disposal fees paid by obligated producers.
Following recognised design guidelines can therefore help businesses make informed packaging choices, improve recyclability and understand potential regulatory and financial implications.

What are you Asking me to Do?

For existing packaging, review your portfolio against these guidelines to identify opportunities to improve recyclability. Where improvements are identified, incorporate them when packaging is next reviewed or redesigned.

For new packaging, consider these guidelines from the outset of the design and development process. Early consideration of recyclability can help avoid the need for changes later in the development process.

More broadly, incorporate design for recyclability into relevant environmental management systems, new product development processes and packaging assessment procedures.

Will it Cost me Money?

Considering recyclability at the start of the packaging design process can help avoid the costs and delays associated with making changes at a later stage. In many cases, good design for recyclability can be incorporated alongside other technical, commercial and environmental requirements during normal packaging development.

Applying these guidelines can help businesses to:

- identify potential recyclability issues early in the design process;
- reduce the risk of costly redesign at a later stage;
- support compliance with relevant packaging legislation and requirements;
- consider the potential implications of packaging design for recycling systems and associated costs; and
- respond to customer, consumer and wider market expectations for recyclable packaging.

Failure to consider recyclability at an early stage may result in additional redesign costs, delays or difficulties in meeting relevant regulatory, customer or market requirements.

UK Recyclability Assessment Methodology (RAM)

The Recyclability Assessment Methodology (RAM) will evaluate packaging to ensure that it can be recycled and transformed into new products. All packaging that is placed on the UK market and reported as household waste in 2025 will be reviewed using details on the RAM. From 2026, modulated fees will be applied accordingly to each packaging format.

Packaging will be rated as either green, amber or red. Green suggests that the packaging has a recognised path for collection, sorting and recycling and will have lower fees applied than less recyclable materials. Although this sounds similar to existing recyclability guidelines, the RAM does not replace recyclability guidelines.

The RAM was written as an instrument to enable fees to be charged for packaging.

RECOUP Recyclability By Design (RBD) is produced by talking to members; and accepting the advice from recyclers as to what happens now, using widely available technology. This distinguishes RBD from other approaches that may consider what could be recyclable using emerging or ‘state-of-the-art’ technologies.

The RAM is an important guidance tool, but at this stage it is by no means the complete and definitive guide to recycling.

The RAM enables brands and packaging producers to assess and grade the recyclability of their packaging. As set out in the RAM Overview, the resulting rating affects the waste disposal fee charged for that packaging material.

The current guidelines in place are still the way brands and producers should be designing packaging. RECOUP’s guidelines are designed using feedback and evidence gathered from the recyclers and end markets for the materials and consider all aspects of the recycling process to ensure the highest quality recyclate is produced.

General Guidelines

Introduction

The guidelines have been compiled to help maximise the opportunity for plastic packaging to be mechanically recycled, without unnecessarily restricting material choice, and to help maximise the value of the post-used material resulting from the mechanical recycling of the packaging.

Up-to-date guidelines can be used to support a process of continuous environmental improvement, a key element of both Sustainable Development and Corporate Social Responsibility.

Careful selection of materials at the design stage will help overcome potential legislative issues, reduce cost and help conserve resources by avoiding obstacles to recovery, improving yields, producing less waste and ensuring a higher value of the recovered material.

The information contained within the guidelines implies no criticism of any material and merely seeks to point out that certain combinations should be avoided to maximise the recyclability of the plastic packaging in question. Plastic materials that cannot be processed with the main material at best reduce reprocessing yields and can, unless care is taken in the design, significantly reduce process efficiency and introduce unacceptable costs. Matrices summarising material compatibilities are provided within each material specific guideline.

Following the recommendations provided in these guidelines should avoid the necessity to evaluate component compatibility. However, if use of non-recommended material combinations is desired, then the user may arrange for more definitive compatibility evaluation tests to be carried out. In addition, specific applications (e.g. food contact) may stipulate more demanding requirements than provided in these general guidelines.

General Principles for Container / Components

In an ideal world, use of mono-materials or mixed materials of the same type are the preferred choice from a recycler's point of view. In this context, type means materials that for all intents and purposes act as if they were a homogeneous material i.e. they are fully compatible, do not downgrade the properties of the recycled plastic and can be sorted and subsequently processed as if it were a single material.

It is recognised that to provide both the technical properties required and to satisfy user needs, sometimes a combination of different types of material is required. Under these circumstances, materials of different densities should be used to facilitate the separation of incompatible materials during mechanical shredding or crushing, or during the subsequent water based washing process. Combinations of different types of plastic with the same density ranges should be avoided.

Unpigmented polymer has the highest recycling value and the widest variety of end uses. Therefore, use of unpigmented plastic containers is preferred to pigmented.

For food contact applications, the additional specific requirements of traceability, guarantee of the use of qualified processes and producer responsibility for recyclates would ensure that specifiers use only food approved additives, to maintain the potential for the recyclate to be subsequently used in food applications.

Residues

To help ensure packs are emptied to their maximum, packaging designers should carefully consider what good design features can be incorporated to aid the emptying of packs.

For example:

- Design the pack with a wide neck.
- Consider using a pack that can be stood inverted to ease emptying.

Non-stick additives can be used to reduce the cling of contents to the container to ease emptying.

Such additives should not, however, affect the ultimate recyclability of the pack.

No firm target figures can be provided as to what constitutes acceptable residue levels as these will be very dependent upon pack size and product viscosity. As a rough guide however, for non-viscous products (i.e. where thickness is similar to water) aim for 50ml-99ml bottle residues <10%, 100ml 499ml bottles < 5% and 500ml+ bottles <2% bottle resides of declared contents when considered empty. For viscous contents it is not practical to set target residue guidelines as the amount of residue depends in part on the properties of the contents.

Composite Materials / Barrier Layers

Where a composite material is necessary to provide the requisite properties (e.g. provide a barrier function) and cannot be designed in such a way that the different types of materials can be separated mechanically or are compatible with the recycling stream, consideration should be given to the use of thin layers.

Colour of Plastic

Colour interferes with the mechanical recycling process in two main ways: Firstly, strongly coloured plastic material has a much lower economic value than nonpigmented plastic. Secondly, heavily coloured (and hence strongly light absorbing) plastic may interfere with automated sorting machinery that uses Near-Infrared (NIR) spectroscopy to identify the nature of the plastic. Such equipment relies on the reflection of NIR radiation and thus there is an issue in identifying plastic items containing carbon black pigment.

The amount of colour to be used should be minimised as much as possible within the constraints set by technical considerations, branding and consumer acceptance.

Avoid direct printing onto natural (not coloured or opacified) plastics.

Readily separable attachments allow reprocessors to remove associated contaminants such as pigments, inks and residual adhesives, hereby raising the quality of the recyclate. This is particularly significant when the primary packaging polymer is colourless or ‘natural’. When the primary packaging polymer is pigmented, e.g. coloured HDPE, the reprocessor specification is less sensitive to low levels of ink contamination and in this case the polymer type of the label, cap and other attachments should be matched to that of the container.

Closures / Closure Liners / Cap Sleeves / Seals

Closures, liners and cap seals should not interfere with the recyclability of the material to be recycled and ideally be recyclable themselves, preferably in conjunction with the plastic of the main container. Unfortunately, this does not mean PET closures on PET bottles. Ideally, HDPE closures are used on PET bottles for carbonated applications.

Closure systems that contain no liners and leave no residual rings or attachments when removed are optimum. Designers should assume seals may be pushed back into empty containers and choose materials accordingly.

Avoid use of metal caps. They are more difficult and more costly to remove in conventional reclamation systems compared to preferred plastic closure systems. Metal residues cause unacceptably high plastic rejection rates with the metal detectors installed in sortation lines and residues can catalyse polymer oxidation and block injection nozzles. Automatic sortation equipment such as eddy current units or electrostatic separation equipment can remove aluminium closures from recovered polymer. However, not all reprocessors have such equipment. In addition, most reprocessors use a caustic wash and any aluminium residues will be converted to aluminium hydroxide, which will then become a contaminant in the recycled material, that could prevent its suitability as a food grade material (e.g. in the case of PET). Use of threaded / snap-on metal closures should be avoided, as these can be difficult and relatively expensive to remove. Prised off (crown) caps are acceptable provided they are completely detached from the bottle on opening and cannot be pushed back on / into the container.

In certain circumstances, seal residues and minor components of a different type of plastic if present in very minor amounts, may not significantly interfere with the recycling process or the quality of the recycled material.

However, this should not be assumed and further

guidance should be sought in these instances.

In applications where tamper-resistance is required, integration into the design feature is preferable. Provided functionality can be maintained, sleeves and safety seals should be designed to completely detach from the container or be easily removed in conventional separation systems. Otherwise they will act as contaminants.

If a full sleeve was to be left on, there is a risk that the bottle may not be correctly recognised by automated Near Infrared (NIR) sorting equipment, in which case the bottle could be either mis-read, or at worst possibly rejected.

While modern 'state-of-the-art' sorting equipment is moving towards being able to recognise this mixture of polymers, the advice is still that, where a sleeve of a different polymer to the bottle is used, this should cover no more than 40% of the surface area.

Labels / Safety Seals / Adhesives

The type of labels and adhesives used has important implications for ease of container recycling. Amount of adhesive used and surface coverage should be minimised to maximise yield and ease reprocessing. Water releasable at 60 to 80°C (140 to 180°F) and hot melt alkali soluble adhesives are the adhesives of choice as they are the most readily removed during reprocessing. Label adhesives that can't be removed can coat the plastic regrind and embed unwanted contaminants.

Foil safety seals that leave remnants of the foil and / or adhesive should be avoided.

Labels should not delaminate in the washing process. Use of paper labels on bottles is not ideal, as some fibres can be carried over into the recycled plastic, causing problems such as surface defects and pinholes during the blow moulding of the recyclate. Paper labels also may pulp in the wash tank. They are acceptable, however, provided they are attached using water soluble adhesives and are not coated in such a way that prevents separation and removal from occurring during reprocessing. For this reason use of decorative / protective finishes (e.g. foil, lacquers, coatings, etc.) should be minimised.

Metallised / foil labels increase contamination and separation costs and should be avoided whenever possible.

Deposition techniques that provide a very thin layer of metal (only atoms deep) are acceptable however and are the method of choice to provide a metallised effect on labels.

Where in-mould labelling is desirable (e.g. to protect containers frequently coming into contact with oils or water) the same plastic as the container should be used wherever possible.

Reference should be made to the specific material sheets to obtain more detailed information about acceptable options for label materials.

The choice of label or sleeve polymer should not have the potential to lead to an error in the identification of the material used for the container itself. This is why various published guidelines for bottles often stipulate that the sleeve labels should cover no more than 40% of the bottle surface.

For pots, tubs and trays and other plastic items, a label should not cover more than 60% as presented for sorting

Pigments / Inks

Inks and pigments selected to colour and print the container and label already have to comply with existing restrictions on the use of heavy metal components and, although beyond the scope of these guidelines, also with relevant health and safety regulations.

In any case, hazardous substances should be avoided in the interests of good manufacturing practice and heavy metal inks not used for printing as they may contaminate the recovered plastic. For these reasons, it is recommended that the regularly updated exclusion list for printing inks and related products, provided by the European Printing Ink Association (EuPIA) is followed.

Inks that would dye the wash solution should be avoided as this may discolour the recovered plastic diminishing or eliminating its value.

Heavily pigmented containers should be avoided. They can result in a significant increase in the density of the polymer thereby causing separation problems and can also cause problems for automated sorting equipment using NIR sensors.

Other Components

The use of other components of a different material (e.g. handles, pour spouts) is discouraged as they may reduce base resin yield and increase separation costs. When required, compatible materials (preferably unpigmented) should be used.

Material Identification

In Europe, material identification is voluntary, but if it is to be used then Commission Decision 97/129/EC should be followed, although the widely adopted and substantially similar SPI system, developed in the US for plastic, seems also to be acceptable.

When used, the symbol should be shown clearly and ideally moulded into the container / component.



On containers, the marking should be clearly distinct from any other letter or cavity reference number to avoid confusion. For consistency, material identifiers should generally be embossed on the base of a container. Exceptionally, the identifier can be located on an alternative position close to the base (e.g. to avoid the risk of cracking due to bottle design).

Printing the material identifier on a label should be avoided, as this is likely to lead to confusion as it could refer to the label material, the container plastic or the full container.

With the use of automated sorting for household waste, the recycler’s need for material identification has become less important.

Material Specific Guidelines

General guidelines apply to all plastic materials used for packaging. Specific guidelines have also been produced for plastic packaging. These material specific guidelines complement the general guidelines and should be used in conjunction with them where appropriate. In the unlikely event that the general and specific guidelines appear contradictory, the material specific guidelines should take precedence.

The compatibility matrices contained in the material specific guidelines are divided into three columns, namely:

- **COMPATIBLE** for recycling in most applications
- **MAY BE SUITABLE** for recycling for some applications
- **NOT SUITABLE** for recycling

The meaning of these three columns is as follows:

COMPATIBLE for recycling in most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
Generally the material is compatible with or separable from the main material and is acceptable in industrialised recycling volumes, processes in large volumes.	Use of material could cause severe recycling issues if used in large volumes. Under certain specific conditions the material may be recyclable, but this would need to be confirmed with the appropriate recycling recyclers, organizations and/or recyclers.	Material is generally not compatible with or separable from the main material in current industrialised recycling processes and will therefore cause severe recycling issues/ cause rejection of recyclate if present even at low volumes.

It should be noted that under certain circumstances suppliers may require, for a specific application, recycled material that conforms to the most demanding requirements outlined in the material compatibility matrices supplied in this document, as evidenced by the following example:

Example - Polyethylene

For the manufacture of polythene bottles from recycled HDPE, one UK manufacturer highlights the importance from a recyclability perspective of the HDPE material stream including only containers made from HDPE, linerless HDPE caps, labels made from only HDPE and that any inserts or other minor components are also manufactured from only HDPE.



Material Specific Guidelines

PET



General

The recommendations given in this section were originally written to cover PET bottles. The same recommendations cover PET trays. These guidelines are driven by the requirements of the mechanical recycling process. For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with PET should have a density < 1 g / cm3.

Material / Material Combinations

Contaminants which generate acidic compounds during extrusion cause problems when recycling PET, as these catalyse ester depolymerisation reactions, decreasing intrinsic viscosity.

A range of contaminants including PVC, rosin acids from label adhesives and EVA cap liners can act as sources of acids. PVC contamination is a potentially major problem as the similar appearance and overlapping range of densities make the two polymers difficult to separate. PET melts between 250°C and 260°C, and at this temperature PVC begins to decompose producing HCl. The presence of very low levels of PVC (ca50- 200ppm) in recycled PET results in measurable deterioration in chemical and physical properties and can render large amounts of PET useless for most recycling applications. For this reason, the use of PVC components of any kind with PET containers should be scrupulously avoided. These components generally include, but are not limited to closures, closure liners, labels, sleeves and safety seals.

Other types of PET that share the same material identifier may cause problems in separation and conventional recycling. Use of PLA (a biodegradable material) with PET should be avoided as the polymers are incompatible and not readily separable (both have a density > 1g/cm3). The presence of very low levels of PLA in PET causes haze and a deterioration of physical properties with the recycled PET. MXD6 also will reduce clarity.

In addition, PLA causes processability problems in the drier as it melts at the drier temperature. Blends of PET with other resins are undesirable unless they are compatible with PET recycling. Inclusion of nucleating agents, hazing agents, fluorescers, scavengers and other additives for visual and technical effects should be examined on a case by case basis for their impact on the overall plastic recycling stream. Such additives which cause the PET to discolour and/or haze should be avoided unless means are readily and economically available to minimise their effect.

Barriers / Coatings

New PET bottles incorporating additives or barrier materials to further improve barrier performance are continuously being developed and will at some time challenge existing recovery schemes. Non-PET multilayers or coatings are not always fully compatible with current recovery technologies and may reduce recoverability of PET bottles. Indeed, constituents can be difficult to separate. It is accepted that newer containers and containers for oxygen sensitive contents may be multi-layer and will, therefore, require additional attention during recovery operations. The European PET Bottle Platform has published guidelines to help the PET production, filling and recovery chain evaluate the impact of such bottles. EVOH barriers in particular have a history of causing significant issues during recycling if residual levels are >= 500ppm. This could include haze and colour issues at low levels and deterioration of mechanical properties at high residual levels. Hence EVOH as a potential barrier material with PET is not recommended at this time.

Product manufacturers, and their suppliers, would need to ensure that levels employed are minimised and that data to show that the proposed packaging provides a recyclate that satisfies all technical requirements (especially discolouration and haze) and that recyclers in general can achieve the separation efficiencies required. Alternatively, where performance enhancing barrier layers are used which could interfere with current recycling, for example in PET beer bottles, it is important to ensure that the container is easily distinguished and sorted from conventional PET bottles.

Clear plasma coatings in general cause no recycling issues, although use of high levels of carbon should be avoided. Other external coatings (e.g. O_2 or CO_2 barriers) can cause issues. To be acceptable the barrier needs to flake off the PET and be efficiently removed

during reprocessing. European PET Bottle Platform protocols have been developed to test suitability.

Colour

Non-coloured, unpigmented PET not only has the highest value and the highest recovery rates but also the widest variety of end markets. At present, tinted (other than light green and blue tints) or opaque PET bottles are not desirable to many PET recyclers because the quality of their end products are colour sensitive. As a result, strongly coloured PET is rejected by many recyclers and can interfere with the recycling process and therefore clear PET should be used as much as possible. The use of opacifiers should be avoided as they significantly reduce the value of the PET recyclate. The presence of TiO_2 in particular causes breakage during fibre production and thus use of this opacifier in particular should be avoided

Closures / Closure Lines

EVA liners are only acceptable in combination with plastics. When combined with aluminium they cause contamination and thus should not be used.

Conventional silicone seals (density >= 1 g/cm³) are neither compatible with PET or easily separable and therefore should not be used in combination with PET. Seal manufacturers have recognised this problem and are now designing silicone seals with a density < 1 g/cm³. These seals should be separable from the PET and avoid potential issue. Potential users are recommended to check that the supplier can provide proof of the compatibility of the seal with conventional PET recycling. It is also worth noting that whilst this development was designed to overcome potential issues within the PET recycling stream, these lower density silicone seals have the potential to end up in the polyolefin stream and adversely affect the quality of this stream.

Closures made from PS or thermoset plastics are undesirable and should be avoided. In general the use of aluminium closures should be avoided, as they are more difficult to separate from bottles compared to the preferred closure systems (PP and HDPE) and add both capital and operating costs to conventional reclamation systems. Foil safety seals that leave foil or remnants or attaching adhesive on the PET bottle should be avoided.

Labelling

Polypropylene and polyethylene are the preferred label materials. Foil, lacquered and coated labels become contaminants and are undesirable. Presently all direct printing and decoration contaminates recovered PET in conventional reclamation systems and discolours the conventional base material. Colour and printing therefore (other than date coding) should be confined to labels.

Other Components

It is preferred that base cups, handles, transportation aids and other attachments are avoided but if used, they should not be welded to the container. If attachments are glued on, they should separate in hot aqueous detergent or caustic solution (60 to 80°C).

	Material Guidelines - PET Bottles			
		COMPATIBLE for recycling in most applications	**MAY BE SUITABLE for recycling for some applications**	**NOT SUITABLE for recycling**
BODY	Colour	Clear/Light blue/light tints	Dark blue / dark green / brown / strong tints	Opaque / solid colours Carbon Black
	Barriers/ Coatings	Clear plasma coating	External coating / PA - 3 layers	EVOH / PA monolayer blends
	Additives		UV stabilisers / AA blockers	Nanocomposites
CLOSURE	Caps	PP HDPE, LDPE - Europe only		Steel / Aluminium / PS / PVC / Thermosets
	Seals	PE/PP	Silicone (density <1 g/cm³)	PVC / Aluminium / Silicone (density >=1 g/cm³)
DECORATION	Direct Printing	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date	
	Labels	HDPE / LDPE / PP / OPP less than 60% coverage on face	Paper Over 60% coverage on face	PET PVC Metalised
	Sleeves (incl. tamper resistance)	PE / PP / OPP / EPS (density <1 g/cm³) Foamed PET / Foamed PET-G less than 60% coverage on face	Over 60% coverage on face	PET PVC PS PS (density > 1 g/cm³) / PET-G
	Adhesive for labels	Removeable water releasable in 60 - 80°C		Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

	Material Guidelines - PET Trays			
		COMPATIBLE for recycling in most applications	**MAY BE SUITABLE for recycling for some applications**	**NOT SUITABLE for recycling**
BODY	Colour	Clear / uncoloured	NIR detectable colours*	Non-NIR detectable colours e.g containing carbon black*
	Barriers/ Coatings	None		PE seal Layer EVOH PA (Nylon)
	Additives	Minimal silicone surface coating (de-nest)*	O2 scavengers / UV stabilisers / AA blockers / Anti-block	
CLOSURE	Lidding film	Easily removed by end user or easily removed early in the recycling process; or; as main polymer (PET)	Removed later in the recycling process (washing process)	
DECORATION	Direct Printing	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date Printing inks that do not lead to NIAS after the washing process	Extensive colour printing with printing inks that result in NIAS
	Labels	HDPE / LDPE / PP / OPP Less than 60% coverage on face Labels that are removed in or before the wash step*	Paper Over 60% coverage on face In Mould label	PET PVC Metalised Labels that cannot be removed Labels that result in detection error
	Adhesive for labels	Removable Water releasable in 60 - 80°C		Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Inserts	Must be fully removable without leaving a trace*	HDPE / LDPE / PP / PET / paper	PVC / PS / EPS / PU / PA (Nylon) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic

*No additives or processes should result in not intentionally added substances (NIAS) as this would contaminate food grade recycled content

Material Specific Guidelines

HDPE



General

For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with HDPE should have a density > 1 g / cm³.

Colour

Applications using clear, natural, colourless polyethylene have the highest recycling value, therefore use of unpigmented containers is preferred. Coloured containers, tubes and films are acceptable.

Barriers / Additives

Some applications require the use of additional barrier layers for specific applications. The use of non-PE layers should be minimised (to maximise PE yield and reduce potential contamination and separation costs), but when required they should be compatible with or easily separable from PE in conventional recycling systems. Current HDPE recycling systems can tolerate the use of low levels of EVOH layers. Similarly MXD6 and other nylon based barrier layers are tolerated, particularly if the layers are readily separated from the HDPE in conventional reclamation systems. In all such cases their content should be minimised to the greatest extent possible to maximise HDPE yield and reduce potential contamination and separation costs. PVDC barriers should be avoided.

The use of additives / fillers such as calcium carbonate, talc, etc. in concentrations that alter the density such that they cause the HDPE plastic to sink in water or alter the properties of the regrind are undesirable and should be avoided. For this reason, the HDPE density should be kept at <= 0.995 g/cm³.

Other Components

Use of PVC components should be avoided as they can cause discolouration and malodour.

HDPE Bottles - Material / Material Combinations

Unpigmented, homopolymer HDPE bottles generally do not use a multi-layer construction at present. It is possible that future bottle designs, however, might require the use of layers for specific product applications and then the barrier advice given should be followed. The principal polymer contaminant of recovered HDPE is PP from bottle caps and bottles. HDPE and PP are opaque and less dense than water and consequently difficult for reprocessors to separate. Even in the small number of reprocessing plants able to separate PE from PP, this is not common as it is costly to carry out. PP has a higher melting point (160-170°C) than HDPE (ca130°C), and so does not disperse readily in the HDPE recyclate mix. PP contamination can limit the recovered HDPE specification to lower value applications. In general, a level of PP contamination up to 5% can be tolerated in the total mix and levels of PP cross contamination in finished product are frequently at around 5%. Higher levels e.g. 10% in the total mix can be tolerated for certain lower specification applications. When designing packaging, it is recommended that PP levels are restricted to a maximum of 5% to avoid potential end use issues. This is in line with US recommendations. Higher levels may be possible but this would require the difficult task of investigating the likely effects on the total mix during recycling.

HDPE is very susceptible to contamination from the contents (e.g. pesticides, motor oil, etc.) which can result in colour and odour problems. Whilst recyclate derived from milk bottles can result in malodour issues, this should be avoidable using a hot washing stage during reprocessing. HDPE containers used for mineral oil based products (e.g. motor oil) are not generally mechanically recyclable as they can cause residual malodour issues but more importantly, the oil migrates into the plastic and is not removed during normal reprocessing operations.

Colour

In general homopolymer bottles are unpigmented whilst copolymer HDPE bottles (detergent bottles) are pigmented. Indeed, some plastic recyclers use pigmentation as the basis for distinguishing and separating copolymer from homopolymer containers. For this reason a communication program to alert recyclers to the potential confusion should

accompany any use of unpigmented copolymer bottles. In multilayer HDPE bottle designs, the use of inner layers of the same colour as the outer layer is preferred to maximise recyclability but inner and outer layers of different colour can be tolerated.

Closures

The use of closures that are the same colour as the bottle is desirable (although not essential). Foil safety seals that leave foil or remnants or attaching adhesive on the HDPE bottle should be avoided.

Labelling

In applications using unpigmented, homopolymer HDPE, all direct printing other than date coding, used either for product labelling or decoration, presently contaminates the recycled unpigmented HDPE in conventional reclamation systems. Use of PVC labels should be avoided as during the density separation the foil is so thin that it is carried over with the PE and does not sink as would be expected from its intrinsic density.

Other attachments

The use of any other attachments is discouraged, as they reduce base resin yield and increase separation costs. If attachments are added to a bottle, they should be made from either materials that are easily separable from HDPE in conventional separation systems or are compatible e.g. PP, LDPE or preferably, unpigmented, homopolymer HDPE. Use of PP or LDPE attachments, if necessary, should be limited to less than 5 % of the total bottle weight wherever possible as higher percentages can contaminate the HDPE for many recycling applications. If pour spouts are added to a bottle they should allow for complete removal of product contents and be designed to leave virtually no product residue when the bottle is empty. If adhesives are used to affix attachments, they should be water releasable or dispersible at temperatures between 60°C and 80°C in order to be removed in conventional washing and separation systems. The use of attachments that contain metallic and other non-plastic components is discouraged and should be avoided.

	Material Guidelines - HDPE			
		COMPATIBLE for recycling in most applications	**MAY BE SUITABLE for recycling for some applications**	**NOT SUITABLE for recycling**
BODY	Colour	Natural	Light blue / green / light tints Opaque / Heavy colours	Carbon Black
	Barriers/ Coatings	EVOH	PA (incl. MXD6)	PVDC
	Additives			Talc / CaCO3 / other fillers that increase the density of HDPE above 0.995 g/cm2
CLOSURE	Caps	HDPE / LDPE / PP		Steel / Aluminium / PS / PVC / Thermosets
	Liner	HDPE / LDPE / PE + EVA / PP		PS / PVC / EVA with aluminium
	Seals	PE / PP / OPP	Aluminium	PVC / Silicone
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	Labels	HDPE / MDPE / LDPE / LLDPE PP / OPP less than 60% coverage on face	Paper Over 60% coverage on face In Mould label	PVC / Aluminium / Metalised PET
	Sleeves (incl. tamper resistance)	PE / PP		PVC / PS
	Adhesive for labels	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Material Specific Guidelines

PP



General

For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with PP should have a density > 1 g/cm³.

Colour

The use of unpigmented PP is preferred to pigmented as the recyclate from unpigmented bottles will have a greater value due to the larger number of potential applications. Clarified PP is acceptable when bottles are shown to be compatible with end uses for recyclate.

Material Combinations

The principal polymer contaminant of recovered PP is HDPE from bottles, closures and attachments.

PP and HDPE are opaque and less dense than water and consequently difficult for reprocessors to separate. Since HDPE has a lower melting point (130°C) than PP (160-170°C) the overall PP mix will be more tolerant to HDPE contamination than the converse.

Nonetheless, when designing packaging, it is recommended that PE levels are restricted to a maximum of 5% to avoid potential end use issues. This is in line with US recommendations. Higher levels may be possible but this would require the difficult task of investigating the likely effects on the total mix during recycling.

Barriers

Current PP recycling systems can tolerate the use of EVOH layers. Similarly MXD6 and other nylon-based barrier layers are tolerated, particularly if the layers are readily separated from the PP in conventional reclamation systems. In all such cases their content should be minimised to the greatest extent possible to maximise PP yield and reduce potential contamination and separation costs. PVDC barriers should be avoided.

Closures / Closure Liners

The use of closures that are unpigmented or the same colour as the bottle are desirable (although not essential). Foil safety seals that leave foil or remnants of the attaching adhesive on the PP bottle should be avoided.

Labelling

In applications using unpigmented PP, all direct printing other than date coding, either for product labelling or decoration, presently contaminates the recycled unpigmented PP in conventional reclamation systems.

Other Components

Use of PVC components should be avoided as they can cause discolouration and malodour.

	Material Guidelines - PP			
		COMPATIBLE for recycling in most applications	**MAY BE SUITABLE for recycling for some applications**	**NOT SUITABLE for recycling**
BODY	Colour	Clear / Natural, or lightly tinted	Opaque / Heavy colours	Carbon Black
	Barriers/ Coatings	EVOH	PA (incl. MXD6)	PVDC
	Additives		Clarifier	
CLOSURE	Caps	HDPE / LDPE / PP		PS / Thermoset plastics / Aluminium / Steel / PVC
	Lidding Film	No residue after removal by consumer; or; as main polymer (PP)		
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	Labels	HDPE / MDPE / LDPE / LLDPE PP / OPP less than 60% coverage on face	Paper over 60% coverage on face In Mould label	PVC / Metalised PET
	Sleeves (incl. tamper resistance)	PE / PP		PET / PVC
	Adhesive for labels	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Inserts	PP	HDPE / LDPE paper PET (light)	PVC / PS/ EPS / PU / PA (Nylon) PET (Heavy) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic
	Trigger Sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Guidelines - Other Plastic Packaging

Contamination

Plastic containers are generally lightweight. Product contamination can therefore represent a significant proportion by weight of the collected material (e.g. the weight of product residues in yoghurt pots can be as much or more than the weight of the container itself).

Contamination lowers the efficiency of the recycling process as polymer weights are much less than weights of material collected and the residues themselves (often oily food) can interfere with the washing process. It is therefore important that containers are designed in such a way as to ensure levels of contamination are minimised as much as possible. This not only provides a benefit to recyclers, but also to the consumer. To further facilitate recycling, consumers / end-users should remove any plastic f ilm, paper, cardboard and foil present and as much food residue as possible before putting the container out for collection.

PET/PE Trays

Rigid PET packaging represents a significant fraction by weight of the domestic plastic waste stream. One particular difficulty is the widespread use of PET/PE multi-layers (e.g. in the processed meat sector). As already indicated, use of mono-materials or mixed materials of the same type are the materials of choice from a recycler's point of view. Hence the current efforts by some producers, encouraged by RECOUP, to switch from PET/PE blends to monolayer PET for trays should further facilitate recycling. However, it should be restated here that it is appreciated that use of multi-layers in this way may have a greater environmental benefit, in extending shelf life, than consideration of recyclability.

As with other PET packaging formats, it is vitally important that contamination by PVC is avoided. PVC trays and blisters represent an important potential contaminant of the PET tray and blister stream and every effort needs to be made to try and ensure that such contamination is avoided either through design and / or at the recycling stage.

PE - Tubs / Dishes

Tubs and dishes are often made of injection grade HDPE, exhibiting higher melt flow rates than blow moulding grade HDPE. Mixing the two types of HDPE together decreases the value of the mixture. Do not mix HDPE bottles with HDPE tubs or dishes.

In principle aluminium lids are acceptable on PE, especially peel-off ones. Adhesive should stay with the aluminium lid.

Tubs that have a clear or colourless body and where the information is presented on the lid are particularly suitable for recycling.

Direct printing is acceptable provided attention is paid to ink types to avoid interference with the quality of regranulate.

Excessive paper content can cause issues during recycling and thus use of paper labels is less desirable. If used, they should be lightweight and cover only a minor area of the container. Paper labels are liable to pulp in a hot caustic washing step.

PE - Tubes

Cap and tube should be manufactured from the same type of plastic and ideally from the same polymer (in this case HDPE). An elevated percentage of PP lowers the quality of the recycled plastic.

Direct printing is acceptable for marking tubes provided the printing is in compliance with the EuPIA Exclusion list. Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue that is difficult to remove.

PP - Tubs / Tubs / Trays

In principle aluminium lids are acceptable, especially peel-off ones. Adhesive should stay with the aluminium lid.

Tubs that have a clear or colourless body and where the information is presented on the lid are particularly suitable for recycling.

Direct printing is acceptable provided attention is paid to ink types to avoid interference with quality of regranulate.

Excessive paper content can cause issues during recycling and thus use of paper labels is less desirable. If used, they should be lightweight and cover only a minor area of the container. Paper labels are liable to pulp in a hot caustic washing step.

PP - Tubes

Cap and tube should be manufactured from the same type of material and ideally from the same polymer (in this case both from PP). Direct printing is acceptable for marking tubes provided the printing is in compliance with the EuPIA Exclusion list. Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue that is difficult to remove.

Film - Material / Material Combinations

As with rigid bottles and mixed plastics, homogeneous films can be recycled optimally. Use of mono-materials or mixed materials of the same type are the materials of choice from a recycler's point of view and combinations with a different type of plastic of similar density should be avoided wherever possible.

Packaging film very often requires the use of a variety of plastic materials, to provide both the technical properties required and to satisfy user needs. Designers should follow the film guidelines now available: for example the RecyClass guidelines from Plastics Recyclers Europe. In the case of films, as some film recyclate is used in applications that have a more tolerant specification e.g. furniture, bin liners, etc, plastic film users can feel less restricted to use material combinations in the MAY BE categories than with rigid containers. Combinations in the NOT SUITABLE category should still be avoided.



Film Recycling

Plastic films and flexible packaging represent a significant part of the UK plastic packaging waste stream and continue to be an important focus for the development of collection and recycling systems.

In the absence of widespread kerbside collection, many major retailers provide front-of-store collection points for plastic bags and flexible packaging. In England, mandatory kerbside collection of plastic films and flexible packaging under Simpler Recycling, originally planned for March 2027, has been deferred until April 2030. Collection, sorting and recycling infrastructure for these materials continues to develop.

As collection systems evolve, it is important that films and flexible packaging are designed to be compatible with sorting and recycling processes. Following Design for Recycling guidance can help maximise the opportunity for collected material to be successfully sorted and recycled.

European Guidelines for Film

For Europe, where film is collected, both RecyClass and CEFLEX have produced recyclability guidelines for flexible packaging.

The tables are not based on the UK market, however design guidance is compatible with UK recommendations for film and flexible packaging.

The RecyClass tables are available to download and are continuously updated based on new laboratory findings, including technology approvals.

https://recyclass.eu/recyclability/design-for-recycling-guidelines/

RecyClass

Recycling of Plastic Packaging

Plastic Packaging Recycling Overview

The development of collection, sorting and reprocessing technology and its techniques is constantly changing. The following information will provide an informative picture of current practices and technologies for the recycling of plastic packaging.

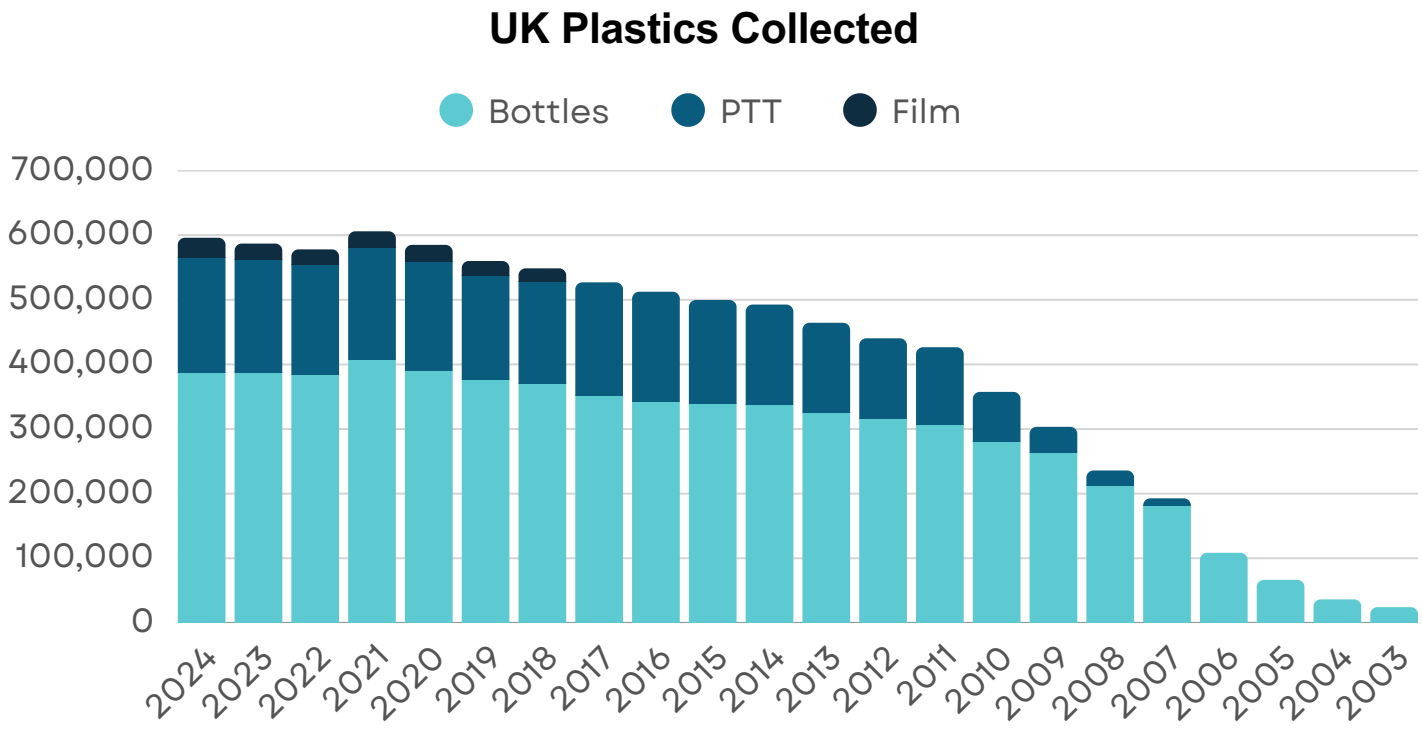
Following the success and interest in recycling plastic bottles, other forms of plastic packaging recycling have been developed and introduced into collection streams. These are primarily, other 'rigid' plastic packaging, such as pots, tubs and trays (PTTs) used for both food and non-food applications, both from households and from commercial and industrial sectors.

Separate waste collection streams have existed for some time for commercial & industrial waste, as recycling of such materials is traditionally more commercially favourable (e.g. cleaner materials, bulk collection). In terms of domestic plastic waste recycling, which is the focus of the current document, the technology and processes for recycling have been designed for rigid plastic packaging, focusing on plastic bottles and PTTs.

Target materials in the UK waste stream are PET, HDPE, LDPE, and PP. All bottles of a given type of polymer are usually compatible and so may be mechanically recycled together. Technical incompatibilities between a number of these different polymers, however, prevent them being directly mixed and mechanically recycled as high specification products. However, they can be readily separated, provided the simple guidelines given in this document are followed.

Packaging design should facilitate the separation of non-compatible polymers and avoid the risk of them being left unseparated by visual or mechanical recognition systems.

A typical plastics mechanical recycling process involves several distinct steps, these are indicated in the following sections.



Household Plastic Collection Data (RECOUP Household Plastic Collection Survey 2025)

Collection

There is a wide variety of collection methods used to receive recyclable materials from households. Most of these methods identify particular material types and products that should be deposited. These products are typically newspaper and magazines, cardboard, glass, steel and aluminium cans and plastic packaging.

The two household recyclables collection methods used by Local Authorities are kerbside and bring schemes. Originally most household plastic packaging recycling collections were achieved by asking the public to place their materials into containers placed in public locations such as supermarket sites and car parks. These are termed bring sites.

Since 2003, there has been a significant growth in the use of kerbside collection systems which provide a recyclables collection service on the householders' doorstep, and the landscape of household plastic packaging collection rates began to change. This is illustrated by the graph above. The householder is provided with a bin, box or bag which is then collected every week or fortnight.

Kerbside collection schemes are now the predominant method for the collection of plastic packaging in the UK, with bring schemes used alongside kerbside schemes to form part of the recyclables collection infrastructure which Local Authorities offer. There are a number of variations in kerbside schemes in terms of collection container, service frequency, and communications, and depending on the specific requirements for each Local Authority.

Sorting and Separation

Once the recyclable materials have been collected the various material types need to be segregated at the Materials Recovery Facility (MRF), and then bulked or baled ready for delivery to material reprocessors. The plastic packaging is separated either using automated NIR optical equipment for higher volumes and throughputs, manually by picking operatives, or a combination of the two.

Sorting Techniques

Automated optical scanners are used to separate materials by polymer type, using NIR (near infrared) sensors, which are installed above the conveyor and ejecting the targeted material using compressed air jets at the end of the conveyor. This technology is frequently used to separate plastic containers into different fractions, as the market requires clean streams of specific resins and colour types. Typical automatic sort rates are up to 40,000 bottles/hour or 11 bottles per second. Although not without its limitations, auto-sorting greatly improves the quality and efficiency of the separation process.

Many countries still rely on the manual sorting of whole plastic bottles by visual inspection. However, automatic bottle sorting is widespread in Europe, where the larger MRFs have throughputs sufficient to offset the capital cost of the equipment. Manual bottle sorting is based primarily on the physical characteristics of the bottle (e.g. shape, colour and product recognition) and experience. Although this method can lead to inaccurate identification and separation due to human error or distorted containers.

In addition, complications arise when bottles of the same design are made using different polymer types. Although most plastic bottles carry a Material Identification Code, this coding system has limited value to sorting personnel. Manual sort rates are typically 1200+ bottles/hour.

Sorters have less than three seconds to pick up, identify and sort the bottle. This precludes looking for the code on every bottle.

Sorting Techniques - Plastic Bottles

Plastic packaging collected through household recycling systems is sorted at Materials Recovery Facilities (MRFs). Sorting arrangements vary according to the facility, equipment, material inputs and end-market requirements, with automated Near Infrared (NIR) sorting widely used to identify and separate different polymers.

PET and HDPE bottles may be separated into higher-value material streams, while other plastic packaging may form part of a mixed plastics fraction for further sorting or processing. The

resulting material fractions are typically baled before being supplied for further sorting or reprocessing.

The introduction of the Deposit Return Scheme (DRS) from October 2027 will change the collection route for in-scope PET drinks bottles, with these containers collected through a dedicated return system rather than relying solely on conventional household recycling collections.

Sorting Techniques - Pots, Tubs and Trays

The sorting of PTTs has increased significantly over the past few years with more and more councils opting to collect these materials at the kerbside. Similar to plastic bottles these materials are segregated using optical equipment into specific polymer streams and colours. Typically at large scale MRFs these materials are baled as a 'mixed plastic' grade where they are then further segregated into individual polymer grades at a Plastic Recovery Facility (PRF). At smaller scale MRFs PTTs are sometimes separated manually by negative picking where, after the plastic bottles have been removed, all remaining plastic materials are baled together as a mixed grade. The picking operatives clean the PTTs material by removing any remaining waste or contaminates before it is baled, however this material is usually low quality, low value. Due to the small size and varying polymer types which are difficult to distinguish, automated equipment is usually favoured as manually picking PTTs is a very inefficient process.

Reprocessing - Label Removing and Washing

Once the plastic packaging has been segregated into individual polymers and colours, the material is then shredded into 5-10 mm flake to begin the label removing and washing stage. The intense friction and cutting action in the presence of circulating water provides the first washing stage, removing most labels and residual contents. Hot water, alkali solution and detergents are then frequently used during further washing stages to remove more difficult to separate contaminants such as residual labels and adhesives.

Separation by Flotation

Density based sorting, such as sink/float tanks, hydrocyclones and air classification separate contaminants on the basis of density. Use of float tanks is very common (e.g. PET recycling) as they are much simpler and cheaper. The ability to separate materials is much more limited however and restricted to two types, namely those that sink and those that float in water. Thus any mix of plastic types that sink together / float together in water are not capable of being separated. The key density difference is now not so much that

between the polymers themselves than the density difference between the individual polymer and water. The density ranges of plastics commonly used for packaging are given in Appendix - Polymer Densities. This table provides intrinsic plastic densities and also indicates how the polymer behaves in a float tank.

Drying Stage

After the wash and flotation processes excess water is removed by, for example, a centrifuge spin drier system. Heat from this is then used to dry the plastic flake. The dried plastic flakes are then transferred to plastic sacks, bulk bags or silos and are either then sold to convertors or further reprocessed into pellets.

Recycling - Plastic Sales and End Products

The values for plastics will fluctuate over time and are dependent on a number of conditions, with a particular focus always on quality levels, and are based on baled material delivered to a plastic reprocessor.

Once the plastic packaging has been dried into a flake or pellet format by the reprocessor the material can be converted into new products. These include food grade plastics such as bottle to bottle and fresh food trays, non-food packaging such as paint pots, and other applications such as building site screens, garden furniture, stationary, and using yarn to produce clothing such as t-shirts, fleeces and jeans.

Appendix - Polymer Densities

The table below shows the density ranges of plastics commonly used to make plastic packaging and components.

Polymer	Density g/cm³	Behaviour in float process*
Ethylene vinyl acetate (EVA)	Less dense than water	Float
Polypropylene (PP)	0.90 - 0.92	
Low density polyethylene (LDPE)	0.91 - 0.93	
High density polyethylene (HDPE)	0.94 - 0.96	
Polystyrene (PS)	1.03 - 1.06	Variable
Nylon (PA)	1.13 - 1.14	Sink
Acrylic (PMMA)	1.17 - 1.20	
Polycarbonate (PC)	1.2	
Polyethylene terephthalate (PET)	1.30 - 1.38	
Polyvinyl chloride (PVC)	1.32 - 1.45	

Densities are approximate and relate to virgin unpigmented and unfilled polymer. Colouring with a 4% pigment can raise density by 0.03 g/cm³ which may cause further overlaps of polymer densities.

Hydro cyclones can be fine-tuned to separate plastic materials provided their densities differ by circa > 0.05 g/cm³. The densities of flake derived from PP and HDPE packaging overlap and are difficult to separate. The density difference between PS and HDPE whilst sufficient to permit separation in a hydro cyclone, is not sufficiently large from water to ensure that is fully separable with either the light or heavy fractions and thus can cause recycling issues with for example, PET.

A density difference between the polymer and water of ca>=0.05g/cm³ is required to ensure that the material will either sink or float in a sink/float tank.

Care should be taken with any application which requests the use of foamed or blown plastics as this process will affect the density.

Recyclability By Design - Versions



Core Principles - A summary of Recyclability by Design

RECOUP and the British Plastics Federation (BPF) launched guidance to help packaging designers create easy-to-recycle plastic packaging. The guide outlines which combination of closures, seals, labels and materials ensure recycling plants can easily separate and recycle the plastics.

Big brands are being encouraged to use the guidance to ensure their packaging products can be easily processed at the end of their lives to avoid going to landfill, and instead be recycled into new products in an important move towards developing a circular economy.



Rigid Plastic Packaging - Design Tips for Recycling

This document explains to all who have an involvement in packaging the simple steps which can be taken to maximise the recyclability of rigid plastic packaging products. This version includes detailed guidance from Recyclability By Design; including best practice and tables for PET Bottles, PET Trays, HDPE Bottles, PP and PS containers.

All documents are available to download on the RECOUP website.

Glossary of Terms

APR	The Association of Post Consumer Plastic Recyclers
CEN	The European Committee for Standardisation
CEPE	The European Council of Paint, Printing Ink and Artists' Colour Industry
COTREP	Comite Technique de Recyclage des Emballages Plastiques
EPS	Expanded Polystyrene
EuPC	European Plastics Converters
EuPIA	The printing ink group within the European Council of Paint, Printing Ink and Artists' Colour Industry
EuPR	Plastics Recyclers Europe
EUROPEN	The European Organisation for Packaging and the Environment
EVA	Ethylene vinyl acetate
EVOH	Ethylene vinyl alcohol
FTIR	Fourier Transform Infrared Spectroscopy
HDPE	High density polyethylene
HCI	Hydrochloric acid
HIPS	High-impact polystyrene
IPP	Integrated Product Policy
IR	Infrared (radiation)
ISO	International Standards Organisation
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
MDPE	Medium density polyethylene
MRF	Material reclamation facility
NAPCOR	National Association for PET Container Resources
NIR	Near infrared (radiation)
OPET	Oriented PET
OPP	Oriented polypropylene
OPS	Oriented polystyrene
PA	Polyamide (nylon)
PBT	Polybutylene terephthalate
PC	Polycarbonate
PCR	Post-consumer recycled material
PEN	Poly (ethylene 2,6 napthalate)
PET	Polyethylene terephthalate
PETG	Polyethylene terephthalate glycol
PLA	Polylactic acid
PMMA	Polymethyl methacrylate
PP	Polypropylene
PPWD	The European Packaging and Packaging Waste Directive
PPWR	The European Packaging and Packaging Waste Regulation
PRS	PET recycling schweiz
PS	Polystyrene
PU	Polyurethane
PVDC	Polyvinylidene chloride
PVC	Polyvinyl chloride
RAM	Recyclability Assessment Methodology
REPA	Service organisation for all recovery organisations in Sweden (except glass)
RPET	Recycled Polyethylene Terephthalate
SPI	Society of plastics industry
6EAP	European Union sixth environmental action program

Useful Organisations

EuPC
European Plastic Converters
71 Avenue Cortenbergh
Brussels,1000 Belgium
(t)+32 2 732 41 24
(f)+32 2 732 42 18
info@eupc.org
www.plasticsconverters.eu

Plastics Recyclers Europe
Avenue de Broqueville 12
1150 Woluwe Saint-Pierre
Brussels
Tel: +32 2 786 39 08
info@plasticsrecyclers.eu
www.plasticsrecyclers.eu

EPRO
European Association of Plastics
Recycling and Recovery Organisations
Konigin Astridlaan 59 bus 5
B-1780, Wemmel
BRUSSEL
(t)+32 (0) 2 456 84 49
(f)+32 (0) 2 456 83 39
epro@epro-plasticsrecycling.org
www.epro-plasticsrecycling.org

Petcore Europe
Avenue de Broqueville 12,
1150 Brussels, Belgium
(t) +32 (0) 2 315 24 88
info@petcore-europe.org
www.petcore-europe.org

APR
Association of Plastic Recyclers
2050 M Street, NW
Washington, DC 20036
www.plasticsrecycling.org

NAPCOR
National Association for PET
Container Resources
8383 Greenway Blvd
Suite 600
Middleton WI 53562
www.napcor.com

BSDA
British Soft Drinks Association
20-22 Bedford Row
London WC1R 4EB
(t)+44 (0) 20 7405 0300
(f)+44 (0) 20 7831 6014
bsda@britishsoftdrinks.co.uk
www.britishsoftdrinks.com

PACSA
Packaging Council of South Africa
PO Box 131400,
Bryanstan 2021,
South Africa
(t)+27 12 001 1914
shabeer@packagingsa.co.za
Samantha@packagingsa.co.za
www.packagingsa.co.za

RECOUP gratefully acknowledge the help of the following for providing photographs and illustrations used in this document;