

Recyclability of plastic packaging

Design criteria for primary packaging

Recycling saves resources

This manual is a practical guide to how plastic packaging should be designed in order to enable recycling.

Experience shows that large amounts of the plastic packagings that are collected for reuse today are not, in the end, used to make new products. They are designed in ways that obstruct e.g. emptying, disassembly, separation and, in the last instance, reprocessing by use of existing technologies.

This can be changed.

How to use the manual

This manual is useful if you want your supplier to focus on the recyclability of packaging. Or if you are a designer or producer of packaging the manual can be used as a practical design guide for which materials, dyes and shapes to use in order to enable recycling.

On next page you will find a table of four levels of recyclability. Comparing your specific packaging items with the criteria below makes it easy to determine their recyclability.

- ✓The green level, indicates a high level of recyclability.
- ✓The yellow level, indicates a good level of recyclability.
- ✓The orange level, means suitability for recycling is uncertain.
- ✓The red level, means the packaging is not suited for recycling.

Any single element of a packaging, e.g. colour or the material used for the label, can determine whether it is recyclable. It is the lowest ranking that decides the final ranking of the packaging item. All components of a packaging must satisfy the criteria for the green level in order to be ranked 'High' on recyclability. Packaging that otherwise satisfies the green level criteria but e.g. includes a subcomponent which fits the yellow level must accordingly be ranked at the yellow level as 'Good'.

At the end of the manual you can read more about the criteria and their significance for recyclability. You will also find explanations of abbreviations and terms.

Tips for design for recyclability

Below we present some principles for design of recyclable packaging:

- The packaging must be suited for the product it is intended for. Otherwise the product can be damaged and discarded.
- If specific considerations like avoiding food waste, enhancing durability require use of particular materials, components or additives etc., these considerations overrule the advice given in this manual.
- Use as few types of material (plastics and other materials) and as few subcomponents as possible. Using one single type of plastic is preferable to using more.
- If more than one material is used (several types of plastics, cardboard etc.) the packaging item should be designed for easy disassembly. Composite materials should furthermore be *compatible*. Read more about which types of material are compatible in Annex A of this guide.
- Avoid use of expanded polystyrene (EPS) as the material does not at present get separated in treatment facilities. The same goes for PVC.
- Avoid use of oxo- and bio-degradable plastics as they 'contaminate' the plastics that are separated in treatment facilities.
- Undyed and lightly dyed plastic is best suited for reuse for other products. Avoid use of black plastic and strongly coloured plastic.
- Labels, stickers and sleeves should not cover more than 40% of the surface of bottles and 60% on cups, tubs and trays. Otherwise, the packaging may not be correctly separated in the treatment facility.
- It is important to design containers so that they can be emptied of product residues as these will otherwise contaminate the material for recycling.

Source: Selected guiding principles from WRAP (2013).

It is the lowest level of recyclability that determines the packaging's final ranking

Criteria Recyclability	Container (Main component)	Subcomponents (Closures, lids, seals, inserts, tamper resistance, labels and sleeves)	Identification	Residues	Mark level:
High	The container is made in mono-material (Either PET, PE, PP or PS). No colouring of the container, prints are reduced to a minimum, e.g. date only.	Sub-components are made of the same mono-material as the container. Adhesives are reduced to a minimum and are water soluble at max 80°C.	Labels and sleeves are made the in same mono-material as the container	No residues after use. Emptying only takes a rinsing in cold water.	
Good	The container is made in mono-material (Either PET, PE, PP or PS). Minimal colouring and prints.	Sub-components are compatible with the container. Adhesives are water soluble at max 80°C.	Labels and sleeves are compatible and does maximum cover 40 % on bottles and 60% on tubs, trays and pots.	Can be emptied in cold water or by use of a simple tool, e.g. a spoon.	
Uncertain	The container is made of compatible materials. The container is coloured and has prints on it.	Sub-components are compatible. Adhesives are water soluble.	Labels and sleeves cover more than respectively 40% and 60% of the surface.	The packaging require separation to be emptied.	
Not fit	The container is made of composite of non compatible materials. The container is black or heavy coloured.	Sub-components contain metals and/or paper. Adhesives are not water soluble.	Labels and sleeves are in a different material than the container and cover the entire surface.	The packaging cannot be emptied.	

Influence of the criteria on packaging recyclability and the environment

Container (main component of the container)	Subcomponents (Closures, lids, seals, inserts, labels and sleeves)	Colouring, print and adhesives	Identification	Emptying
<ul style="list-style-type: none"> ❖ The types of materials we know collectively as plastics consist of a long list of different polymers. Though they often resemble each other they must be separated and be reprocessed separately to enable reuse in new high grade products. This is also true when the packaging includes other materials like paper or metal. Consequently, the best way to ensure a high levels of recycling is to design the entire packaging of a single material. This avoids the issues that can be caused by composite materials. ❖ If packaging made of composite materials is desired due to other considerations that recyclability, these materials should be compatible with each other (cf. Annex A). Compatibility is determined in terms of which types of materials can be included in a packaging item without hindering separation, reprocessing and reuse. Compatibility requires that e.g. lids, labels, sleeves and seals must be designed with materials that can be separated and reprocessed together with the container itself. In the Annex A to this manual you will find specific guides to which combinations of materials are compatible. ❖ Recyclability is further enhanced by choosing those types of plastic that are in demand on the reprocessing market, namely PET, PE, PP and PS. ❖ Biodegradable and bio-based plastics as well as metal and paper fibres from e.g. labels, sleeves and closures should be avoided as they often contaminate the reprocessed raw material so that it cannot be reused for new products. 	<ul style="list-style-type: none"> ❖ Colouring and prints influence recyclability. Natural or clear plastic is to be preferred because they give a wider range of options recycling than intensely coloured plastic. Besides this, carbon black coloured plastic cannot be separated by polymer type with the prevalent Near-Infra-Red (NIR) scanning technology. This means that black plastic can either not be reused or that it can be reused only for low-quality. ❖ If colour or prints are desired e.g. for the purpose of marketing these must be used only on subcomponents e.g. lids and labels. ❖ Types and quantities of inks and adhesives also play a crucial role in the recycling process. Adhesives that cannot be removed in washing processes may encapsulate impurities and prints can rub off. Both inks and adhesives can lead to such a degree of contamination of the reprocessed raw materials that it cannot be reused. 	<ul style="list-style-type: none"> ❖ Separation of plastic types is frequently done using Near-Infra-Red (NIR) scanning technology and this technology cannot separate correctly if the container itself cannot be hit by the scanner beam*/light. ❖ The safest approach is, of course, to design labels and sleeves of the same type of material as the container itself. If this is not possible, a good rule of thumb is that labels and sleeves may cover a maximum of 40 % on bottles and 60% on cups, tubs and trays. 	<ul style="list-style-type: none"> ❖ Residues of the contents of packaging items influence the recycling process and consequently the quality of the reusable raw material. For this reason, it is crucial to design packaging in ways that reduce the amount of residue as far as possible. ❖ With optimal design, the consumer is spared from doing an extra effort to empty the packaging. This is familiar in the cases of thin *liquids and hard*, dry products e.g. juice, bread, fruit and screws. ❖ Fatty and viscous products often require wider openings or that the packaging can be placed upside down. In this case, consumers frequently need to rinse the packaging in cold water after emptying. ❖ Packaging which is very difficult to empty of residue is the cause of the greatest problem in recycling. We are all familiar with mayonnaise or hand cream tube where there is always some residue left after end of use. ❖ That a packaging item can be emptied, has added environmental 	

Abbreviations and explanation of terms

Plastic

The term plastic covers a large group of materials with the common trait of being plastically formable in the production phase, as well as being made of polymers. In other respects plastics differ greatly in terms of chemical structure and attributes. Plastic materials, furthermore, often contain additives which enhance or modify polymer attributes (Plastindustrien, 2010).

We recommend use of the types of plastic listed below in order to attain large enough volumes to make recycling attractive. Read more on recycling options for individual types of plastic and on the compatibility of materials in Annex A.

PET Polyethylene Terephthalate

Including

A-PET Amorphous Polyethylene Terephthalate (amorphous and transparent)

C-PET Crystalline Polyethylene Terephthalate (part-crystalline and opaque)

PET-G Polyethylene Terephthalate Glycol-modified, also used in foamed form (PET-G foam)

PE Polyethylene

Including

HDPE High-density Polyethylene

LDPE Low-density Polyethylene

MDPE Medium-density Polyethylene

PP Polypropylene

PS Polystyrene

Including

EPS Expanded Polystyrene

XPS Extruded Polystyrene Foam

Materials

The term *materials* covers the various types of plastics (polymers) like those listed above as well as other materials e.g. paper, metal and glass. Where the guide text states that e.g. containers should be made of a single material this means it should be made of a mono-material, e.g. pure PE.

Separation

Separation may refer to the process of separating a packaging made of multiple materials or to the separation of bulks of packaging into diverse material streams in households and businesses as well as at mechanical sorting facilities. The plastics must be separated into uniform materials to enable recycling of packaging plastics in new high-quality products.

Near-Infra-Red (NIR) Scanning

Most of the large separation facilities that handle plastics use Near-Infra-Red light beams to scan the plastics and determine polymer types in order to separate them into uniform material streams. A few facilities also use Near-Infra-Red scanning to separate the plastics by colour.

Reprocessing

When plastics have been separated into polymer types and perhaps also by colour, they can be used for reprocessing. Here, the plastic is often shredded into flakes or pellets and sold as regenerate (raw material for new products).

Futher details regarding the manual

Marketing, product protection and costs have not been taken into account.

The manual is aligned with the ambitions of the Danish Government's resource strategy 2013, Denmark without Waste, and with Directive 94/62/EC of the European Parliament and the Council of Ministers.

Since technologies as well as markets are in development the criteria for recyclability will continuously be assessed and adjusted.

About Plastic Zero

This manual was produced under the project 'Enhanced* recyclability of packaging' under EU LIFE+ project Plastic Zero – Avoiding Plastic as a Waste, a public-private innovation initiative. Findings from the project are available at www.plastic-zero.com

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Comments and suggestions for improvement

Please send Comments, suggestions for improvement or your experience with using this guide to: plastic-zero@tmf.kk.dk. Your input will be worked into the next revision of the guide.

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