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RECYCLASS RECYCLABILITY METHODOLOGY

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1 Introduction

Traditionally, plastic packaging has been designed with functionality and marketing display in mind, while its end-of-life management has been disregarded. Today, moving forward in the transition towards circular economy, design for recycling stands as an essential measure to accomplish circular life for plastics and contributes towards diverting plastics away from landfills and incineration plants, ultimately contributing to achieve higher recycling targets while saving natural resources. The overarching goal of RecyClass is to enable high-quality recycling of plastic packaging.

RecyClass is an initiative aiming to create a value chain community around plastic packaging recyclability to find the correct way to approach and evaluate design for recycling of plastic packaging products, with the goal of improving their recyclability.

The RecyClass Platform aims at filling the existing gap between different industry actors and works towards combining the technical knowledge of polymer suppliers, converters, brand owners, waste managers and recyclers. The RecyClass Platform gathers members across the whole plastics value chain with recyclability in the core of their strategy to work on the development of testing Protocols[1], as well as on Design for Recycling Guidelines[2].

In order to create a level playing field around recycling claims, RecyClass defines two different Recyclability Assessments:

- Design-for-Recycling Assessment

  The package is designed to be recyclable, following the RecyClass Design for Recycling Guidelines. This Assessment evaluates and ranks the recyclability of a plastic packaging, determining to which extent it is suitable for a specific recycling stream based on the state-of-the-art sorting and recycling technologies available in Europe. This assessment does not consider collection, sorting and recycling specificities in a given country. The Assessment is based on RecyClass Design for Recycling Guidelines and its associated self-assessment tool[3], which allows to classify the technical recyclability of a plastic packaging on the EU market.

- Recyclability Rate Assessment

  The package is designed to be recycled, following the RecyClass Design for Recycling Guidelines, and is effectively recycled in the specific geographical area for which the assessment is conducted. In this assessment, the existence of selective collection schemes, as well as the existence of sorting and recycling infrastructures are being checked.

[1] Recyclability test Protocols are available at: https://recyclass.eu/recyclability-evaluation-protocols/

[2] Design for Recycling guidelines are available at: https://recyclass.eu/recyclass/design-for-recycling-guidelines/

[3] RecyClass Online Tool is available at: https://recyclass.eu/tool/account/

Both Assessments are the basis for the RecyClass Certification scheme which evaluates a package qualitatively – Design-for-Recycling Certification; and quantitatively – "Recyclability Rate Certification". The methodology behind these assessment processes is laid down in this document.

2 Design for Recycling Assessment

The RecyClass freeware tool is a user-friendly online self-assessment which provides an analysis of the technical recyclability of a plastic packaging according to the state-of-the-art recycling technology available in Europe. The evaluation results in a class ranking from "A" to "F" resembling the energy efficiency grading. The Audit Report provides specific indications and recommendations on how to improve the design of the package to make it compatible with recycling in Europe.

The results achieved with the RecyClass freeware tool only give an indication to the user and cannot be considered as an official RecyClass Certification. Prior to being advertised publicly as such, this self-assessment must be validated by an independent Certification Body who will issue an official Certification. More information on the use of claims may be found in the document "Use of Claims" available on the website.

2.1 Recyclability Classes

All the information reported in the RecyClass Design for Recycling Guidelines is transposed into the RecyClass Tool. The class ranking ranges from "A" to "F", where an "A" implies that a package is designed to be fully recyclable[4], while a "F" indicates that a package is unrecyclable, and its only available option is energy recovery.

The use of recycled plastic in the packaging, if properly certified (this is not part of the current scope of RecyClass) will be illustrated with a "+" bonus. One, two or three "+" bonus can be indicated depending on the amount of post-consumer recycled plastic (see section 2.2.6 for details).

The recyclability classes are described as follows:

CLASS A: The packaging does not pose any recyclability issues and the recycled plastics can potentially feed a closed-loop scheme to be used in the same quality application.

[4] Types of packaging considered recyclable in Europe have to fit with the definition of recyclability available at the following link: https://www.plasticsrecyclers.eu/design-recycling

CLASS B: The packaging has some minor recyclability issues that slightly affect the quality of the recycled plastic generated. However, majority of recycled plastics from this packaging can still potentially feed a closed loop.

CLASS C: The packaging presents some recyclability issues that affect the quality of the recycled plastics or lead to material losses during recycling. In the first case the recycled plastic could be used in a cascade open-loop scheme, whereas in the latter case the plastic could potentially feed a closed loop scheme.

CLASS D: The packaging has significant design issues that highly affect its recyclability or imply large material losses. In both cases the recycled plastic can only be fed into low-value applications (i.e. the packaging will be downcycled).

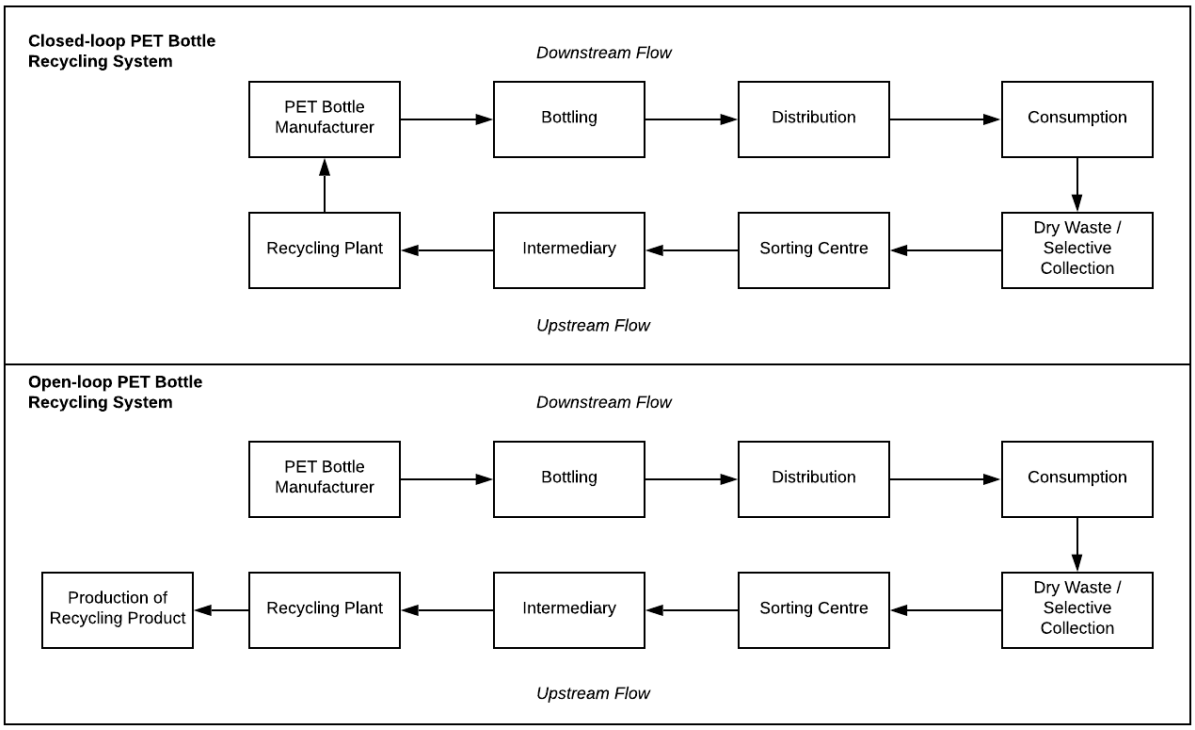
CLASS E: The packaging has major design issues that jeopardize its recyclability or imply severe material losses. The packaging is not considered recyclable and can only be used in incineration with energy recovery.

CLASS F: The package is not recyclable at all, either because of fundamental design issues or a lack of specific infrastructure for collection, sorting and recycling in EU28+2.

The class grading indicates a decrease of recyclability which can be caused by many different factors of a packaging design. As defined above, packaging with class "A" can be recycled in closed-loop systems, for instance "beverage bottle to beverage bottle" or "food to non-food packaging". This class however would not apply to packaging destined for open loop recycling– see figure 1. High-quality applications are strongly supported by the Circular Plastic Economy, as they:

- minimize the loss of materials,
- minimize plastic degradation, allowing for more recycling cycles,
- preserve the plastic economic value.

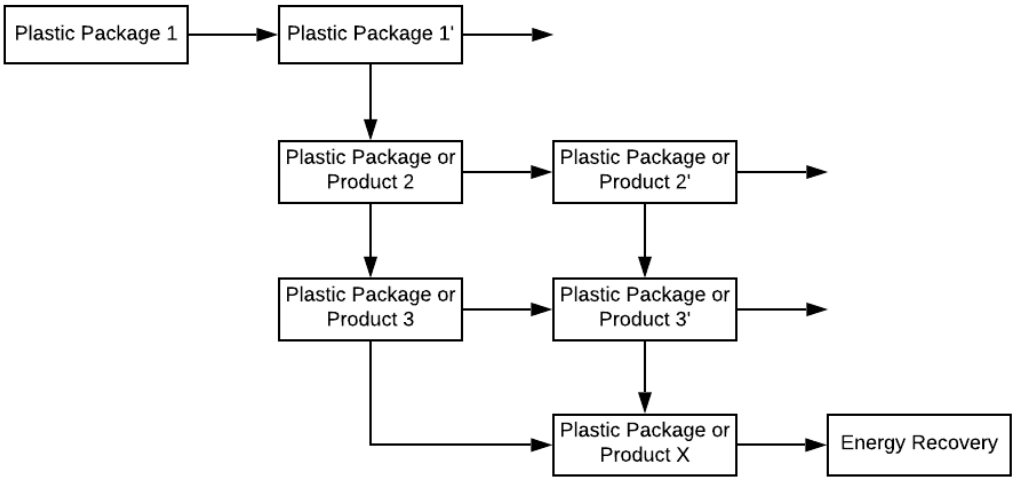
Fig. 1 PET bottles in closed loop and open loop recycling



However, even if not ranked "A", open-loop recycling also results in a positive environmental impact reduction when compared to the utilization of virgin plastic feedstock, in particular if several cycles of utilization are ensured as it is the case with packages obtaining class "B" or "C".

There are cases where functionality requirements make certain packaging hard to be designed for closed-loop recycling systems. However, design choices leading to the longer multiple-step cascaded recycling should be favoured as illustrated in figure 2.

Fig. 2 Cascade open-loop recycling



2.2 Modus Operandi of the RecyClass Freeware Tool

The RecyClass Tool is structured in 7 sections:

1. Suitability analysis, to define whether the packaging falls into the definition of plastics packaging or whether the packaging has generic design issues that render the packaging non-recyclable per definition, being the entry condition for using RecyClass methodology
2. Type of packaging (flexible or rigid) and main polymer used in the packaging
3. Area 1: General Questions on the packaging design
4. Area 2: Questions related to the compatibility of materials used in the packaging
5. Area 3: Questions related to the recycled contents of the packaging
6. Area 4: Questions to calculate the Index on "Easy-to-Empty" and "Easy-to-Access"
7. Area 5: Questions on compliance of the used materials with REACH

Each section is detailed below.

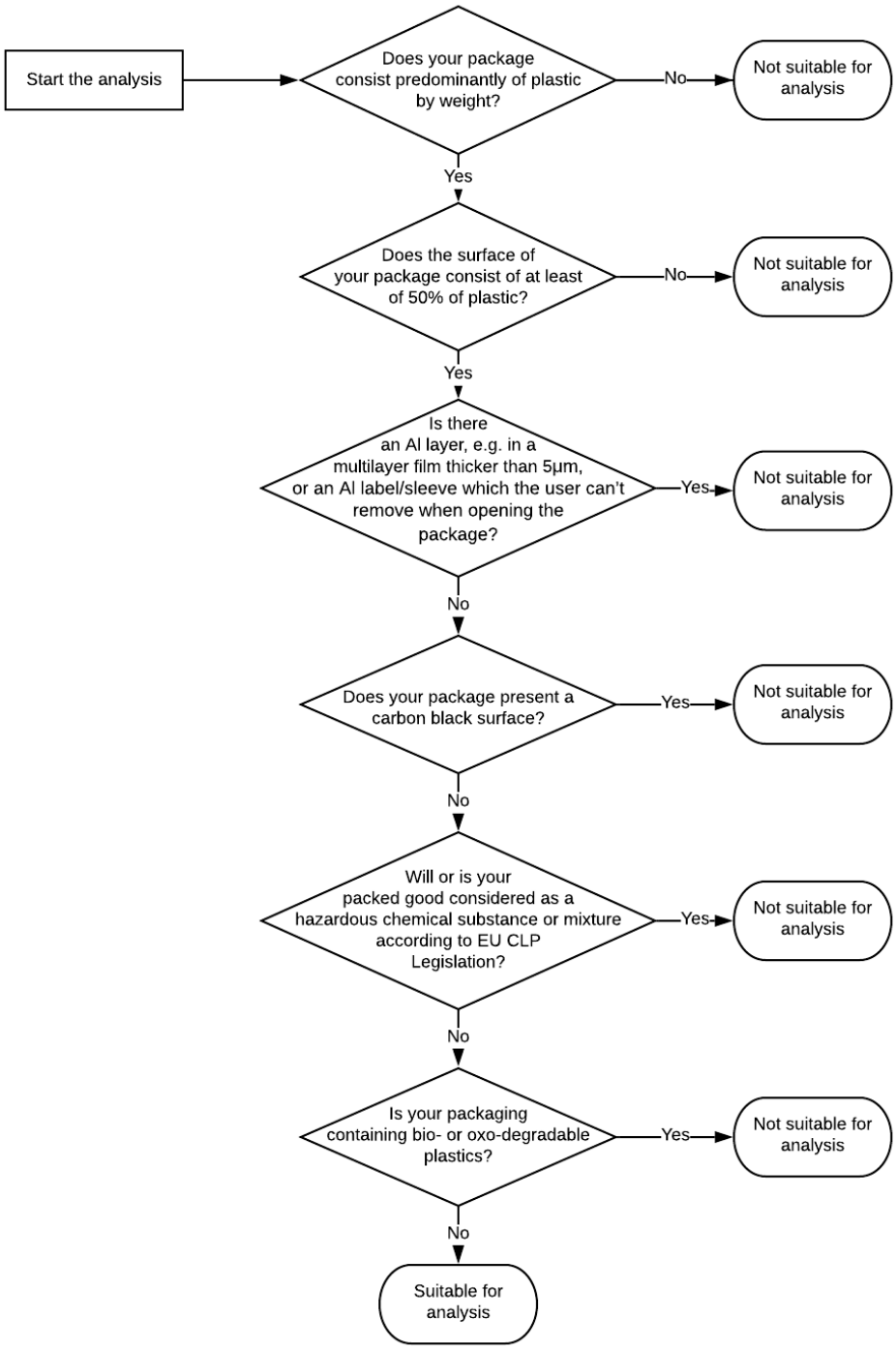
2.2.1 Suitability analysis

The first section of the Tool aims at identifying whether the packaging is suitable for the analysis by asking whether it contains a minimum of 50% of plastics; whether it is intended to package non-hazardous goods, and whether it contains any bio-/oxo-degradable materials. This section determines whether the packaging is designed with elements that could compromise its sortability, and therefore impact the recycling of its main material.

The result of this section will not give an indication of recyclability but will only determine whether the analysis may continue.

Detailed information on each question of this section is illustrated in Figure 3.

Figure 3. Suitability section decision tree



2.2.1.1 *Does your package consist predominantly of plastic by weight?*

The efficiency of recycling is highly linked to the main polymer in the packaging. A packaging containing more than 50% of non-plastics likely belongs to another recycling path, as e.g. paper, aluminium, glass or combined cardboard materials. Designers need to ensure that if the package is a combination of materials, the materials are not welded together and that non-plastic materials can be removed by consumers to access the product. In case of multi-material

packaging, the compatibility of the materials with plastics recycling processes will be further analysed in the following sections.

2.2.1.2 *Does the surface of your packaging consist of at least 50% of plastic?*

A packaging needs to be sorted into the right stream in order for its main material to be recycled. For this, it must be efficiently identifiable by optical (NIR) sorting devices. When less than 50% of the surface of a packaging is made of plastics, this identification becomes inefficient, faulty and expensive. If a plastics packaging contains a label or sleeve made out of another material than plastic, to ensure the package sortability, the maximum covering of the package body should be 50%; otherwise, the non-plastic materials should be removed by consumers to access the product with the intention to have at least 50% of naked plastics surface. In case of doubt and multi-material packaging, further tests using Recyclass Protocols may be required.

2.2.1.3 *Is there an aluminium layer, e.g. in a multilayer film thicker than 5 µm, or an aluminium label/sleeve which the user can't remove when opening the package?*

State-of-the-art eddy current sorters operated in MRFs or by the recyclers detect all thick aluminium parts and separate them into the aluminium fraction. Hence, a plastic package with a thick aluminium layer will end up in the aluminium recycling stream, and the plastics will be lost.

2.2.1.4 *Does your packaging present a carbon black surface?*

Near Infra-Red (NIR) technology is by far the most used technology to sort out collected packaging in Europe. Plastics packaging with non NIR-detectable black surface will not be detected by near-infrared technology due to light absorption phenomenon. NIR detectable black will be tested for sortability with the Sorting Protocol.

2.2.1.5 *Will or is your packed good considered as an hazardous chemical substance or mixture according to EU CLP Legislation?*

Packaging containing hazardous substances should not be collected, and therefore recycled, with other household packaging, in order to prevent contamination of the recycled plastics.

To be considered hazardous, the packaged substance or mixture will meet one (or more) of the classification criteria prescribed by the Classification Labelling and Packaging Regulation (Regulation (EC) No 1272/2008, as amended) and is in turn labelled and packaged according to the requirements of this regulation.

2.2.2 *Is your packaging containing bio- or oxo-degradable plastics?*

Oxo- and bio-degradable plastics consist of polymers that are incompatible with today's conventional plastic polymers. That hence cannot be mixed with standard polymers because they have a strong negative impact on the recycled plastic properties.

2.2.3 Type of Packaging

The main plastics polymer in the packaging has to be selected, as this choice will determine which guidelines[5] to use for that specific kind of packaging. The different types of packaging included in the RecyClass Tool are:

- Clear / light blue PET bottles
- Transparent Coloured PET bottles
- Clear mono PET blisters and trays
- Transparent PE flexible film
- Coloured PE flexible film
- Transparent PP flexible film
- Coloured PP flexible film
- Natural HDPE container
- Coloured HDPE container
- Natural PP container
- Coloured PP container
- HDPE & PP crates & pallets
- Polyolefin-based pots, tubs & trays

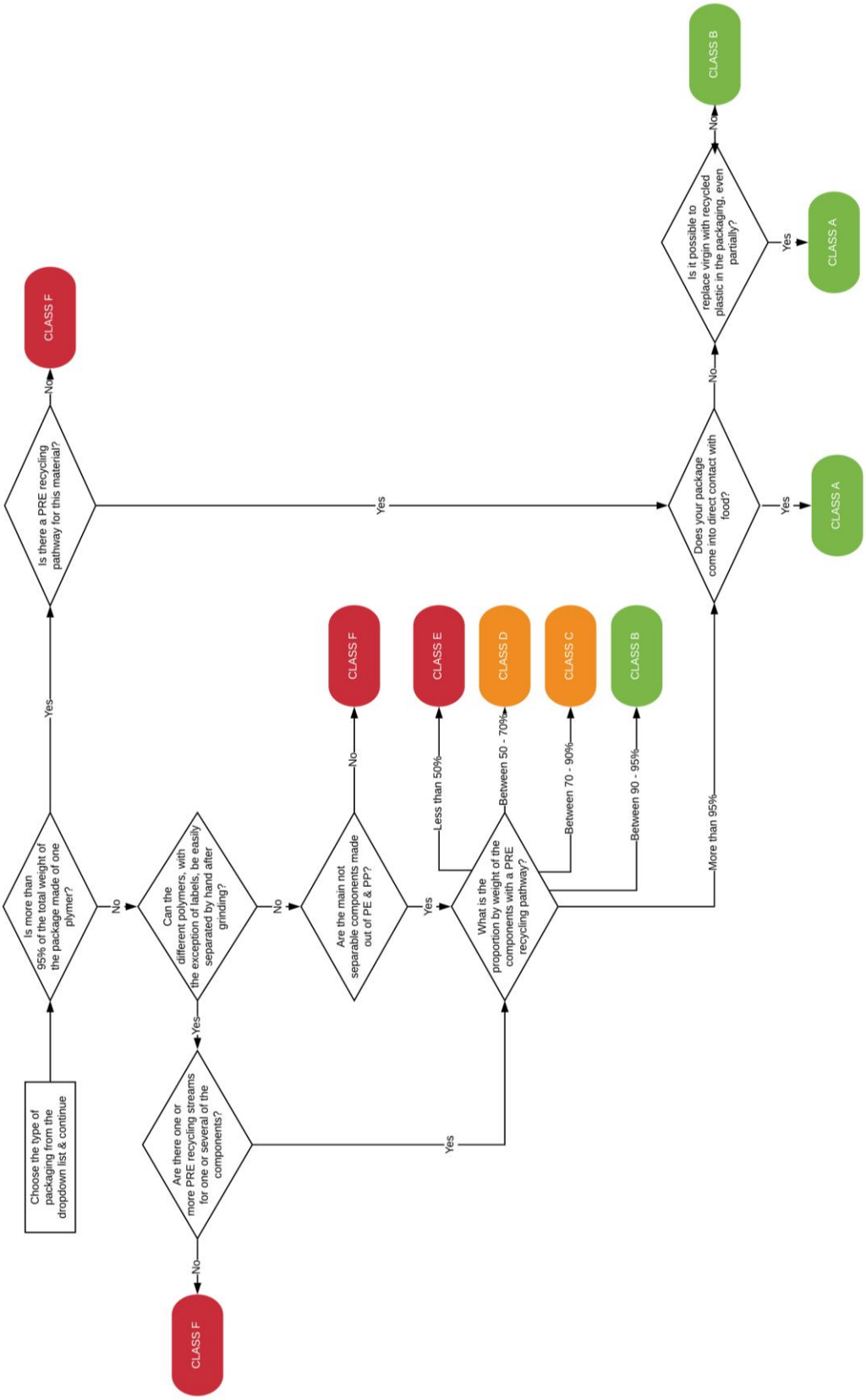
Additionally, an option “other materials” allows to provide additional information for packaging not being listed, in order to check its recyclability with a RecyClass expert.

2.2.4 Question Area 1: General Questions

The first question area addresses the overall design of the packaging to assess if it will be sorted into one of the established recycled streams in Europe. Depending on the answers provided according to figure 4, the system will give a first provisional indication of the packaging recyclability, known as an interim result.

[5] Design for recycling guidelines for plastic packaging are available at https://recyclass.eu/recyclass/design-for-recycling-guidelines/

Figure 4. Question area 1 decision tree



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2.2.4.1 *Is more than 95% of the total weight of the package made of one polymer?*

Weights of barrier, coating, mineral fillers, closure, label/sleeve, adhesive, printing, as well as any other components have to be considered in the total weight of the package.

Mono-material packaging is preferred. Indeed, the larger the content of one polymer in the packaging, the higher its recyclability rate will be (i.e. the amount of main plastic effectively recycled). Exception is the use of PET labels/sleeves on PET bottles, because the inks/printing on PET label/sleeve will have a negative impact on the PET recycling process and PET quality. In that case olefin-based plastics are preferred (PE or PP) and are recycled as by-products.

Also, in case of mono-material packaging based on a multilayer structure, the amount of adhesive between the layers can affect the recyclability of the plastic. Consequently, in a packaging combining two or more layers of the same polymer type, the amount of adhesive is not counted in the amount of targeted polymer.

Flexible packaging (films, pouches) presenting at least two layers of two different polymers are downgrading the quality of the main recycled polymer and its further applications. This is also valid for combinations of olefin-based layers as PE and PP because PE and PP are only partially compatible but not miscible on molecular level. For pouches, PE closures are preferred for PE package (vice versa for PP package, PP closure are preferred). Combination of different grades of PE (i.e. LLDPE, LDPE, MDPE, HDPE) will not reduce the packaging recyclability. Combinations of polyolefin (PE or PP) with PET, as well as with PVC, PVDC or PA, will strongly reduce the recycled plastics quality due to the different thermal behaviour of polyolefin and polyester. The latter combinations are never considered recyclable.

Rigid polyolefin packaging combining components or layers of HDPE and PP are considered to downgrade the quality of the recycled plastic and its further applications, even if the components are separable. For example, a PP cap on a HDPE bottle will reduce the quality of the recycled HDPE if not separated from the bottle.

2.2.4.2 *Is there a Plastics Recyclers Europe recycling pathway for this material?*

Plastics Recyclers Europe represents more than 80% of waste plastics recycling capacity in Europe. Its structure is based on Working Groups which are organized around existing waste streams. If a Working Group exists in Plastics Recyclers Europe, it means that there is already a significant plastics waste stream in existence for that polymer or product, as well as a significant industrial recycling capability in Europe.

The Working Groups within Plastic Recyclers Europe are at present covering the following recycling pathways:

- PET-bottles
- PET trays
- PE films

- PP films[6]
- PE containers
- PP containers
- PE and PP crates & pallets
- Polyolefin-based pots, tubs & trays

2.2.4.3 Does your packaging come into direct contact with food?

Plastic-based packaging can protect both food and non-food products. Plastics packaging intended to come into contact with food are covered by Regulation (EU) 2019/37 of 10 January 2019.

2.2.4.4 Is it possible to replace virgin with recycled plastic in the packaging, even partially?

In a circular economy model, the value of products and resources is kept as long as possible in the economy. Following this approach, if you use recycled content in your packaging, you help keep the resources inside the loop for a longer period.

2.2.4.5 Can the different polymers, with the exception of labels, be easily separated by hand after grinding?

Recycling processes typically start by grinding the sorted packaging in the form of flakes. These flakes are washed and floated to remove as much as possible decorations (labels and adhesives) and packaging components made of other polymers (closures, seals, valves, etc.). Packaging designed by using a combination of polymers is difficult to recycle if the polymers cannot be separated mechanically or are presenting a similar density. For example, a multilayer package with different polymers as layers cannot be separated by the recycling process and will always compromise in part or in total the quality of the recycled plastic.

Labels can be separated by the recycling process and their compatibility is evaluated in the Question Area 2.

2.2.4.6 Are the main not separable components made of PE and PP (therefore belonging to the recycling stream of blended plastics or PO)?

If the components cannot be separated after grinding, they will have to be processed together during recycling which will limit their possible end applications. This is mostly the case of the combination of polyolefins with other polymers like PET, PA, PVC, etc.

In the case of a combination of polyolefins (PE and PP), the packaging recyclability will not be completely compromised. In the case of small concentrations of PE in a PP packaging or vice

[6] A dedicated recycling pathway for PP film is currently under construction. PP films are typically recycled with PP rigids or with PE flexibles as mix of polyolefins.

versa, the quality of the recycled PE or PP will be only slightly affected. For higher concentrations of PE in a PP packaging and vice versa, there is an established market for the recycling stream of blended plastics named "mix of polyolefins" or "PO", even if their value and applications are quite limited.

Based on the answers provided in this first area of questions, the following interim results are provided by the tool:

A: > 95%; B: 90-95%; C: 70-90%; D: 50-70%; E: < 50%

2.2.5 Question Area 2: Compatibility

This section focuses on the evaluation of the compatibility of the different packaging components with the recycling of the main polymer, based on the information reported in the Design for Recycling guidelines[7].

Based on the interim result obtained in the previous sections, the following rules are applied:

- Presence of limited compatibility (yellow light of the guidelines): one or more issues = -1 class
- Presence of low compatibility (red light of the guidelines): one or more issues = -3 classes
- Presence of both limited and low compatibility issues = - 3 classes
- Packaging compromising the polymer density = Class F
- Packaging with any PVC and PVDC component = Class F

2.2.6 Question Area 3: Recycled Content

A circular plastics economy is based on the fact that plastic is recycled and used in the production of new products. In order to foster this perspective, "+" bonus to the recyclability result is granted for the use of post-consumer recycled plastic as follows:

- Between 15% and 50% of recycled content = +
- Between 50% and 89% of recycled content = ++
- More than 90% of recycled content = +++

The use of recycled plastic in the packaging is considered a bonus in the assessment because of the replacement of a certain rate of virgin plastic; however, the content in recycled plastic never determines an improvement in the recyclability class.

This Question Area is introduced to make the user of the tool aware that he/she can design a packaging which is not only recyclable but also circular by re-integrating recycled contents.

[7] Design for Recycling guidelines for plastic packaging are available at https://recyclass.eu/recyclass/design-for-recycling-guidelines/

RecyClass is currently working on a method to certify the amount of recycled content in each packaging[8]. Until that method is made available to certification auditors, the '+' symbol is provided only for information and cannot be printed on a packaging.

2.2.7 Question Area 4: Easy-to-empty & Easy-to-access indexes

The presence of residual product content in the packaging negatively affect its recyclability. Therefore, a packaging which is designed to be emptied easily is more recyclable than one which still contains significant quantities of the product it contained.

"Easy-to-empty" index (Ete_i) is to be assessed for packaging where the product content is not accessible for emptying (i.e. tubes); whereas the "easy-to-access" index (Eta_i) is to be used for packaging where the content is accessible for emptying (i.e. pots). Both indexes represent the percentage of product that remains in the packaging after its normal emptying.

For a package that contains liquids, creams, gels or pasty products the easy-to-empty / easy-to-access index should be calculated. The results of the following index will influence the recyclability ranking as follows:

- More than 5% = -1 class
- More than 10% = -2 classes
- Further loss of a class, with each gain of 5% in the calculated index

The calculation method is the following:

$$Ete_i = \left(\frac{Pe - W}{Pf}\right) x\ 100$$

where,

1. *W* = weight of a fully empty packaging (without product inside)
2. *Pf* = declared net weight of content (in case of volume it must be converted in weight)
3. *Pe* = average weight of empty packaging after normal use, in minimum 10 emptying tests.

Ete_i = Easy-to-empty (e.g. tubes): a packaging with the declared quantity of product has to empty easily without being forced (i.e. for liquids just holding the open package vertically for 1' with open side downwards; for pasty products just squeezing the tube as in its normal use, for creams taking them out of the jar as per normal use, etc.)

Eta_i = Easy-to-access (e.g. pots): a packaging with the declared quantity of product has to be emptied simulating a normal use by the end consumer (i.e. with a spoon).

[8] For more details, please contact us at info@recyclass.eu

The weight of non-plastic sortable (by magnet and eddy current) and valuable parts (by-product i.e. Al/Fe) must be not considered in the calculation; weight of components that must be completely removed by the consumer in order to empty/access the product must not be considered in the calculation.

2.2.8 Question Area 5: REACH Compliance

The final area of questioning refers to the packaging compliance with REACH regulation. Any substances of very high concern added to the packaging would result in a downgrade of the interim result by 3 additional classes.

The list of Substance of Very High Concerns (SVHCs) can be assessed by the following link: https://echa.europa.eu/candidate-list-table

2.3 Interim result and Self-Assessment Report

The Tool shows the recyclability interim results by compiling the questions of each sections. In this way the users can monitor what and to which extent affects the recyclability rank. Once the analysis is completed, a self-assessment report is generated automatically by the system which may be downloaded as PDF. It includes all the questions and answers provided during the assessment, as well as the interim results for each of the sections and the final result. Highlighted in red are reported design aspects negatively affecting the recyclability of the packaging. Companies may contact RecyClass if they would like an expert to review the self-assessment report.

Following the completion of the assessment, companies are also welcomed to apply for a Recyclability Product Certification. The certification is carried out by an independent auditor.

3 Recyclability Rate Assessment

The Recyclability Rate Assessment provides a quantitative evaluation of plastic packaging recyclability. The rate is calculated as a ratio between the weight of the recyclable plastic extracted from the package and the total weight of the package, according to the formula described in Annex I. The rate is determined as a percentage (i.e. %). Design aspects of the packaging that will result in material losses in the sorting and recycling processes, or that will result in a downgrading of the recycled plastic quality, will impact the rate.

The Design for Recycling Assessment is evaluated considering the state of the art of sorting and recycling infrastructures in Europe, while the Recyclability Rate is assessed considering the collection schemes, as well as the effective availability of sorting and recycling infrastructures in the audited area.

The formula considers:

- if the packaging is collected (locally or at a European level)
- if the packaging is sorted and recycled (locally or at a European level),
- if the packaging design is compatible with sorting and recycling process (with the same methodology used for achieving the Design for Recycling Assessment),
- if and to which extent the recycled plastic can be used to replace virgin as raw plastic (with the same methodology used for achieving the Recyclability Class certification).

3.1 Incompatibilities

Compatibility of the packaging components is checked based on the Design for Recycling Guidelines and when necessary through dedicated tests based on the RecyClass Protocols.

Identified incompatibilities between components of the packaging are classified as:

- downgrading the recycled plastic quality, referring to components that will be correctly separated but not recycled or inseparable substances/materials that will reduce the recycled plastic quality. A factor will be applied to the formula, the value of which will depend on the kind of material/substance present in the packaging. Then, the recyclability rate will be reduced by the value of the factor (slight or strong downgrading).
- disqualifying the recycled plastic quality, referring to substances/materials that completely compromise the packaging recyclability. A multiply factor equal to "0" will be applied to the formula. Then, the final recyclability rate will be 0%.

The rating requirements are described in the following table:

Table 1. Recyclability rating requirements

		Accepted materials	Downgrading or disqualification	Factor
3.1.1	Suitability	Packaging made predominantly by plastics	Disqualification: - Less than 50% plastic - Less than 50% plastic surface - Bio- or oxo-degradable additives - Al layer > 5 µm - Carbon black surface	"0" factor is applied
3.1.2	Presence of an available PRE Recycling Stream	Package with a PRE recycling stream in place, meaning that collection, sorting and recycling are established and	Disqualification: No collection or recycling infrastructures to treat the stream in Europe.	"0" factor is applied (in case of disqualification) or

		functioning at least in one European Country. PRE recognized recycling streams are: • PET Bottles • PET Trays • PE Films • PP Films • PE Containers • PP Containers • PE and PP Crates & Pallets • Polyolefin Pots, Tubs, Blisters, Trays	Downgrading: Any non-recoverable materials will downgrade the rating. The factor "X" represents (if any) the % of non-plastic material non separable by consumers by the main packaging (e.g. plastic blister coupled with cardboard on one side)	'X' factor is applied (in case of downgrading)
3.1.3	Sortability	Package that can be sorted into a polymer stream according to the state-of-the-art technology available in Europe.	Disqualification: - Carbon black surface - Multilayer with Aluminum layer higher than 5 µm Downgrading: Each package will have different sorting efficiencies. "η" represents the sorting efficiency evaluated on the base of big data or on the base of the results of testing with the "Sorting Protocol". The Protocol must be applied in the following cases: • Large labels (covering > 50% of the surface) made from a different polymer • Full body sleeves • Perforated full body sleeves • Multi-layer structures (excluding PE/PP EVOH) • Metallisation (excluding on the inside/in the middle layer) • Non NIR detectable colours (also when dark colours used for internal layers) • Different types of plastic used on front and back sides.	"0" factor is applied (in case of disqualification) OR 'η' factor is applied (in case of downgrading)

			• Different types of plastic (rigids and flexibles) used in the package. The "η" factor will be applied following the guidelines below: • ≥ 70% → η = 1 • 30% ≤ x < 70% → η = 0,5 • < 30% → η = 0 Furthermore, in case of external metal components, a 0 (material lost) OR 100 (sorted) value can be applied on the base of a ferromagnetic test with a metal detector.	
3.1.4	Design for recycling incompatibilities: loss of material	Package designed according to the Design for Recycling Guidelines.	Downgrading: It accounts for all the parts of packaging such as inks, adhesives, labels, sleeves, valves/seals, caps, etc. that will be separated by the recycling process and will not get recycled. The weight of these materials, represented by the factor "Y", will be deducted from the rate. See Annexes II, III and IV for a list of incompatibilities or Design for Recycling guidelines.	'Y' factor is applied

3.1.5	**Design for recycling incompatibilities: Easy-to-Empty index**	Packaging easily accessible and emptied which minimises the contained residues in the recycling stream.	**Downgrading**: Presence of product residues on the packaging is evaluated by applying the following formula: $$Ete_i = \left(\frac{Pe - W}{Pf}\right) x\ 100$$ where: - **Pe** = net weight of brand-new package - **W** = weight of emptied package - **Pf** = net weight of content "Z" represents the value of the Easy-to-Empty index (**Ete_i**): • If $Ete_i < 5 \rightarrow$ no downgrading • If $5 \leq Ete_i < 10 \rightarrow$ -10% • If $10 \leq Ete_i < 15 \rightarrow$ -20% A 10% more deduction will be applied in case of each 5 more points evaluated with the index.	'**Z**' factor is applied
3.1.6	**Design for recycling incompatibilities: recyclate quality**	Package designed according to the Design for Recycling Guidelines allowing for high quality recycled plastic.	**Disqualification**: - PVC and PVDC - Additives changing the polyolefin packaging density up to 1 g/cm^3 **Downgrading**: Parts of the packaging such as barriers, additives, printing, and all other non-detachable components which will not be separated during the recycling process and will be part of the final recyclate. The weight of these materials is represented by "V" factor and will deducted by the final rating. See Annexes II, III, and IV for a list of incompatibilities or consult the Design for Recycling guidelines.	"**0**" factor is applied (in case of disqualification) OR '**V**' factor is applied (in case of downgrading)

3.2 Sortability

Sorting is a key step in the recyclability evaluation of plastic packaging and can be compromised by certain design aspects. The sorting process is a well-developed process based on the following steps:

1) Consumer behavior: for certain packaging, consumer action is required to make it recyclable or not, like removing part of a packaging. When consumer action is significant and needed to make the packaging recyclable, the packaging before consumer action should not be considered as recyclable.

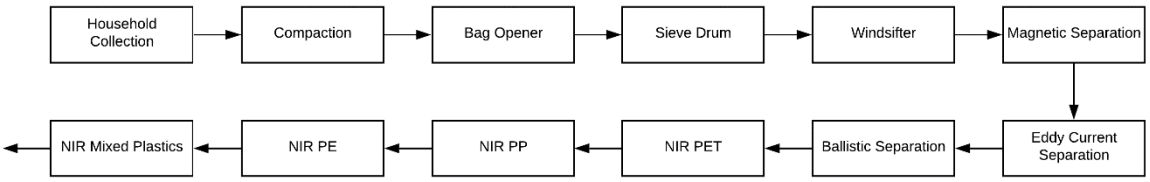
2) Compaction: it occurs during the collection of packaging waste in most cases. This can have an impact on the readability of the packaging during the sorting steps. Compaction test conditions are defined in the "*Sorting Protocol*".

3) small pieces removal, with a size lower than 50 x 50 mm, to purify the stream.

4) metal and aluminum detection and separation by means of magnetic and eddy current separators,

5) discrimination of polymers in separate streams by a series of NIR (near infra-red) detectors. Color sorting is not applied in general to olefin-based package. However, color sorting is a standard for PET bottles.

Figure 5. Flowsheet of the sorting process



On that basis, it is essential for certain types of packaging to be effectively sorted in the appropriate recycling stream. Moreover, the design can affect either partially or fully the packaging sortability, leading to the losses of materials.

In particular, the packaging designed with the following characteristics shall be tested with the Sorting Protocol in order to determine the sensor-based sorting efficiency:

- Large labels (taking up > 50% of the surface) made from a material other than that of the main packaging body,
- Full body sleeves,
- Multi-layer structures (excluding PE/PP EVOH)
- Metallization (excluding on the inside/in the middle layer)
- Non NIR detectable colors (also if applied as internal layers)

- Different types of plastic used on front and back sides
- Different types of plastic (rigids and flexibles) used in the package (e.g. pouches).

4 Recyclability Certification Schemes

Assessment procedures described in chapters 2 and 3 are a basis for a Recyclability Certification, which are respectively called Design for Recycling Certification and Recyclability Rate Certification. The procedures allow the applicant to communicate externally about the packaging recyclability by using the RecyClass logo reporting the class achieved. Details are described in the "Recyclability Claims" and "Use of Claims" documents.

It is worth to note that the class obtained through the self-assessment with the RecyClass Tool is a first indication of the packaging recyclability and may be audited by a third-party auditor in order to validate the results and obtain a certificate. It must be also highlighted that the results of the certification process may vary from the results of the self-assessment, especially for more complex packaging that needs to undergo sorting and/or recycling tests following the RecyClass Protocols.

Packaging which has already been introduced to the European market is eligible for Recyclability Certifications, as well as packaging which has not yet been introduced to the market but where no further alterations are to be made to its design.

Detailed information about the material composition of a given packaging must be provided to the auditor to ensure sound scientific recyclability analysis. As packaging often consists of multiple components with specific functionalities, to certify its recyclability the behaviour of each component (e.g. bottle, label/sleeve, closure system, seal, adhesive, ink, printing, other attachments, etc.) in sorting and recycling processes must be considered by the auditor.

The Certification Body will require the applicant:

- To specify whether the assessment concerns a Design for Recycling or Recyclability Rate Certification and, in the case of latter, for which geographical area (all Europe or specific countries),
- In case of a Design for Recycling Certification, to share the self-assessment report by the RecyClass tool,
- To fill in a standard template with details on the different components of the packaging and on the packaging design,
- To provide a number of samples of the packaging that varies from 10 units to several kg depending on the scope of the tests.

The applicant will receive:

- An assessment report,
- The Recyclability Certificate,

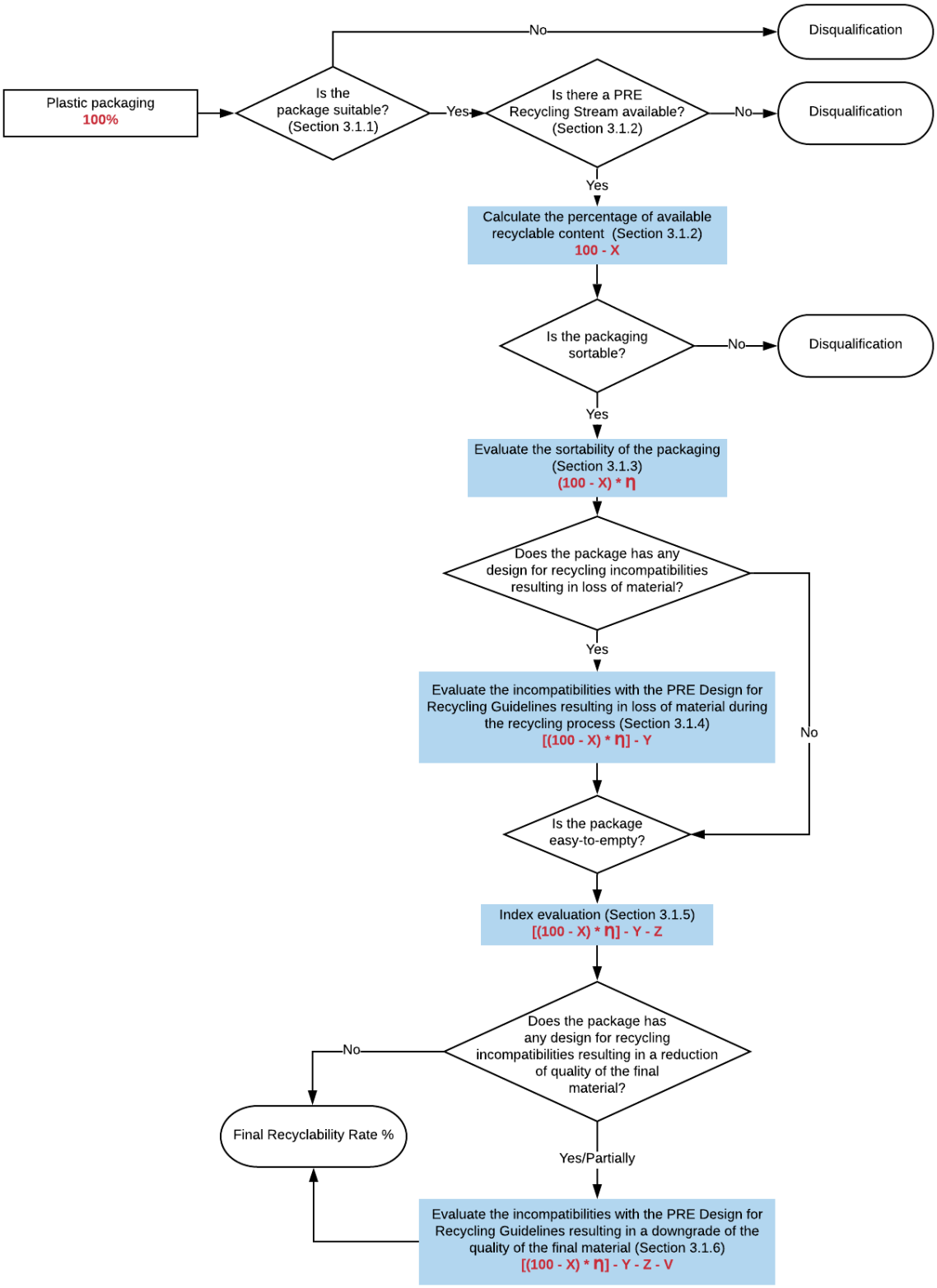
- The RecyClass logo including the recyclability class and/or the recyclability rate.

The certificate is valid for 3 years and guarantees that the packaging is designed to be recycled in Europe. Any change in the packaging design must be communicated to RecyClass in order to revise its recyclability.

Retailers, brands, converters and any other companies involved in manufacturing or designing of the packaging can apply for the Certification. Detailed information on how to apply for the Recyclability Certification may be found in the document "*Recyclability Certification Procedures"* available on the RecyClass website[9].

[9] The "Recyclability Certification Procedures" and the "Application form" are available at: https://recyclass.eu/recyclass/recyclability-product-certification/

Annex I. Formula and evaluation of the Recyclability Rate



Annex II. Design for recycling incompatibilities: Disqualification criteria

	Recyclable plastic	Disqualification (separable and inseparable components)
PET Bottles	PET share PO share	PVC/PVDC Carbon black Opaque, fluorescence or metallic colours Bio-/oxo-/photodegradable additives Nanocomposites Aluminium layer All metal parts
PET Thermoforms (only clear)	PET share	PVC/PVDC Carbon black Opaque, metallic, and any other transparent colour Bio- or oxo-degradable additives Nanocomposites Aluminium layer Metal parts
HDPE & PP Rigids	HDPE share PP share	PVC/PVDC Additives changing the density to more than 1 g/cm^3 Non-NIR detectable colours Bio- or oxo-degradable additives Aluminium layer Metal parts
PE & PP Films	PE share PP share	PVC/PVDC PET Additives changing the density to more than 1 g/cm^3 Non-NIR detectable colours Bio- or oxo-degradable additives Aluminium layer Metal parts

Annex III. Design for recycling incompatibilities: Light Downgrading[10] criteria

Type of package	Recyclable plastic	Light Downgrading
PET Bottles	PET share PO share	Carbon plasma-coating; PA multilayer with <5wt% PA and no tie layers; PGA multilayer PTN alloy. EVOH multilayer with < 3 wt%, EVOH and no tie layers (only for coloured bottles) UV stabilizers, AA blockers, oxygen scavengers, optical brighteners Any component in foamed PET and PETG, EPS, LDPET, floatable silicone < 0.95 g/cm^3 Lightly metallized labels Paper labels without fibre loss Hot-melts adhesives Water/alkali soluble/releasable adhesives (non-recyclable per definition) Non-toxic inks (non-recyclable per definition)
PET Thermoforms (only clear)	PET share	PET based oxygen scavenger with limited yellowing effect UV stabilisers; AA blockers; optical brighteners; anti-blocking masterbatch (> 3%); anti-stat agents; anti-blocking agents; anti-fogging agents (on coating area) Any component in PE, PP, foamed PET, foamed PET-G, EPS, LDPET with density <1 g/cm3 (e.g. BPA-Free Paper labels without fibre loss Water or alkali soluble/releasable adhesives at 60-80°C (non-recyclable per definition) Non-toxic inks (non-recyclable per definition) PE, PP and Paper and cardboard inserts non loosing fibres
HDPE & PP Rigids	HDPE share PP share	Dark colours Mineral fillers not changing the plastic density EVOH < 1% with any tie layer (exception for >6% for HDPE in case of PE-g-MAH tie layers)

[10] More information are reported in the design for recycling guidelines at https://recyclass.eu/recyclass/design-for-recycling-guidelines/

		Any component made by PET; PETG; PS; PLA (all with a density >1g/cm^3) PP components in HDPE package removable aluminium fasteners PO foamed labels paper labels without fiber loss PE full body sleeve for HDPE and PP full body sleeve for PP containers Water/alkali soluble/releasable adhesives (non-recyclable per definition) Non toxic inks (non-recyclable per definition) Direct printing
PE & PP Films	PE share PP share	Dark colours EVOH < 5% by weight EVA Metallized layers Any multilayer PE/PP Paper label without fibre losses Any PP component for PE films and any PE component for PP Any PET, PETG, PS, PLA component Removable aluminium fasteners Water/alkali soluble/releasable adhesives (non-recyclable per definition) Non-toxic inks (non-recyclable per definition) Direct printing

Annex IV. Design for recycling incompatibilities: Strong Downgrading[11] criteria

Type of package	Recyclable plastic	Strong Downgrading
PET Bottles	PET share PO share	Dark colours Any part made by PLA, PS, PETG PA multilayer with >5wt% PA or tie layers Monolayer PA blend EVOH (only for clear/light blue bottles) Any material and blend with density higher than 1 g/cm^3 (highly filled PE, silicone, etc.) Any non-detaching or welded component Any metallized material Paper labels with fibre loss Heavy printed sleeves Non water/alkali soluble/releasable adhesives for labels/sleeves Toxic/hazardous or bleeding inks any direct printing (apart production and expiry date)
PET Thermoforms (only clear)	PET share	Dark colours Any part made by PLA; PS; PETG; C-PET; any PET based multi-material including PET/PE; PET-GAG; expanded PET EVOH; PA; any other barrier; oxygen scavenger with high yellowing effect Printed PET-lidding (other than best-before-date) Any lidding film (apart unprinted PET or floatable without adhesive residues) Any printed plastic labels with density > 1 g/cm^3 Paper labels loosing fibres (pulping) Paper labels containing BPA Non water/alkali soluble/releasable adhesives for lids/labels/sleeves Toxic/hazardous or bleeding inks any direct printing (apart production and expiry date)

[11] More information are reported in the design for recycling guidelines at https://recyclass.eu/recyclass/design-for-recycling-guidelines/

		Any sinkable or welded or loosing fibre insert
HDPE & PP Rigids	HDPE share PP share	Any part made by PLA, PS, PET, PETG, aluminium, metal, foams, silicone, TPE EVOH > 1% (exception for HDPE in case of PE-g-MAH tie layers) EVA and PA. PP components in HDPE packaging > 10%, PE components in PP packaging > 10% Non-PO and/or foams components with density <1g/cm^3 Foiled paper Paper labels with fibre losses Full body sleeve (except PE one for HDPE and PP one for PP containers) Non water soluble/releasable adhesives for labels/sleeves Toxic/hazardous or bleeding inks any direct printing (only natural containers) Any aluminium, paper or glass component
PE & PP Films	PE share PP share	Any part made by PLA, PS, PETG, aluminium, metal, foams, silicone, TPE EVOH > 5% by weight PA any other barrier foaming agents used as expanded chemical agents non-PO or foams with density < 1 g/cm^3 Paper label with fibre loss Metallized label Non water soluble/releasable adhesives for labels/sleeves Toxic/hazardous or bleeding inks Direct printing (only transparent films)

Annex V. Case studies

Clear PET bottle

Clear PET bottle

Composition:

- PET bottle 88,0 %
- PP cap 9,0 %
- PE label 3,0 %

Additional information:

- PET bottle without barrier layer
- No direct printing on the bottle
- 0.1% water-soluble adhesive (in hot alkaline wash water
- 0.2% printing on the label

- Suitability:

It is made of more than 50% plastic

More than 50% of its surface is made of plastic

The bottle is not coupled with other materials X = 0 ; Interim result = (100 – X) = 100%

- Collection: PRE recycling stream exists Interim result = (100 – X) = 100%
- Sortability

No carbon black surface, No Al layer > 5 microns, No full sleeves, no dark color, no multilayers, no metal components, label covering < 50% the bottle surface -> no need to sorting test

-> $\eta_{sort} = 1$ Interim result = (100 – X) * η_{sort} = 100%

- DfR compatibility

No disqualifying items

The PP cap will float and will be recycled as by-product

The PE label will float and will be recycled as by-product

The water-soluble adhesive will allow the PE label to detach from the bottle (i.e. -0,1%)

Y = 0 Interim result = [(100 – X) * η_{sort}] – Y = 99,9%

- Easy to Empty

The bottle will be completely emptied after use (Index = 0)

Z = 0 Interim result = [(100 – X) * η_{sort}] – Y – Z = 99,9%

- Replace virgin plastic

The PET bottle is designed with all separable materials/substances

The PP cap will be recycled in a mix of polyolefin stream (i.e. -9*0,25)

The label will be recycled in a mix of polyolefin stream (i.e. -3*0,25)

Adhesive and inks never get recycled and are deducted by the rate (i.e. 3-0,1-0,2)

Final result = [(100 – X) * η_{sort}] - Y – Z – V = 99,9 – 9*0,25 –3*0,25 = 96,9% (Class A)

PE pouch

Clear PE pouch

Composition

- PE pouch 92,0 %
- PP cap 8,0 %

Additional information:

- Multilayer PE with 5% EVOH barrier
- Direct printing with clear colour 4%
- < 50% printing covering
- No label or other attachments

- Suitability:

It is made of more than 50% plastic

More than 50% of its surface is made of plastic

The pouch is not coupled with other materials X = 0; Interim result = (100 – X) = 100%

- Collection: PRE recycling stream exists (PE) Interim result = (100 – X) = 100%
- Sortability

No carbon black surface, No Al layer > 5 microns, PE Multilayers, Clear colour

Sorting test with the Sorting Protocol to identify where the pouch will end and the sorting efficiency

If sorted in the flexible stream -> $\eta_{sort} = 1$ Interim result = (100 – X)* η_{sort} = 100%

- DfR compatibility

No disqualifying items

The PP cap will float and cannot be separated by the PE stream

Y = 0 Interim result = [(100 – X) * η_{sort}] – Y = 100%

- Easy to Empty

The pouch will be almost completed emptied after use (Index < 5)

Z = 0 Interim result = [(100 – X) * η_{sort}] – Y – Z = 95%

- Replace virgin plastic

EVOH will affect the recyclate quality (if 5% -> -5% should be applied)

PP cap will affect the recyclate quality (PO mix -> -25%)

Small direct printing will affect the recyclate quality (i.e. -15%)

V = 45 Final result = $[(100 - X) * \eta_{sort}] - Y - Z - V = 55\%$ (Class C)

Clear PET tray

Clear PET tray

Composition

• PET tray	73,0 %
• Paper display	25,0 %
• PE lidding film	2,0%

Additional information:

- Clear PET tray
- PE lidding film
- 0,1% water soluble adhesive
- Non welded/glued paper display

- Suitability:

The paper display will be removed and completely separated by the consumer to access the product. The paper display will be then discarded in the paper bin and the tray in the plastic bin.

Then, the tray is suitable for the analysis (made of more than 50% plastic; more than 50% of its surface is made of plastic , etc.)

➔ X = 0; Interim result = (100 – X) = 100%

- Collection:

PRE recycling stream exists Interim result = (100 – X) = 100%

- Sortability

No carbon black surface, No Al layer > 5 microns, No full sleeves, no dark color, no multilayers, no metal components, no label -> no need to sorting test

-> $\eta_{sort} = 1$ Interim result = (100 – X) * η_{sort} = 100%

- DfR compatibility

No disqualifying items

No inserts

The PE lidding film will float and will be discarded (i.e. -2/(73+2)= -2,7%)

The water-soluble adhesive will allow the PE lidding film to be completely detached by the tray (-0,1%)

Y = 2,8 Interim result = [(100 – X) * η_{sort}] – Y = 97,2%

- Easy to Empty

The tray will be completely emptied after use (Index = 0)

Z = 0 Interim result = [(100 – X) * η_{sort}] – Y – Z = 100

- Replace virgin plastic

The PET tray is designed with all separable materials/substances

No direct printing is applied on the tray

Final result = [(100 – X) * η_{sort}] - Y – Z – V = 97,2% (Class A)

Clear HDPE bottle

Clear HDPE bottle

Composition

- HDPE bottle 79,0 %
- PE/PP closure 20,0 %
- Paper label 1,0%

Additional information:

- Clear HDPE bottle
- PP < 4% in the closure
- Paper label without fiberloss
- 0,3% water soluble adhesive
- 0,1% printing on the label

- Suitability:

It is made of more than 50% plastic

More than 50% of its surface is made of plastic

The bottle is not coupled with other materials X = 0; Interim result = (100 – X) = 100%

- Collection: PRE recycling stream exists Interim result = (100 – X) = 100%
- Sortability

No carbon black surface, No Al layer > 5 microns, No full sleeves, no dark color, no multilayers, no metal components,

Paper label covering on both side -> need to sorting test

If sorted with high efficiency -> $\eta_{sort} = 1$ Interim result = (100 – X) * η_{sort} = 100%

- DfR compatibility

No disqualifying items

The PP component in the closure will float and cannot be separated by the HDPE stream

The water-soluble adhesive will allow the paper label to detach by the bottle (i.e. -0,3%)

The paper label will sink and will be removed by floatation (i.e. -15%)

Y = 15,3 Interim result = [(100 – X) * η_{sort}] – Y = 84,7%

- Easy to Empty

The bottle will be almost completely emptied after use (Index <5)

Z = 0 Interim result = [(100 – X) * η_{sort}] – Y – Z = 84,7%

- Replace virgin plastic

The PP components in the closure will slight reduce the r-HDPE quality (i.e. -4%)

Final result = [(100 – X) * η_{sort}] - Y – Z – V = 80,7% (Class B)