Verification and examination of recyclability

Requirements and assessment catalogue

of the Institute cyclos-HTP

for EU-wide certification

Revision 3.7*

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* Compatibility with orientation guide for the assessment of recyclability (draft version of 19 June 2018) according to § 21 (3) VerpackG

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1. Assessment framework and methodology

Recycling is an important factor for the sustainable utilisation of resources. Recyclability can be determined for different packaging types and goods as an individual attribute and, in the form of a gradual index, an expression and instrument of applied product reliability.

Recyclability is generally defined by two parameters: the compositional quality of the object and the real recycling options after usage.

A recyclability examination has to provide objective information about the status of the recycling capability of packaging and goods. Moreover, it can give additional important information on the optimisation of packaging and goods. In order to do this, scientifically validated, comprehensible and requirements and assessment criteria transparent to all stakeholders have to be established.

For this reason, Institute cyclos-HTP has applied its expertise in engineering to develop both a conceptual framework as well as a catalogue of requirements and assessment criteria for the examination and verification of recyclability.

This catalogue is continually expanded and updated with particular focus on technical changes of the circular economy that alter its classifications. In its most recent version, it is the evaluation basis for certifying a product as "recyclable" by the Institute cyclos-HTP.

Recyclability is not a theoretical property. Defined correctly, it determines the material suitability of a product in regards to its ability to close material cycles in established collection and recycling structures.

The widespread expansion and continuous development of recycling processes, in particular their extensive standardisation with regards to recognized state-of-the-art industry standards, were the prerequisites which enabled the definition of general requirements for the design of products to make them accessible to recycling after usage.

Complementing to the guidelines for recyclable packaging design, such as "Recoup" and "EPBP", the Institute cyclos-HTP developed a requirements and assessment catalogue in 2011 that quantitatively measures the recyclability of packaging and other similar products for the first time.

After consultation with trade associations like IK, FKN, DAVR etc. this catalogue was published and has, since then, been updated regularly. Many brand manufacturers and producers of packaging material use this tool to define the status quo of their packaging and optimize the sustainability of their packaging. The company ”Der Grüne Punkt” also evaluates the packaging of its licensees via this method.

1. Assessment framework and methodology

The main key aspects of this method are:

- Recycling processes, which generate recyclate of such a quality that they can replace virgin material of the same material in a 1:1 ratio, served as benchmark for the recyclability assessment.
- These reference processes have to be implemented and available on an industrial scale. This applies to the entire recovery chain, from collection to sorting and re-processing to the final recyclate.
- Existing recycling processes are material-specific. Correspondingly, the assessment criteria are derived from the respective, relevant reference processes.
- The quantitative assessment considers all possible uses arising from closing of the material cycle. Thus, after completing all separation, cleaning, melting and forming processes the recyclate can serve as a raw-material equivalent.
- The rating is between 0% (non-recyclable) and 100% (fully recyclable).

The assessment "100% recyclability" thus means that **the packaging or product meets the material and physical prerequisites to become, after its initial use phase, a secondary product comparable to a primary product with identical material**.

In fact, this is a very rare rating since recyclability is not an end in itself but potentially secondary to the functional requirements of the product. For example, a paper label reduces the recyclability of a glass bottle, but is unavoidable as it contains consumer information. Or a barrier layer of another plastic (e.g. EVOH) is incorporated, to ensure the durability of a plastic film of polypropylene (PP), which also slightly reduces recyclability.

Recyclability is a relevant environmental requirement. It serves also as basis for ecological assessments, however, it is not a direct ecological assessment indicator or category.

The following explanation highlights the difference of "recyclability" compared to ecological assessments such as "lifecycle analysis" (LCA) or "carbon footprint":

While the latter accounts for both the pre-and post-usage phase, "recyclability" solely focuses on the post usage phase. Therefore, the assessment evaluation “recyclability” characterises not only the ecologically but also the economically added value after the product has become waste. First of all, recyclability is an independent variable to asses the savings through recirculation and not an ecological evaluation category. As the ecological assessment also takes the production into account, comparisons between different products can lead to configurations in which a higher ecological benefit is associated with a lower degree of recyclability, for example, when much fewer resources are used to produce a product at the expense of its recyclability.

In short: The assessment of recyclability is always part of an ecological assessment but cannot replace it. When comparing both figures, recyclability and ecological assessment categories can correlate, but they do not need to.

If a comparison of the recyclability of different types of packaging is made, the named limitations must be taken into account. Unaffected by such limitations, the derived conclusions regarding the **recyclability as an independent, absolute quantifying parameter for the closure of material cycles and, with it, the related added ecological and economic value, remains. The latter is always framed in the context of the characteristic (material).**

2. Recyclable – what does it mean?

2.1 Recyclability as key figure for the requirements and assessment catalogue

Recycling means closing loops. For this reason, the term "recycling", as it is used this assessment catalogue, is used closely according to this definition. In the following, recycling always refers to the processing of materials to produce recyclates, regenerates, blends or alloys to replace corresponding virgin material in standard applications. This benchmark is illustrated by the red marking in figure 1.

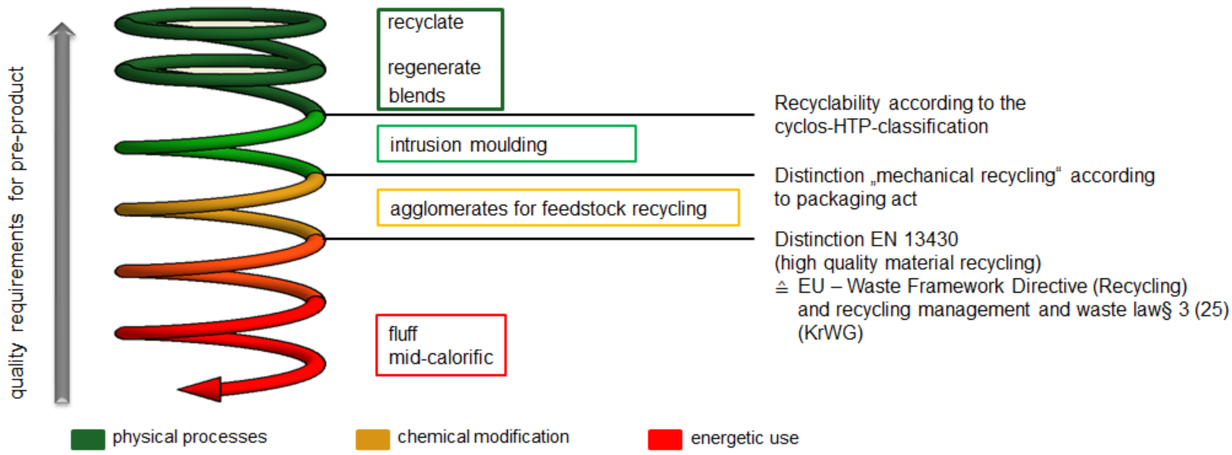


Figure 1: Definition and delimitation of the term "recycling"

The basic understanding of closed-loop recycling, in which recyclate material does not only replace corresponding virgin material but is also repeatedly used in identical primary applications, is hereby expanded through a second level in which closed recycling loops may be implemented on a lower quality level. An example for this is the production of polyolefin-based regranulates made from, among other things, yoghurt cups and bowls. The application of these regranulates, such as in flower pots or pipes, replaces corresponding virgin material; however, it is limited, e.g. in coloring or in relation to contact with food, compared to actual virgin material. This quality of level 2 is, depending on new coloring, additives, etc. also achievable when the recycling process chain is run through repeatedly, so that potentially closed loops can be achieved after a first cascade level in the utilisation chain.

In contrast, material utilisation processes, which include secondary raw materials in production without replacing the virgin material typical for the respective application, are **not** taken as reference process in this assessment catalogue. Utilisation processes using materials directly or indirectly as an energy source are also not taken into account.

The declaration of a product, e.g. packaging, as "**recyclable**" or "100% recyclable" must have a substantial basis. This also helps preventing public debates and legal arguments.

Important underlying principles include:

- DIN EN ISO 14021 "Environmental labels and declarations - Self-declared environmental claims (Type II *environmental labelling*)" – This standard requires that environmental product declarations must not be misleading but substantiated and verifiable. **The property must be actually and not only hypothetically met.**
- DIN EN 13430 "Packaging - Requirements for packaging recoverable by material recycling" – This standard defines certain minimum requirements in terms of a declaration of conformity. For this assessment catalogue e.g. the gradual assessment of the recyclability of this DIN norm has been incorporated. However, reference is also given to requirements which exceed the norm, but are crucial for a substantial verification and examination in accordance with DIN ISO 14021. These include:
  - Individual recyclability must be at least specifically already applicable to a relevant extent. Establishing recyclability simply as a possibility in appropriate intervals is not sufficient.
  - For the measurement and declaration of the recyclable content of products consisting of different material components, which are only recyclable via different recycling paths, a positive influence of the individual components is only declared if a respective separation is actually applied.
  - When measuring or declaring the percentaged proportion of recyclability, the potential rate of substitution of the corresponding virgin material is applied instead of the interface of secondary raw material provisiono.

In summary, recyclability can be defined as follows:

Recyclability is the individual, gradual suitability of a packaging or a product to factually substitute material-identical virgin material in the post-use phase; “factually” hereby means that collection and processing structures in industrial scale are available.

2.2 Legal definition and specifications

Recyclability has been instrumentalized by § 21 ("ecological design of participation fees") in the German Packaging Law for the first time. Corresponding regulations within the scope of the European legislation can be expected for the future.

In the German Packaging Law (VerpackG), a recommendation given by the sworn experts of the Institute cyclos-HTP to initiate monetary incentives for recyclable product development is established. This is based on study on the further development of the product responsibility from 2012 (compare Christiani, J.; Dehoust, G: Analyse und Fortentwicklung der Verwertungsquoten für Wertstoffe: UBA Texte 40/2012 s. 42 and 57).

Critics of the regulation of § 21 Packaging Law argue, that an incentive to improve recyclability opposes the aim of waste prevention. As response to this argument, it can be said that this fear is totally unfounded since the incentive system is designed fair according costs-by-cause principle.

There is already a strong incentive on weight reduction as participation fees are levied mass-related. This still remains dominant when recyclability is honoured fair according to costs-by-cause principle, due to the reason that the bonus can only amount a small proportion of the participation fees.

An illustrative example is that an invertible substitution from a (not recyclable) stand-up bag into a three times heavier PE-bottle is not possible! However, it is intended to replace the non-recyclable stand-up bag by a recyclable version.

Unfortunately, legislators have neglected to define the term "recyclability" as well as recycling respectively in the sense of § 21 Packaging Law. This allows for a scope for interpretation due to the recycling definition of § 3 (25) in the German law of life-cycle management (KrWG). However, it is shown in the following context that such a broad definition was not intended (and is counterproductive): In § 21 (2) Packaging Law there is a further specification ("high-quality recycling") and in § 21 (4) Packaging Law "…assessment of participation fees for promotion of material recycling" the intention is clarified.

Furthermore, the Central Agency (so-called "Zentrale Stelle") has defined the recyclability of packaging, which is obligated to be licensed, in its orientation guide as follows: In this document, recyclability is understood as high grade material recycling in contrast to the definition in the German law of life-cycle management (KrWG). Recyclability is the individual gradual suitability of a packaging after passing industrial recovery processes to factually substitute material-identical virgin material.

Therefore, it becomes apparent that the underlying limitation of the definition of a high-quality material recycling given in the assessment and requirements catalogue complies with the assessment standard of recyclability according to § 21 Packaging Law.

Since revision 3.6 of this catalogue, a complete compatibility check regarding the single criteria of the orientation guide (so-called minimum standard) is conducted. **Thus, the present revision of the requirements and assessment catalogue fulfils the minimum standard without any exception**.

It should be noted for the translation of recyclability in monetary added value, bonification etc., that this proportional relationship is quantified by a material and path dependent factor. Besides the indicator “recyclability”, the suitable recycling path is also stated on the certificates and the examination documents respectively of the Institute cyclos-HTP. With these two information, it can be assured that the test result can be used as assessment basis in the sense of § 21 Packaging Law.

2.3 Scope of application

The present requirements and assessment catalogue pursues the claim of European scope of application on a national level. On the one hand, it should be noted that actually existing (and supplied) collection and processing structures are the prerequisites for the certification of recyclability by the Institute cyclos-HTP. On the other hand, collection and processing structures in European countries are continuously developed and expanded as part of adapting the targets of the EU Packaging Directive. In this regard, the Institute cyclos-HTP is committed to constantly updating but cannot exclude that the requirements and assessment catalogue is not up to date at all time. As a consequence, those countries for which appropriate requirements are clearly given, are explicitly named in our examination documents. However, this does not mean that no recyclability outside of these countries listed exist, but rather that the recyclability is not assessed yet for the not mentioned countries.

3. Research and assessment matrix, overview and process

The term “recycling” combines multi-staged, complex engineering chains process on an industrial scale which have been established intermediately. Due to continous standardisation, an assessment of the specific properties of a product in the post-use phase is possible.

Against a background of more than 25 years of practical discussions with the framework conditions of recycling structures and technical design of recycling processes, the Institute cyclos-HTP developed the present requirements and assessment catalogue. Based on objective standards, recyclability can be both qualitatively and quantitatively characterized for waste materials, that are collected via the offered collection schemes for recyclable material.

Relevant criteria were substantiated and further specified based on the requirements for material recycled packaging according to DIN EN 13430.

Recyclability is the key figure for the qualitative and quantitative behaviour of a product in the post-use phase via the respective, specific process chain to primary raw material substitution. This means that it has to be possible that the products are collectable via the existing collection possibilities and sortable in a qualified manner after their use. Its reprocessability must enable recirculation.

For the assessment, reference schemes are required to realistically illustrate the existing processing structures in the relevant stages. During the assessment, the product runs through this simulated reference process chain. This reference process chain is referred to as paths. Currently, we distinguish between 13 different paths. They all have in common that at the end of the process cascade, a recyclate is produced which can replace material-identical virgin material. The assessment criteria are derived from the influencing parameters of the related stage of the specific process cascade.

A simplified decision map illustrating the verification process is shown below. It also shows that the individual test steps (such as the technical processes themselves) are connected into a series meaning that if in one of the steps a "zero" or 0% is assessed, this will be the overall result as well.

3. Research and assessment matrix, overview and process

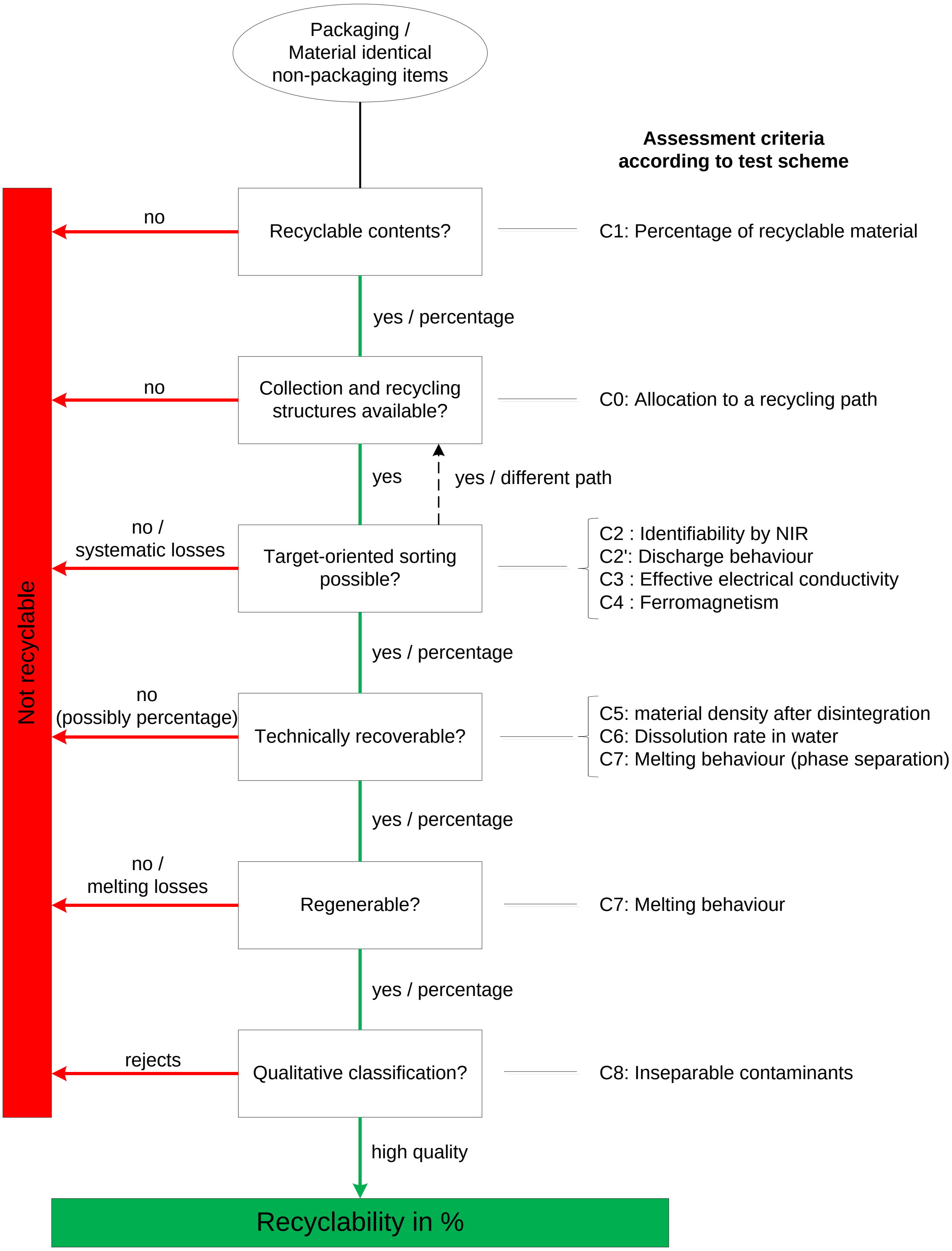


Figure 2: Flowchart of the test process

3. Research and assessment matrix, overview and process

The reference processes (paths) applied for the preparation of this requirement and assessment catalogue, as well as their technical requirements are specified in appendix 2. The individual European countries providing specific collection and processing structures are specified as well.

The assessment or certification object is the product as a whole (packaging is assessed without its content). If utilisation requires the product to be disassembled into individual components, these are classified, examined and assessed individually. Then the overall result is determined by adding up the weighted individual results. This is also valid if it is known by experience that a splitting up by the final user or by mechanical impact during transport can be generally assumed or are at least plausible.

If packaging cannot be fully emptied for technical reasons, filling material proportions, which always remain in the packaging after use, are incorporated qualitatively according to their separability and compatibility with the recyclate (see C8).

The following assessment matrix lists the individual recycling paths with their respective central assessment criteria. If a criterion is mandatory for the individual path, it is marked with an x. During the individual assessment, the entire cascade process has to be considered so that, in individual cases, criteria which are not relevant for the general case following table 1 are identified and added (e.g. size, format and surface weight).

3. Research and assessment matrix, overview and process

Table 1: Recycling paths of individual material fractions and assessment criteria

Recycling Path / C 0 Assignability to a recycling path	C1 Percentage of recyclable material[1)	C2 Identifi-ability by NIR/optical detection[2)	C3 Electrical conductivity[3)	C4 Ferro-magnetism[3)	C5 Material-density after disinte-gration 2) or 3)	C6 Time[3) and yield[1) for dissolution in water	C7 Melting behavior[1)	C8 Inseparable recyclate contami-nants[3)	total score[1) 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 in %
1. Plastic foil	X	-	-	-	X	-	X	X	
2. PE	X	X	X	X	X	-	X	X	
3. PP	X	X	X	X	X	-	X	X	
4. PS	X	X	X	-	X	-	X	X	
5. PET	X	X	-	-	-	-	X	X	
6. Mixed plastics (rigid/dense)/ MPO	X	X	X	-	X	-	X	X	
7. Mixed plastics (soft/flexible)/MPO	X	(X)	X	-	X	-	X	X	
8. Liquid packaging boards	X	X	-	-	-	X	-	X	
9. Ferrous metals	X	-	X	X	-	-	X	X	
10. Non-ferrous metals	X	-	X	X	-	-	X	X	
11. Paper cardboard composites	X	X	X	X	-	X	-	X	
12. Glass	X	X	-	-	-	-	X	X	
13. Paper, cardboard	X	X	-	-	-	X	-	X	

1) scoring 0-1 (ease of emptying will be evaluated)
2) scoring 0 to 1
3) scoring 0 or 1

Please note: The values to be determined for criteria 5 and 7 refer to the proportion of recyclable material as specified under criterion 1.

Explanations of the individual criteria

C0: Path allocation

A superordinate criterion for the classification of products according to their recyclability is the availability of an applicable collection and processing structure. This structure is required when the product can be classified as accepted stock, with respect to its material content to one of the recyclate pre-products listed under "path". If such assignment classification is not possible, the recyclability usually cannot be verified unless specific, publicly accessible collection and processing structures are available.

Thus, only specifications with an option for high-quality recycling, which are available to a significant extent (industrial benchmark) are considered under the column ‘Path’ in table 1.

Attributability means that the product – subject to potential, additional checks – cannot only be tolerated with the specifications of the respective recycling technology according to its composition but even more that regarded as valuebale material in the recycling process. All following criteria are applied or assessed path-specifically.

C1: Percentage of recyclable material

The "percentage of recyclable material" specifies the potentially recyclable mass proportion of the total mass of the product (new goods). Thus, C1 represents the recoverable recyclable proportion of material in the narrow sense of the word. If packaging cannot be fully emptied for technical reasons, these unavoidable filling material proportions are applied as related material component and respectively taken into account in the following qualitative assessment criteria.

The classification of recyclable or non-recyclable fractions corresponds to the target product or impurity definition of the respective recycling process (path). The usually occurring correlations are specified in the following table.

Table 2: Overview of recyclable percentages

Path	Percentage of recyclable material	Non-recyclable components
Plastic foil; PE; PP; mixed-plastics rigid/dense and mixed plastics soft/flexible	PO-percentage	Other plastics; paper labels
PS	PS-percentage	Other plastics; non-plastic material; paper labels
PET	PET-transparent percentage; additional PO-percentage (caps)	Other plastics; labels/sleeves
Liquid packaging boards / plastic-coated cardboard packaging	Percentage of fiber	Plastic foil; aluminum foil; other packaging components; wet-strength fiber
Tin cans / ferrous metals	Percentage of ferromagnetic metal alloys	Plastic components; labels/sleeves
Aluminum / non-ferrous metals	Percentage of non-ferrous metals	Non-aluminum components; labels/sleeves
Paper and cardboard composites	Percentage of fiber	Plastics; aluminum; wet-strength fiber
Glass	Glass and metal percentage	Plastic caps, labels/sleeves
Paper, cardboard	Percentage of fiber	Non-fiber incl. binding agent; wet-strength fiber

3. Research and assessment matrix, overview and process

The assessment factor determination is based on plausible manufacturer specifications on the product material composition. Generally, the result is directly applied proportionally in the overall assessment result (exceptions see CAT 2).

High-quality recycling requires the separability of individual materials in a narrow sense. The currently established recycling processes are mostly only focused on one, rarely on a few materials, whose admissible component and processing properties are specified in the respective products or recyclate characterisations according to DIN standard. All other components are regarded as process-specific contaminants irregardless if they are fully or only partially entailed in the recyclate.

With regard to the quality of contaminants, three categories can be generally distinguished (the respective mass proportions are specified under C1 within the assessment):

CAT 1: Materials, quantitatively separable by the treatment steps established in the recycling process.

According to CAT 1, the proportion of contaminants leads to a quantitative limitation of the recyclability and is taken into account in C1 by respectively reducing the factor.

CAT 2: Materials, not separable by the treatment steps established in the recycling process, having no or negligible impact on the recyclate properties up to a defined relevant concentration.

The respective proportion is not added as accepted material (recyclable proportion) within assessment criterion C1. An exception is often polymers with additives as well as regular mixture components of the recyclate (alloy, blend, master batch) such as TiO_2-percentage in HDPE or HDPE-percentage in PP blends.

CAT 3: Materials, not separable by the processes established in the recycling treatments processes, degrading the quality of the recyclate to uselessness or otherwise lead to disproportionately high process costs.

The assessment of contaminant proportion of CAT 3 is specified under C8 and defines that the recyclability cannot be verified (factor 0).

The following table 3 contains examples of typical "contaminants" of CAT 1 - 3 (i.e. particularly neither final nor fixed assignment). In some cases, the assessment depends on the concentration. Therefore, individual assessments are applicable at all times. For this reason, the examination always includes research on potential incompatibility of inseparable material combinations and additives, printing colors, etc.

3. Research and assessment matrix, overview and process

Table 3: Overview of typical contaminants in individual recycling paths

	Path	CAT 1	CAT 2	CAT 3
1	Plastic foil	Paper labels; water-soluble adhesives; non-PO plastics	PP-foil*, EVOH barrier layers	Non water-soluble adhesives combined with wet strength paper labels; PA barrier layers; PVDC barrier layers; non-polymer barrier layers (exception SiO_x and AlO_x); non-EVOH barrier layers
2	PE	Paper labels; water-soluble adhesives; plastics > 1 g/cm³	EVOH barrier layer; PP* (e.g. caps, labels); chalk; other thermoplastic polymers < 1 g/cm³ in small amounts (e.g. EVA, TPE), PO based	Silicon components; components of foamed non-thermoplastic elastomers; non water-soluble adhesives combined with wet-strength labels; PA barrier layers; PE-X-components; PVDC barrier layers, non-PO-plastics with density < 1 g/cm³
3	PP	Paper labels; ALU lid(s); water soluble adhesives; plastics > 1 g/cm³	EVOH-barrier layer; LDPE* (e.g. labels); other thermoplastic polymers < 1 g/cm³ in small amounts (e.g. EVA, TPE), PO based	Silicon components; components of foamed non-thermoplastic elastomers; non water-soluble adhesives combined with wet-strength labels; PA barrier layers; PVDC barrier layers; non-PO-plastics with density < 1 g/cm³
4	PS	paper labels; aluminum lid foil; water-soluble adhesives; plastics < 1 g/cm³ and > 1,08 g/cm³		Impurities or multilayer in density range 1,0 – 1,08 g/cm³; non water-soluble adhesives combined with wet-strength labels
5	PET bottles (transparent, clear-/, light blue)	Plasma coating (clear); water-soluble or basic soluble adhesives; paper labels; PE, PP-labels and sleeves	AA-blockers UV-stabilizers, TPE-PO based	PET-G; POM-components; EVOH /PA monolayer barrier layers and other blended barriers; PVC, PS, PET-G/S-labels/sleeves; PA additives (PET-A-copolymer); non-soluble adhesives (water or basic at 80°C); non-ferromagnetic metals; elastomer components with density > 1 g/cm³; direct printing except expiration date and batch number, silicon components
5a	PET bottles, other	Plasma coating (clear); water-soluble or basic soluble adhesives; paper labels; PE, PP-labels and sleeves	AA blockers; UV stabilizers (PA-copolymer, PET-A-copolymer, TPE-PO-based) EVOH / PA-monolayer-barrier layers	PET-G; POM-components; PVC, PS, PET-G/ S-labels/sleeves; non-soluble adhesive (in water or basic at 80°C); non-magnetic metals; elastomer components with a density > 1 g/cm³, silicon components
6/7	Mixed plastics (MPO)	Paper labels; PS, PET, PA, PVC, ABS, PC components and etc.	LDPE*; EVOH layer; PA layer; other thermoplastic polymers < 1 g/cm³ in small amounts (e.g. EVA, TPE-PO based)	Silicon components; foamed non-thermoplastic elastomers with density < 1 g/cm³; foamed non polyolefin components, PO barrier layers
8/11	Paper and cardboard composites/ Liquid packaging boards	Plastic labels; plastic and metal layers; plastic and metal parts; wet-strength paper;	printing inks and adhesives; water-soluble re-dispersive inks and adhesives; paper coating and bulking agents	wet-strength agents, as far as it cannot be proved that fibre recovery and recycling are given (PTS Method PTS-RH 021/97); insoluble dispersing adhesives, as far as it cannot be proved that they are removable (INGEDE Method 12 or 4); components of EuPIA (Exclusion list for printing Inks and related products)
12	Glass	Paper and plastic labels	lead oxide	Lead and barium from crystal glass packaging; glass composites with metal or plastic layers
13	Paper and cardboard	Plastic parts; wet strength paper	printing inks and adhesives; water-soluble re-dispersive inks and adhesives; paper coating and bulking agents	wet-strength agents, as far as it cannot be proved that fibre recovery and recycling are given (PTS Method PTS-RH 021/97); insoluble dispersing adhesives, as far as it cannot be proved that they are removable (INGEDE Method 12 or 4); components of EuPIA (Exclusion list for printing Inks and related products)

*percentage will be evaluated in a 75% ratio as product and 25% subtracted as unwanted

C2: Identifiability in NIR reflection measurement / optical detectability

Materials that are separated by default using NIR spectrometric reflection measurements, i.e. that need to be pre-concentrated, are tested for compliance with the requirements of unambiguous detection with regards to the target fraction. If these conditions are not met, e.g. due to considerable labelling with foreign material or as a consequence of too dark colors caused by carbon black additives, the factor 0 is assigned. If correct identification depends on the position, this is taken into account. For example in the case of two-dimensional items whose two surfaces consist of different materials, a factor of 0.25, 0.5 or 0.75 (0.25 and 0.75 for two-stage process steps) is assigned. Factor 1 corresponds to unrestricted identifiability.

The determination is made on the basis of empirical measurements under standardized conditions with operationally deployed classifiers (reference program) of the current generation.

For glass, the NIR reflection behaviour is replaced by the transmission of visible light.

C2´: Discharge behaviour

The sensor-based sorting methods exhibit, compared to other separation techniques, the particularity that the separation of items is a separate stand-alone part of the process specifically independent of the detection of physical properties such as mass and shape.

The corresponding assessment (sub)criterion is called “separation behaviour”.

Measurement and quantification take place in a dynamic test under standard conditions varying in terms of pressure and valve block design.

A test result of >70% correct separation at positive registration is required for a positive unrestricted consideration of this criteria. A result of less than 30% leads to 0 (not separable) for C2`. In between 30% and 70% the factor is set to 0.5. If deductions are made, the cause for insufficient separation behaviour must be shown in the test certificate.

C3: Effective electrical conductivity

On the one hand, this criterion for materials to be recycled via the fraction non-ferrous metals/aluminum takes into account whether sufficient requirements for separation using the standard eddy current separation process are met. The classification separable (assessment factor 1) or insufficiently recyclable is carried out on empirical basics. Depending on the format, an examination of the position dependency is also empirically carried out.

On the other hand, all other materials with a recycling path not defined according to the non-ferrous metal proportion of the article, except coated carton packaging, are assessed differently using the same measuring method: If the separation behaviour is defined by the metal proportion, the factor 0 applies for the examined recycling path; the product is then obligatory set using path 10 (aluminum/non-ferrous metals). If practically no relevant impact can be identified, factor 1 is set.

C4: Ferromagnetism

Ferromagnetic product properties are usually dominant for recyclability. In all standard recycling processes, this material property is applied for separation as one of the primary process stages.

If the product has ferromagnetic components, it has to be firstly checked whether these are sufficient to define the recycling path. In borderline cases, this is regarded as fulfilled when the product can be lifted with a magnet system installed at an operational height of 450 mm from a distance of 300 mm.

If this is the case, the material is assessed independently of the other material proportion via the recycling path for tin plate / ferrous metals. Exceptions from this assessment benchmark are made for products that exceed a length of 220 mm in minimum 2 dimensions (for example a PE bucket with steel handle). In the actual recycling process, it can be assumed that these products are mechanically disintegrated prior to separation.

C5: Material density after disintegration

The density criterion takes into account the fact that float-sink sorting is the central process step to produce high-quality recycles within plastics reprocessing.

Classification and assessment according to the density criterion are carried out after disintegration by grinding to approx. < 12 mm. The assessment criterion is whether the generated material parts are under or over the technically relevant separation density of 1 g/cm³ (PE, PP, PO cut) or 1.08 g/cm³ (PS).

If, for example, the above specified values are exceeded due to filling material or coating, the material is assessed as non-recyclable. Partly exceedance, unless already considered under C1, is quantitatively included in the assessment. (The application of incompatible plastics of one density class in a product within the plastics recycling process is managed under C1 or C8.)

The test for density criteria is usually done empirically. If theoretical testing is carried out and no specific manufacturer data are available, relevant substance data are applied.

A survey of data on commonly used substances is given in Appendix 1.

C6: Dissolution rate in water

If products are to be recycled using one of the existing recycling paths for waste paper, fibers need to be dissolved under the technical operation parameters of the paper recovery process.

As a reference for products to be assigned to path 13, the required pulping time for mixed waste-paper (type 5.02) is applied. For assignment to path 8 and 11, the dissolution time for beverage cartons is applied.

Fiber losses in reject are applied by a deduction factor of 1.

C7: Melting behaviour

Solid / liquid separation, as implied e.g. in melt filtration for regranulation of plastics, is basically assessed as other physical separation processes without phase change.

Materials or contaminants (see C1), that can only be separated from the recyclate proportion in molten condition are taken into account in the assessment of the recycling rate by a deduction factor of 2 as the solid / liquid separation is always connected with a loss of accepted material, which is to say, a loss of recyclate.

An estimation of which materials do not melt at the processing temperatures used in the re-melting to recyclates (about 230°C at PO and up to 285°C with PET), is provided in the material data collection in Appendix 1. If no specific manufacturer information exists, this information is used.

Process-intrinsic losses of recyclate due to evaporation or oxidisation is subject to a standard deduction based on documented data. Relevant and adequately studied are e.g. Melting and oxidation losses of metallic aluminum with pyrolytic recovery. These are likely to depend primarily on the material thickness of the aluminum. For very thin layers (barrier layers) of 7 - 9µg, the losses are about 10 % of the metal content (Source: Survey of VAW Aluminium AG: Ökologische Effizienz der stofflichen Verwertung der DSD-Aluminium-Verpackungs-Fraktion durch Pyrolyse [ecological efficiency of material recycling of the DSD aluminium packaging fraction by means of pyrolysis]; 2000).

For aluminum cans and comparable aluminum scrap, 1 - 2 % have to be estimated according to different sources (eg Giese / Rahms / Mackenstedt: Optimierung der thermischen Prozessführung beim Recycling von Aluminiumschrott durch Pyrolyse; 2007, S. 6 und European Aluminium Industrie, 2018 DATA for year 2015, Tab. 8 - 2). Assuming a 2% loss rate for beverage cans with a mean wall thickness of 200 μm and 10 % for very thin layers, the loss can be estimated as follows

$$R_v = 0.1 - 0.0004/\mu\text{m} \ \times \text{material thickness in } \mu\text{m}$$

Melting furnace losses during recovery of ferrous metals (evaporation of the tin content) are subject to a standard deduction of 70% of the tin proportion. (Source: Wullrich, W.; Schicks, H.: Presentation at the Duisburger Recyclingtage, Moers, 1992). Losses by oxidation of ferrous metals in a converter are not regarded for the time being. Until further notice the losses are evaluated as marginal and therefore not taken into account. Losses that occur during melting by oxidation of paint or additional plastic coatings are already taken into account under C1.

All losses are regarded as partly difference to the factor of 1, or 100%.

(For material systems with comparable melting behaviour or finely-dispersed inclusions, reference is made to C1 and C8 under observation of the mixing capability (blends, alloys, filling materials) and compatibility with the recyclate properties. The same applies for materials that are subject to decomposition in the temperature range of remelting required for recyclate production.)

C8: Inseparable contaminants / material-conditional cross contamination

The assessment regarding the incompatibility of inseparable foreign components is usually based on manufacturer's data (e.g., data from safety data sheets, data on thermal stability, specifications of adhesives, printing inks, etc.). If no specific substance data are available, the assessment is carried out as far as possible on the basis of relevant data.

Incompatibility based on the decomposition of material in the context of thermal forming processes is usually determined on the basis of the material data collection in Appendix 1

If the product to be assessed contains contaminants of CAT 3 (see C1, table 3), economic production of marketable recyclate can no longer be assumed and the product in total is classified as non-recyclable (factor 0).

Overall assessment

3. Research and assessment matrix, overview and process

In overall assessment, the determined individual factors C1 to C8 are multiplied. If the result is not 0, the result is classified as recyclable according to the assessment standard of this catalogue and DIN EN ISO 13430.

The total score in % is configured in such a way, that it represents the proportion of the product that is actually available for monetary creation of value after application of high-quality recycling for resource saving.

A differential test certificate is issued on the classification. The overall assessment is indicated quantitatively as "% recyclable".

The certification entitles to use the test seal of the Institute cyclos-HTP to indicate the independent verification of the environmental label and declaration "recyclable". Rights and obligations of the utilisation of the seal are specified separately.

Instead of the number, a classification (Class.) of the degree of recyclability can also be specified. It is also specified on the test certificate.

The following classification scale is to be applied:

Class. C	recyclable, recyclable proportion	< 50%
Class. B	recyclable, recyclable proportion	50% - 70%
Class. A	recyclable, recyclable proportion	70% - 90%
Class. AA	recyclable, recyclable proportion	90% - 95%
Class. AAA	recyclable, recyclable proportion	> 95%

4. Appendices

4.1 Material data collection

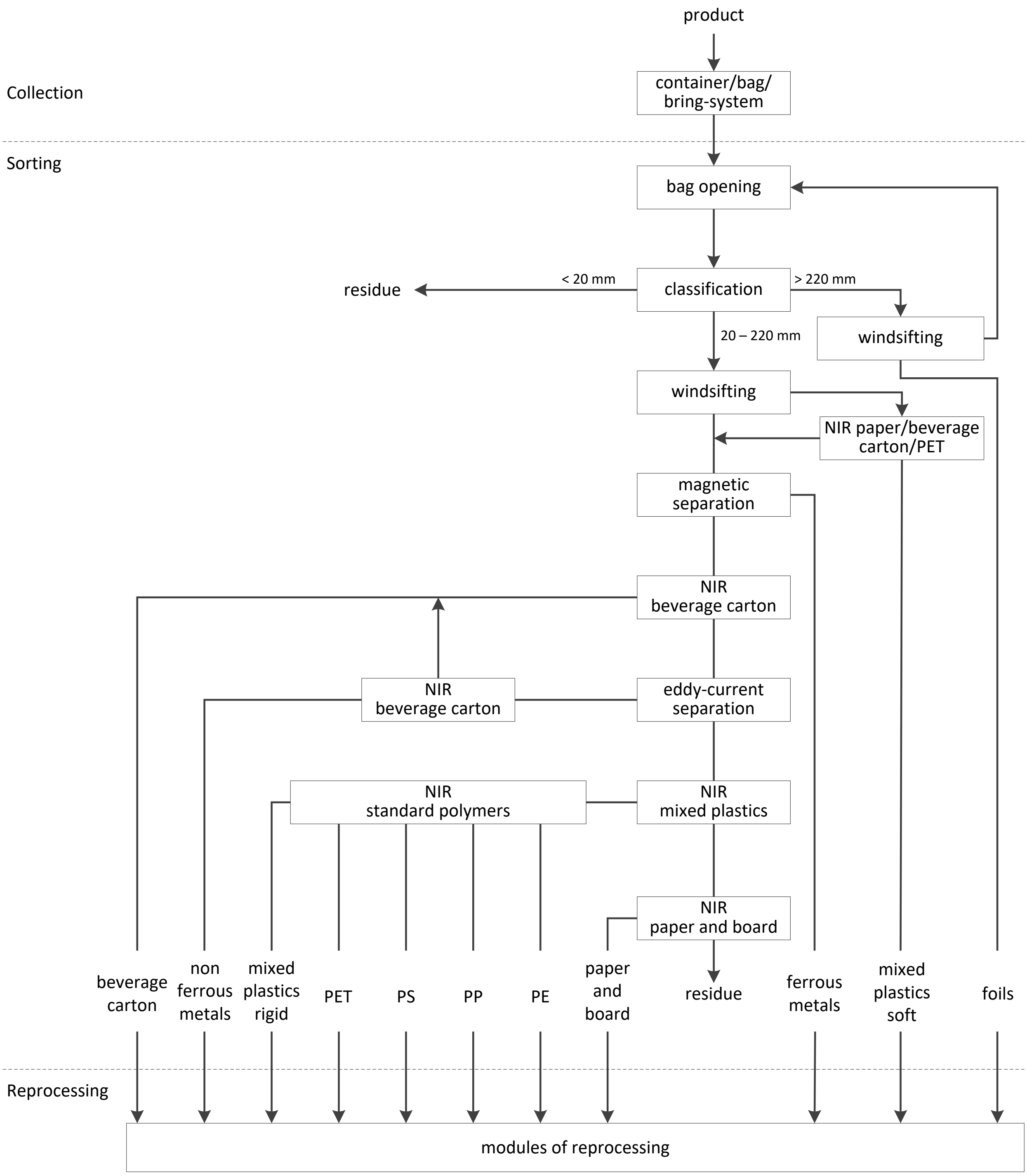
short symbol	name	density	glass transition temperature T_g or melting point T_m	decomposition temperature / remarks
PE-LD	Polyethylene low density	0.915 - 0.935 g/cm³	T_m: 105 - 118°C	340 - 440°C
PE-HD	Polyethylene high density	0.94 - 0.97 g/cm³	T_m: 126 - 135°C	340 - 440°C
PP	Polypropylene	0.91 g/cm³	T_m: 160 - 170°C	330 - 410°C
PS	Polystyrene	1.05 - 1.06 g/cm³	T_m: 240 - 270°C	300 - 400°C
EPS	Expanded polystyrene	0.015 - 0.1 g/cm³	T_m: ~ 240°C	300 - 400°C
PET-A	Polyethyleneterephthalate amorphous	1.33 - 1.35 g/cm³	T_m: ~ 260°C	from 340°C
PET-G	Polyethyleneterephthalate glycol modified (copolymer)	1.27 g/cm³	T_m: ~ 260°C	from 280°C
PET-C	Polyethyleneterephthalate partially crystalline	1.38 - 1.40 g/cm³	T_m: ~ 280°C	320°C
PET-S	Polyethyleneterephthalate /styrol-modified	1.15 g/cm³		
PA 6	Polyamide 6	1.13 g/cm³	T_m: 220 - 225°C	300 - 350°C discoloration by thermolysis-oxidative degradation from 200°C
PA 66	Polyamide 66	1.14 g/cm³	T_m: 250 - 260°C	320 - 400°C discoloration by thermolysis-oxidative degradation from 200°C
EVAL; EVOH	Ethylenevinylalcohol (copolymer)	1.21 - 1.31 g/cm³	T_m: 165 - 183°C depending on the mole%	ab 200°C
PVAL; PVOH	Polyvinylalcohol (copolymer)	1.19 - 1.31 g/cm³	T_m: 200 - 228°C	180 - 200°C
PVC (rigid)	Polyvinylchloride	1.40 g/cm³	T_g: ~ 80°C	from 180°C pure PVC: 200 - 300°C; browning by HCL-cleavage from 180°C
PVDC	Polyvinylidenechloride	1.63 g/cm³	T_m: 200°C	225 - 275°C browning by HCL-cleavage from 180°C
POM	Polyoxymethylene	1.42 g/cm³	T_m: 175°C	from 220°C
PMMA	Polymethylmethacrylate	1.18 g/cm³	T_m: 160°C	180-280°C
PAN	Polyacrylonitrile(copolymer)	1.17 g/cm³	T_m: 326°C	homopolymer > 200°C
PC	Polycarbonate	1.20 g/cm³	T_m: 220 - 230°C	350 - 400°C
PEN	Polyethylenenaphthalate	1.36 g/cm³	T_m: 270°C	
Al	Aluminum	2.7 g/cm³	T_m: 660°C	
CaCO3	Calciumcarbonate / chalk	2.73 g/cm³		825 - 899°C
EVA/ EVAC	Ethylvenylacetat	0.931 g/cm³		

4.2 Reference scenarios including explanations

- Overview - Lightweight packaging / PMD / recyclables
- Recycling path 1: Plastic foil
- Recycling paths 2 and 3: PE and PP
- Recycling path 4: PS
- Recycling path 5: PET-Bottles
- Recycling path 6: Mixed plastics (rigid) / MPO (rigid)
- Recycling path 7: Mixed plastics (flexible) / MPO (flexible)
- Recycling path 8: Beverage carton / plastic-coated carton packaging
- Recycling path 9: Tin plate / ferrous metals
- Recycling path 10: Aluminum / non-ferrous metals
- Recycling path 11: Paper and cardboard composites
- Recycling path 12: Glass
- Recycling path 13: Paper, cardboard

4.2.1 Overview – Lightweight packaging / PMD / recyclables

Reference scenario recyclability, overview (dated 01/2013)
Collection scheme lightweight packaging / recyclables



The sorting of lightweight packaging/PMD does not constitute its own separate path. Because of their particular importance as a partial reference for the paths 1 to 11, a detailed description of the current state of the art is here given. MRFs in other countries (such as PMD-Sorting in Belgium and in the Netherlands) also follow comparable standards and process sequences so that a German-focused description of lightweight packaging sorting also applies in large part to those applications as well.

The reception area of a state-of-the-art lightweight packaging/material sorting plant is designed as a fully enclosed flat bunker. Delivery is partly carried out directly, by means of collection vehicles, but more predominantly, this work is done from handling transfer stations plants by means of container trucks or walking floors trucks.

Lightweight packaging/material has a very low bulk density. In its bulk state, as it is relevant for the overall mechanical design, only 25 kg/m^3 to 40 kg/m^3 is estimated. As a result of compression during transport, however, the material mixture has even higher bulk densities upon delivery; at 4m high stacks, a 100 kg/m^3 density and a storage area requirement of 2.5 m^2/t plus driving and unloading areas have to be taken into consideration.

Due to differing delivery and operating times, the delivered material is firstly mostly stacked by means of a wheel loader; in parallel, and also by means of a wheel loader, the system infeed is carried out by means of a sub-surface conveyor belt or overhead system (dosing feeder, feed hopper).

A rough overview of current best practices for lightweight packaging/material sorting is given in the flowchart below. The figure also shows the resulting products of a modern, state-of-the-art lightweight packaging/material facility. The product names are abbreviated in the figure, but for exact identification and description, please refer to the list of varieties of the Dual Systems [available at http://www.gruener-punkt.de/en/download.html].

Today's existing facilities have only partially incorporated all of the elements necessary to make them state-of-the-art. In the basic procedure, however, standardisation has been reached. This results from the fact that the lightweight packaging/material collection plants are largely uniform throughout Germany, and uniform requirements are also placed on the sorted products.

4. Appendices

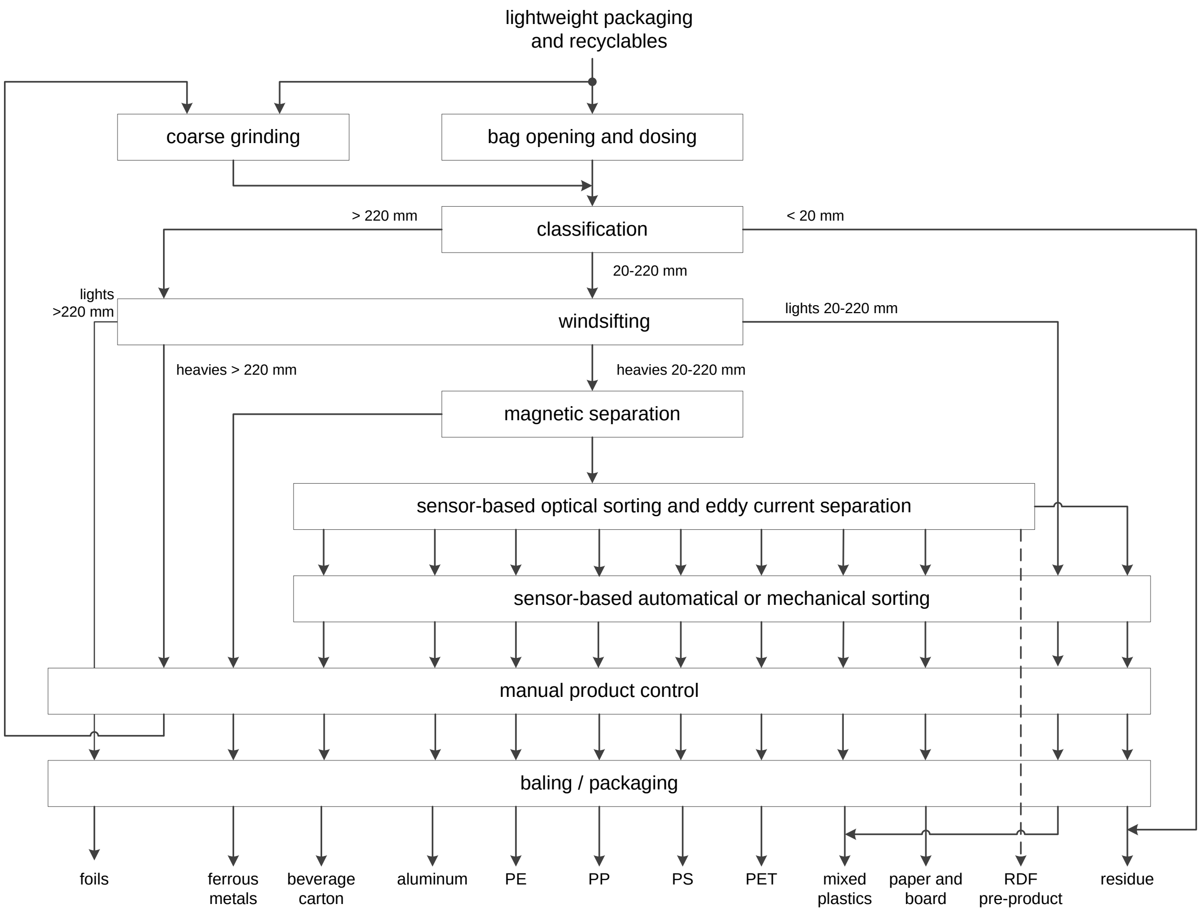


Figure 3: Schematic of the current state-of-the-art lightweight packaging / material sorting process

The bag opening always forms the input stage of the process. The objective of this step is the complete mechanical rending not only of collecting bags, but also of small, closed containers in particular, such as, for example, garbage bags. Through this process, all individual components are released. This is an obligatory prerequisite for the operability of all downstream operations within the process. As it stands now, this partial operation is usually executed in two stages and is coupled to a volumetric metering. As an alternative to two bag openers connected in series, slow-running pre-shredders (single-shaft shredder or rotary shears) have also proven to be reliable, for which, by means of relevant implementation, only bag opening and not disintegration of the material inside takes place.

Screening and Wind Sifting

The first separation stage is made up of a screening step that grades material from coarse to fine into 3 to 5 particle size classes, which are produced by means of 3 or 4 screen machines. The first screening machine has, in addition to this grading function, some other core functions, which include to empty opened bags, the further homogenisation of the volume flow, and, if applicable, the distribution of volume flows to parallel sorting lines. Best practice dictates that only trommel screens equipped with mesh blinded sections or that is clearly below the separation size be used in order to ensure the emptying of bags in the infeed area. Moreover, the prevention or, at the very least, minimisation of accretion of the screen machines is achieved through wrapping protection, which involves the wrapping of bands and plastic foil. The design of the wrapping protection usually consists of rectangular or round pipe sections of approximately 150 mm length, which are applied from the outside to the drum body.

The target of concentration of large-format materials in the overflow of the first drum machine fulfills several functions. Primarily, it is used to limit the flow of material which is automatically sorted further downstream with regard to the grain class of what can be processed. In addition to that, an initial accumulation of large-sized plastic foil is achieved, which is then set aside as a separate type. A cut size of 220 mm has proven effective for this so-called primary screening. Depending on the capacity of the plant, sub-fractioning is also carried out for distribution to several functionally identical lines.

For throughputs up to approx. 1000 m^3/h, drum screens up to 3.8 m in diameter and up to 18 m effective screen lengths are put in place.

The screen overflow (approx. 10-15% of the input flow, and below referred to as coarse grain) is passed through wind sifters for the separation of plastic foil. The current best practice is a layout that utilizes cross-flow wind sifters with lightweight material discharged via rotary valve. The remaining heavyweight material can then be sorted manually. Additionally, the coarse heavyweight material is subsequently shredded in order to make it available for the mechanical and automatic sorting processes of the medium-sized grain lines.

A second sorting screen section is set for fine grain. For wear protection, current practice is to eliminate virtually all non-recyclable fine grain by 20 mm mesh within flat screens. The fine grain fraction is usually about 5%.

The main mass flow (20 mm to 220 mm, approx. 80% to 85% of the input flow) is also conducted via wind sifters after screening. In high-capacity plants, the material flow is split over the screening machines, and the wind sifting, just as the subsequent process stages, is performed in parallel lines. Unlike in the case of coarse granulation, the purpose of separating medium-sized grain is not to create a product, but rather to prepare recyclable fractions for downstream sorting processes: lightweight packaging is a mixture with extremely low bulk density, which is largely due to the content of plastic foil in almost double-digit range. All modern sorting techniques require a monolayer material flow, which cannot be delineated without extensive removal of extremely thin-walled, flat components. The light material of the medium-sized grain wind sifting (approx. 10% of the input tonnage and with a bulk density <10 kg / m^3) is discharged as mixed plastic. Depending on the paper content of the lightweight packaging material collected, an automatic secondary cleaning is necessary beforehand.

Magnetic Separation

The next step in the process chain is the separation of ferromagnetic components (essentially tinplate) by means of suspension magnet separators (9-13% of the input flow). The product of the magnetic separation is generally not cleaned further. In a state-of-the-art facility, the suspension magnets are installed lengthwise over a transfer point of a conveyor belt, and the feed belt is set up as a regulated, fast-running belt in order to minimize missorting due to the overlapping of material. Splitters are also designed as drums which rotate against the direction of the belts. This is done for the purpose of optimizing product purity, as well as avoiding blockages. Additionally, rotating splitters are also standard in eddy current separators and sensor-based sorting machines.

Subsequently, the remaining material flow, in which rigid/dense plastics, non-ferrous metals, liquid cartons and other materials, as well as impurities such as paper and cardboard, have accumulated, is fed to a cascade of automatic separation stages with intermediate eddy current separation.

Eddy Current Separation

Eddy current separation serves to separate metallic, non-ferromagnetic components; from the standpoint of the packaging sector, only aluminum is relevant here. The system is set up in such a way that liquid cartons with aluminum coating, that have not been sorted out by upstream NIR-beverage carton sorting, are discharged into the product flow, which necessitates its subsequent purifying via a NIR separation stage.

The principle behind eddy current separation is based on the induction of electrical currents in electrically-conductive materials by a high-frequency magnetic alternating field.

This is implemented by means of a rotor that is covered with high-intensity permanent magnets in alternating polar order and which is then rotated in a conveyor belt head drum at high speeds.

The current induced in the conductive particle forms a separate magnetic field, which is always opposed to the alternating field of the machine. The resulting repulsion leads to the deflection of electrical conductors from the flow. Ferromagnetic fractions are attracted and must therefore be separated before the eddy current separation.

The deflecting force is relatively low compared to the attracting force of a magnetic separation. The ratio of electrical conductivity to mass can simplified been defined as the separating characteristic. In addition, the shape of the electrical conductor plays a major role; a precondition for separation is that the induced current flows directionally. Therefore, an aluminum foil which is crimped into the ball cannot be separated well.

The description of the separation principle makes it clear that the technique is essentially suitable for separating all electrically conductive waste material, i.e. all metals. Aluminum, with a conductivity of 35 m/(Ω·mm^2) at a density of 2.7 g/cm^3, has a different conductivity than, for example, lead (conductivity 4.82 m/(Ω·mm^2), density: 11.34 g/cm^3). Correspondingly, different machine types can be used depending on the application, which differ essentially in the type and configuration of the magnet system.

Eddy current separators are necessary in facilities that sort lightweight packaging only for fine and medium size flows, since aluminum packaging is not contained in coarse material. Materially-identical non-packaging items (NVPs) are represented over the entire spectrum. According to relevant analyses, up to 70% can be generated in the size class > 220 mm. A sorting for coarse heavy material, whether by secondary grinding and re-circulation, or by manual sorting, is minimally recommended for extended (not only packaging) schemes of dry recyclables sorting.

Sensor-Based Sorting

The automatic separation stages (processing technology: sensor-based sorting = single particle sorting) differ from all other basic processing operations of sorting in that different material properties need not be simultaneously usable for physical separation. It is possible to separate that which can be differentiated by measurement technology. A disadvantage is the comparative principle-dependent throughput weakness and the high dependence of the separation success on the possibilities of material separation. Typical of this sorting type are detection methods and discharge devices which enable separation from a monolayer at high transport speeds.

The most important detection method in the field of light packaging/material sorting is near-infrared spectrometry, with which plastics and other hydrocarbon-containing materials are differentiated. The detector is arranged over an accelerator belt just before a belt transfer point. The conveying speed is up to 3 m/s. Radiation from a conventional halogen light source reflected from the near-surface layers of an object is measured. The emitted spectrum is compared in the process computer with reference values. In the case of positive detection, a targeted pulse of compressed air is triggered based on the coordinates of the object by means of a valve block (valve distance 16 mm to 33 mm) set into the transfer point, which then leads to the deflection of the target object.

State-of-the-art facilities have up to 20 of these sorting machines in different functions. In addition to pure NIR separators, specific applications are also used which implement several types of detection (e.g. NIR, color measurement and induction measurement) in one machine (known as multi-sensor separators).

In lightweight packaging/material sorting plants, the process for separating liquid cartons, as well as for the collective plastic separation, is correspondingly automated. State-of-the-art systems also have a sub-fractioning out of form-stable plastics by type of plastic. A separation of standard packing plastic polymers HDPE, PP, PET, and PS takes place at this point. This process methodology was first implemented successfully in 1999 as a modular retrofit option and is now found in nearly all plants with a larger capacity, though not all four fractions are always produced.

Conveyor Technology

The conveyor system is an integral part of the processes used in sorting plants. This is true for magnetic separation, air sifting and eddy current separation, the operability and efficiency of which depends on thin- or monolayer loading. The functional dependency of the success of the sensor-based sorting systems must be emphasized in particular. The singling out of components that are to be separated is a prerequisite for this.

Both a continuous material flow and a uniform distribution of the material over the usable widths of the conveyors must be ensured. Sensor-based sorting units are available in system widths up to 2.8 m. In the sorting of light packaging, specific throughputs, which have to be applied depending on a partial flow between 0.5 t/h and 3 t/h per meter of system width can only be suitably put into place in accordance with the aforementioned preconditions.

Current state-of-the-art practice is to set up all the conveying components in such a way that in areas of separation processes, there are no surge-type stresses, one-sided loadings, or other such complications. This must be ensured by constant volume metering; avoidance of elevating conveyor belts, conveyors with cleats, and right-angled transfers points with low transfer heights at sensitive positions; if at all possible, straightforward design of sorting cascades; suitable layout of transfer points; and the use of vibrating feeders, as needed.

4. Appendices

Manual Product Inspection

Despite all automation, it is not possible at current standards to completely dispense with manual sorting. This is essentially due to systematic false sorting of materials in the automatic or mechanical separation stages. These are, in fact, not errors, but rather result from certain materials not corresponding to the separation characteristics being looked for by the automated systems. The cause of this comes down to something in the composite nature of some material or in limitations to the process of singling out specific items. For example, paper covered by LDPE foil is in the reference range for liquid cartons. Liquid cartons, which due to their aluminum inner coating are erroneously discharged by the eddy current separator, are a further example of a systematic discharge error. Also, the sorting task may not be completed with correct recognition of a material type, since the evaluation in a particular case requires yet another limiting factor. For example, PE foils in the sorting product PE are undesirable; silicone cartridges made of PE are even completely excluded due to the possible residual contents.

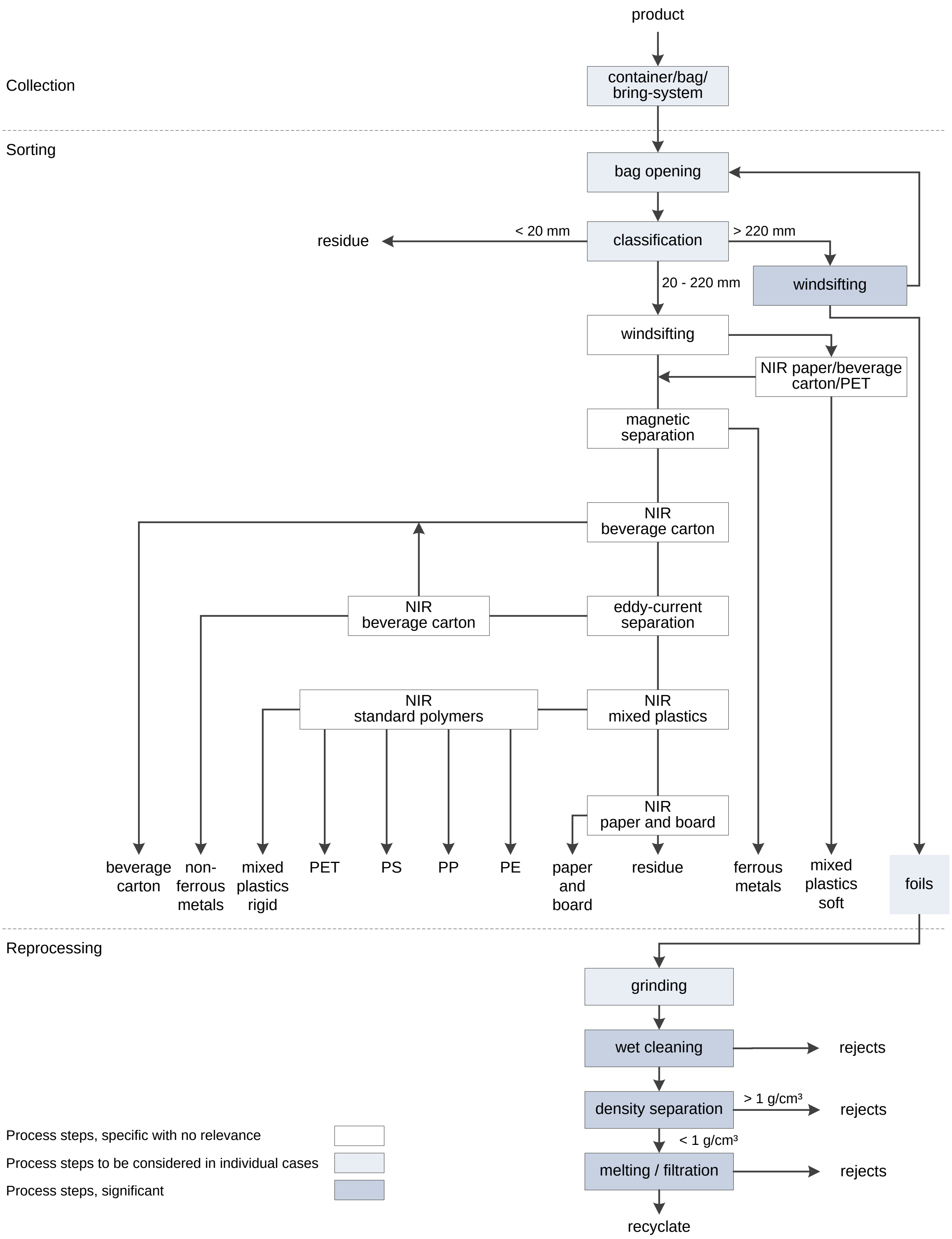
In industrial large-scale plants, such deficits of single-stage mechanical and automatic separation are, however, further reduced by secondary cleaning processes. But here, too, the option is open to carry out a manual follow-up. This is why even the most modern systems have a sorting cabin which provides optional access to all sorting products before buffering and baling.

In contrast to the systems utilized in other areas of waste material sorting, there are no continuous sorting belts in the area of lightweight packaging/material sorting cabins. The products are fed into the cabin on belts and end above the respective product bins. In some plants, the remainder left over from the sorting process is also conveyed again into the sorting cabin for visual inspection of how well the plant is operating at that time.

Places for required sorting personnel are equipped with air curtain ventilation with a supply of conditioned external air and waste heat recovery. To optimize energy efficiency, waste heat from the compressors required for the sensor-based sorting units can be used for heating purposes.

4.2.2 Recycling path 1: Plastic foil

Reference scenario recyclability, plastic foil (dated 01/2013)



4. Appendices

Collection structures for plastic foils can be assumed in the following countries without further assessment:

- Germany
- Italy
- Netherlands
- Norway
- Austria
- Spain

Plastic foils are pre-concentrated in the sorting process by grading and wind-sifting. The target fraction is narrowed down (generally > A4) in order to ensure a significant enrichment of LDPE.

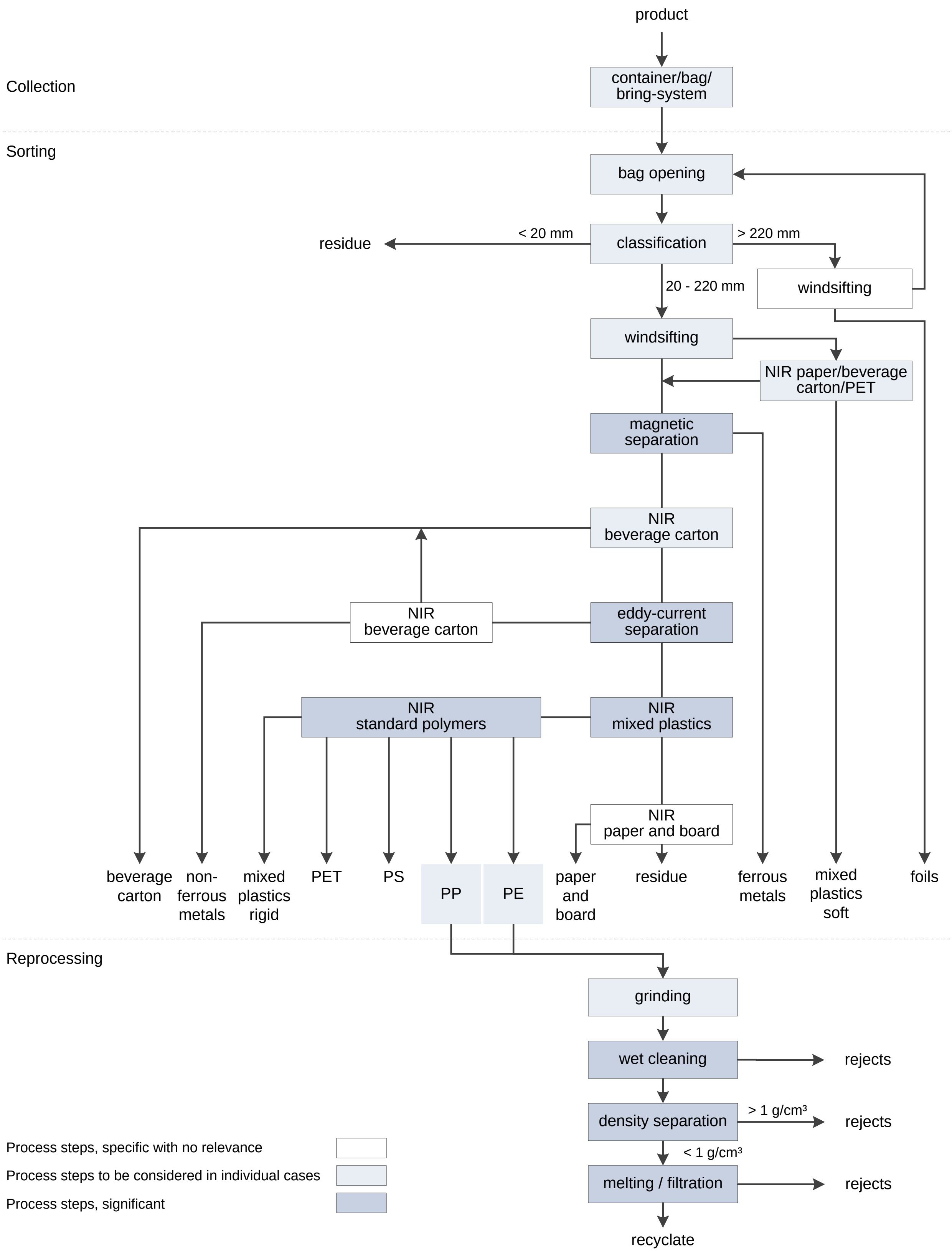
A uniform standard process of foil recycling is wet processing with the processing stages of grinding, washing, sink/float separation, drying and extrusion with melt filtration.

Accordingly, to assess recyclability, the following process technology is usually required:

- wind-sifting for foil sorting
- Washing and qualified float-sink separation
- No additional requirements like hot washing, washing additives, etc.
- Extrusion with melt filtration

4.2.3 Recycling paths 2 and 3: PE and PP

Reference scenario recyclability, PE and PP (dated 01/2013)



Collection structures for PE and PP packaging can be assumed in the following countries without further assessment:

- Germany
- Italy (PP)
- Netherlands
- Norway
- Austria
- UK

With the additional attribute "Bottle and / or container" also in:

- Belgium
- Spain
- France
- Italy
- Switzerland
- Luxembourg

PE and PP are specifically sorted out in large-scale sorting plants using NIR-based sorting machines. In Belgium the sorting of PP is not mandatory; but practically a sorting exists. Thus, there are no compromises made.

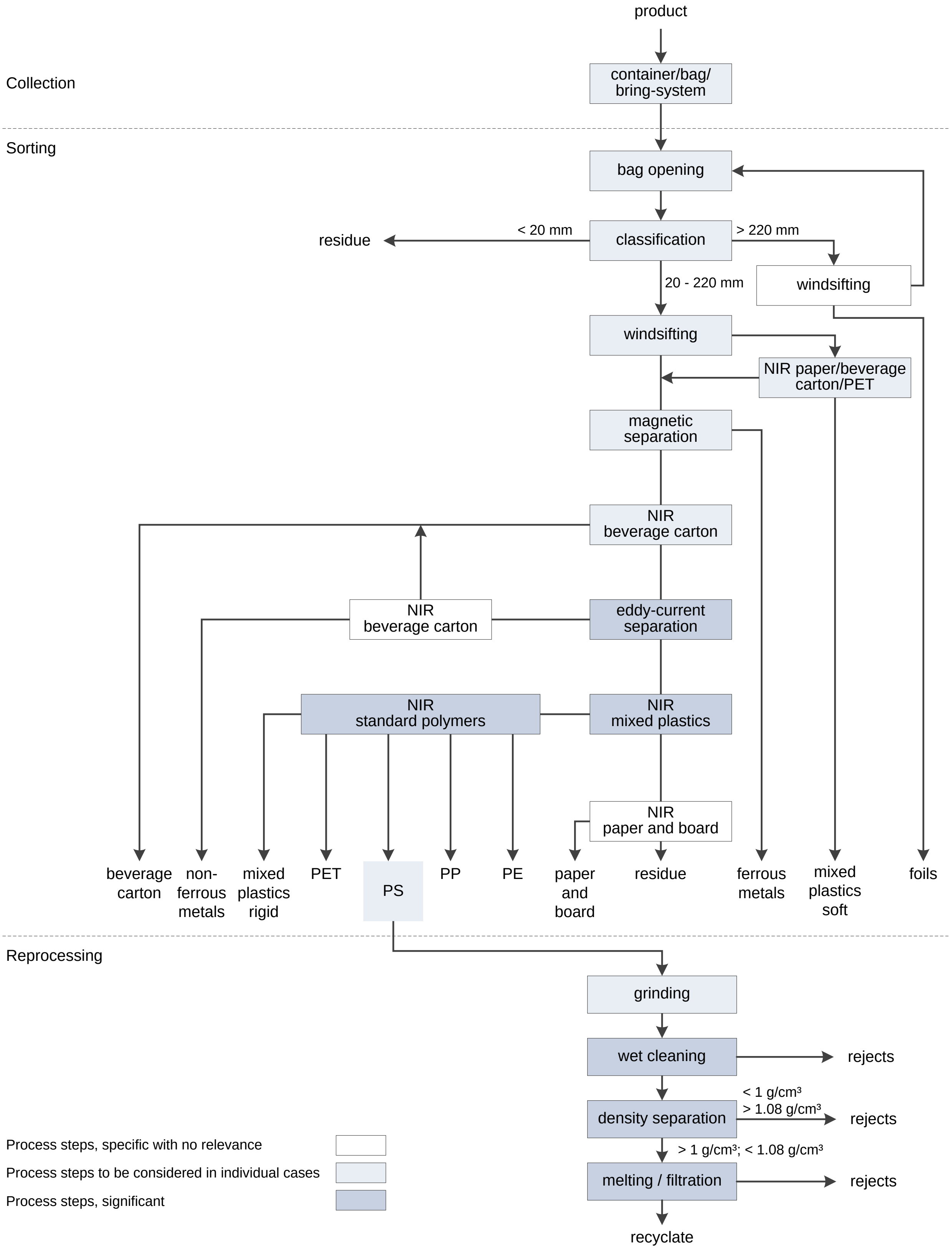
Further recycling is carried out uniformly by means of wet processing with the processing stages of grinding, washing, sink/float separation, drying and extrusion with melt filtration to a HDPE or PP regranulate.

Accordingly, to assess recyclability, the following process technology is usually required:

- NIR detection for PE/PP (22.5 mm maximum valve distance)
- Ideal conditions for NIR detection of small / small format material
  - High-resolution detection
  - Valve distance ≤ 16.5 mm
- Integration of the entire grain range > 20 mm by return and / or manual sorting in coarse grain > 220 mm
- Washing and qualified float-sink separation
- Extrusion with melt filtration

4.2.4 Recycling path 4: PS

Reference scenario recyclability, PS (dated 01/2013)



4. Appendices

Collection structures for PS packaging can be assumed in the following countries without further assessment:

- Germany
- Norway
- Austria

For waste collection schemes from the Netherlands, however, PS is not compulsorily sorted as a "monofraction". Additionally, the conceivable alternative path concerning preparation of stable plastics (wet-processing mixed-plastic preparation with PS recovery) is currently not practiced, which means that there currently is no high-quality recycling structures that exist.

German sorting plants are for the most part equipped with specific separation stages for (form-stable) PS related to processing quantity.

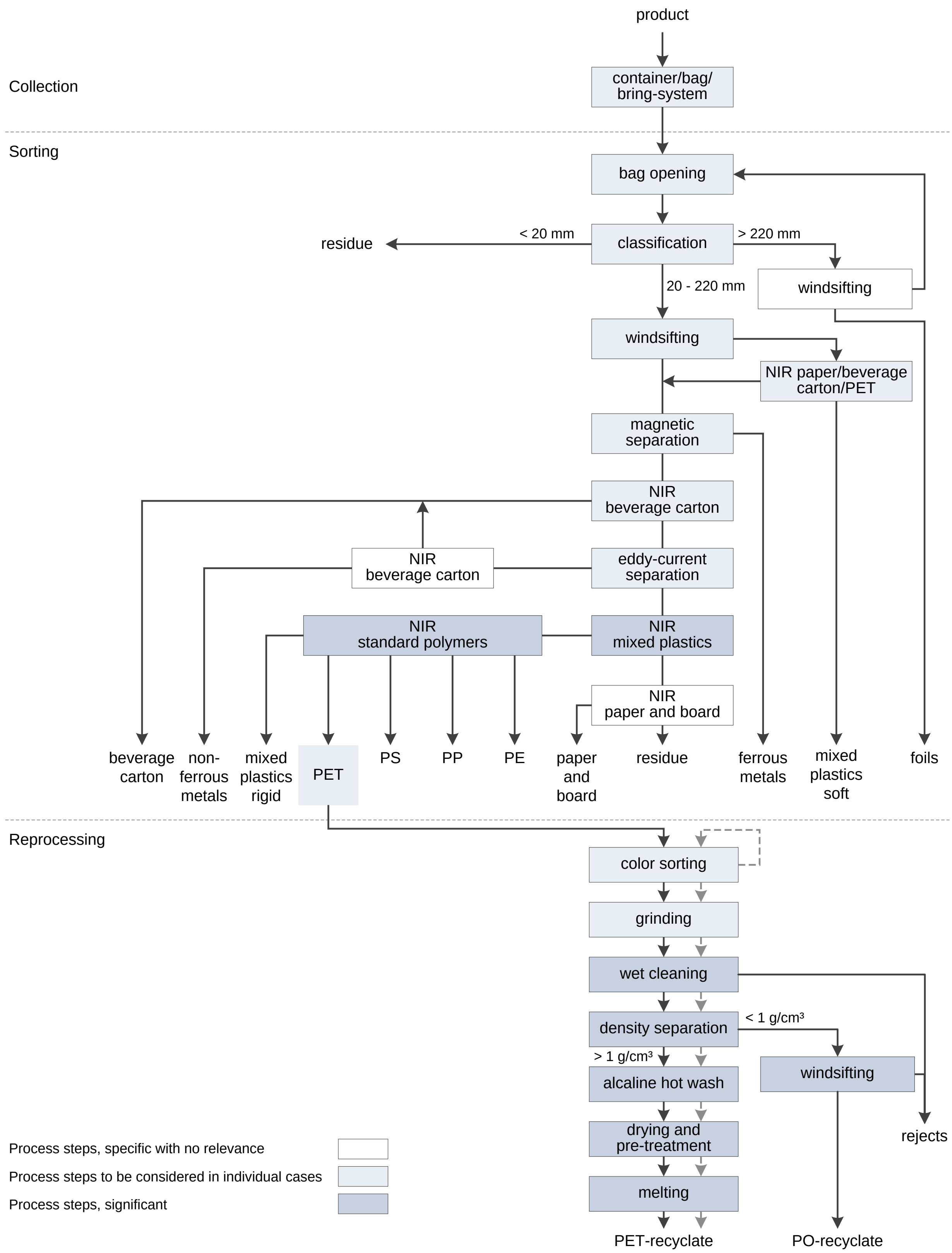
The sorting product is turned into PS regranulate exclusively by means of wet processing, with the processing stages of grinding, washing, sink/float separation (twice: at 1 g/cm^3 and approx. 1.08 g/m^3), drying, and extrusion with melt filtration.

Accordingly, to assess recyclability, the following process technology is usually required:

- NIR detection for PS (22.5 mm maximum valve distance)
- Ideal conditions for NIR detection of small / small format material
  - High-resolution detection
  - Valve distance ≤ 16.5 mm
- Washing and qualified float-sink separation
- Extrusion with melt filtration

4.2.5 Recycling path 5: PET-Bottles

Reference scenario recyclability, PET (dated 02/2017)



4. Appendices

Collection structures for PET beverage bottles can be assumed in the following countries without further assessment:

- European Union
- Switzerland

In Germany, Austria, France, Belgium, Italy and the Netherlands, non-beverage bottle PET is also collected. However, recycling options only currently apply to transparent PET-A and not to other types, such as PET-C and PET-G or opaque PET.

The exception to this is Austria. Here I was given the Spez. 499 by the ARA for both the sorting fraction for opaque PET bottles, as well as for an independent recycling path developed, which corresponds approximately to the colorful-transparent bottles. To a **very** limited extent, this can also represent a PET-shell utilization.

In Belgium, non-beverage bottles are currently not allowed to be included in the sorting product, which means that, for Belgium, no recycling structures can be assumed at present.

PET, if not included in the mono-flow as a beverage bottle, is sorted out in all large-scale sorting systems via NIR-based sorting machines. However, it is also true that bottles for which a deposit is paid by the consumer must be identifiable in the NIR spectral analysis since the PET recyclers carry out an automatic control sorting of their input. Related to color and material.

Furthermore, according to current EU standards, it can be assumed that PET recyclers have multi-stage washing processes, of which at least one stage is designed for alkaline hot-wash.

Recovering the cap material (HDPE or PP) via sink/float separation is also standard. PET recyclers often do not regranulate the ground material, but sell the PET recyclates as ground material, so-called "flakes". However, the remelting process is always part of the recycling process, independent of the recyclate input, whether it be bottles, film, packaging straps or fibers. This takes place at the processors, at the latest. Owing to the high melting point of PET, its high sensitivity to organic impurities, such as from other plastics or adhesives, must be considered, especially with clear PET, which can significantly reduce the amount of recyclate due to temperature-induced decomposition or color changes.

Accordingly, to assess recyclability, the following process technology is usually required:

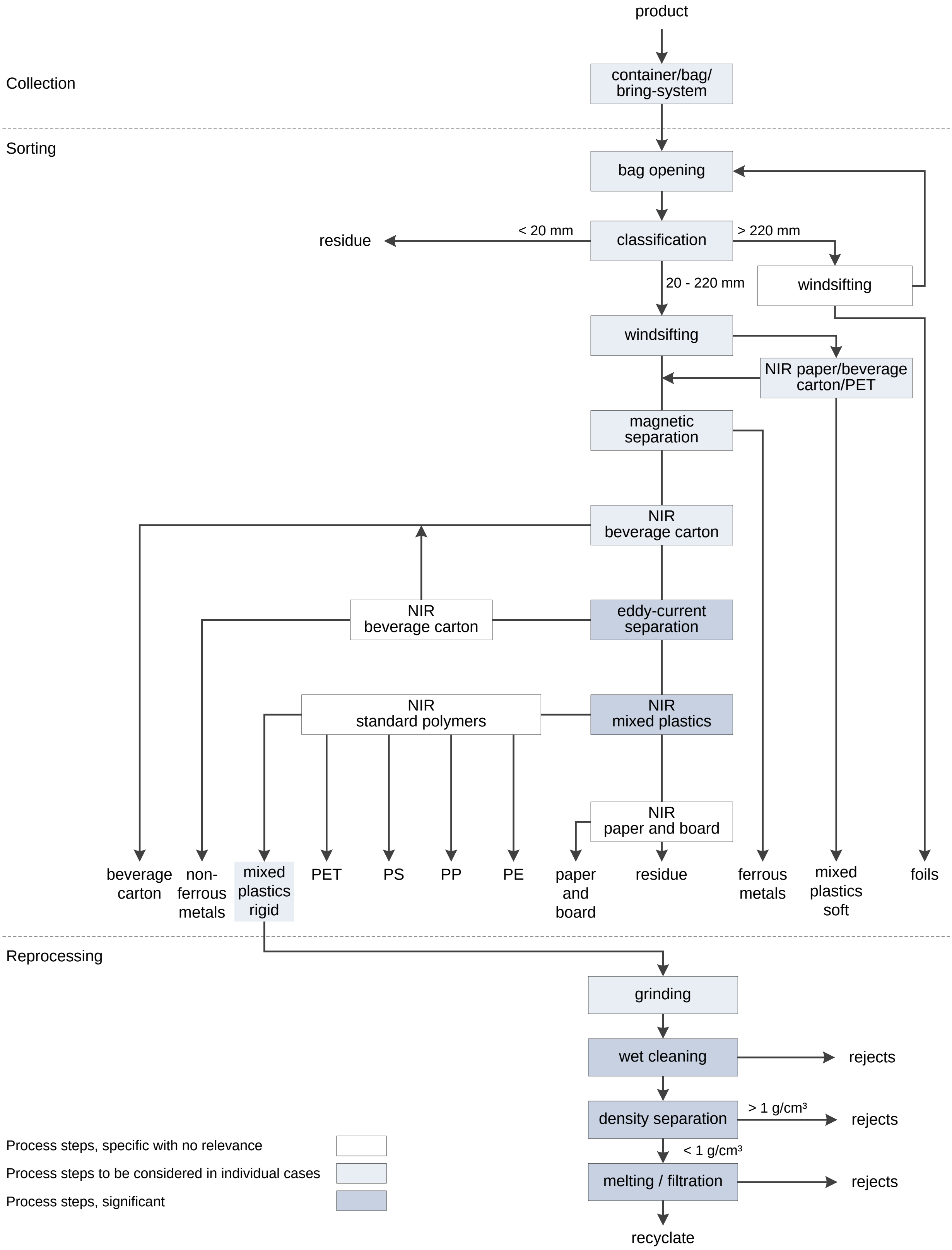
- NIR detection for PET
- Two-stage washing with at least one alkaline hot washing process and qualified float-sink separation

4. Appendices

- Extrusion with remelting temperatures up to 285°C and with melt filtration

4.2.6 Recycling path 6: Mixed plastics (rigid) / MPO rigid

Reference scenario mixed plastics rigid/dense (dated 01/2013)



4. Appendices

Collection structures for mixed plastics rigid/dense can be assumed in the following countries without further assessment:

- Germany
- Italy
- Austria
- The Netherlands
- Norway

But recycling capacities for high-quality material recycling of mixed plastics are currently concentrated in Germany. Specifically, the actual recyclable fraction is the polyolefin fraction. The supply of mixed plastics for high-quality material recycling is also not mandatory in Germany; however, there are considerable capacities present. They are competing for the energetic mixed plastics recovery and intrusion processes. It should be assumed that, with increasing demands on recycling, the importance of high-quality mixed plastics recycling will increase.

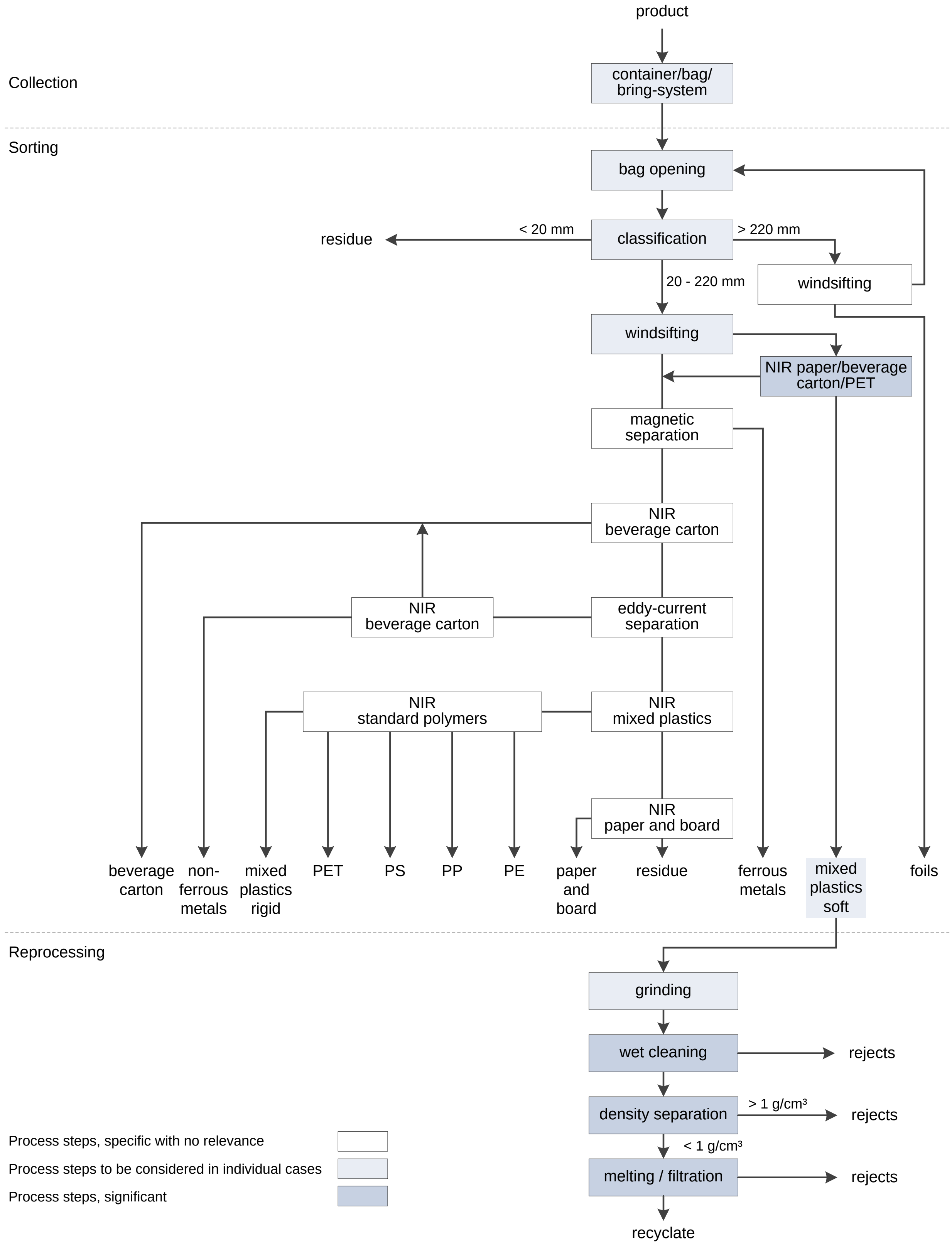
In most cases, mixed plastics are already set up during the sorting process according to the special requirements of these systems; suitable input materials are PS and (mixed) polyolefins, whether flexible, rigid or semi-rigid (HDPE, LDPE, PP). The treatment is achieved in a way that's fundamentally comparable to that of monosorts, namely by grinding, washing, sink/float separation, drying and extrusion with melt filtration. Products (regranulates) are blends e.g. for injection moulding applications.

Accordingly, to assess recyclability, the following process technology is usually required:

- NIR detection for plastics (22.5 mm maximum valve distance)
- Ideal conditions for NIR detection of small / small format material
  - High-resolution detection
  - Valve distance ≤ 16.5 mm
- Integration of the entire grain range > 20 mm by return and / or manual sorting in coarse grain > 220 mm
- Washing and qualified float-sink separation
- Extrusion with melt filtration

4.2.7 Recycling path 7: Mixed plastics (flexible) / MPO (flexible)

Reference scenario recyclability, mixed plastics soft/flexible (dated 01/2013)



4. Appendices

Collection structures for mixed plastics flexible can be assumed in the following countries without further assessment:

- Germany
- Italy
- Austria
- The Netherlands
- Norway

Recycling capacity for high-quality material recycling of mixed plastics is currently concentrated in Germany. Specifically, the actual recyclable fraction is the polyolefin fraction. The supply of mixed plastics for high-quality material recycling is also not mandatory in Germany; however, there are considerable capacities present. They are competing for the energetic mixed plastics recovery and intrusion processes. It should be assumed that, with increasing demands on recycling, the importance of high-quality mixed plastics recycling will increase.

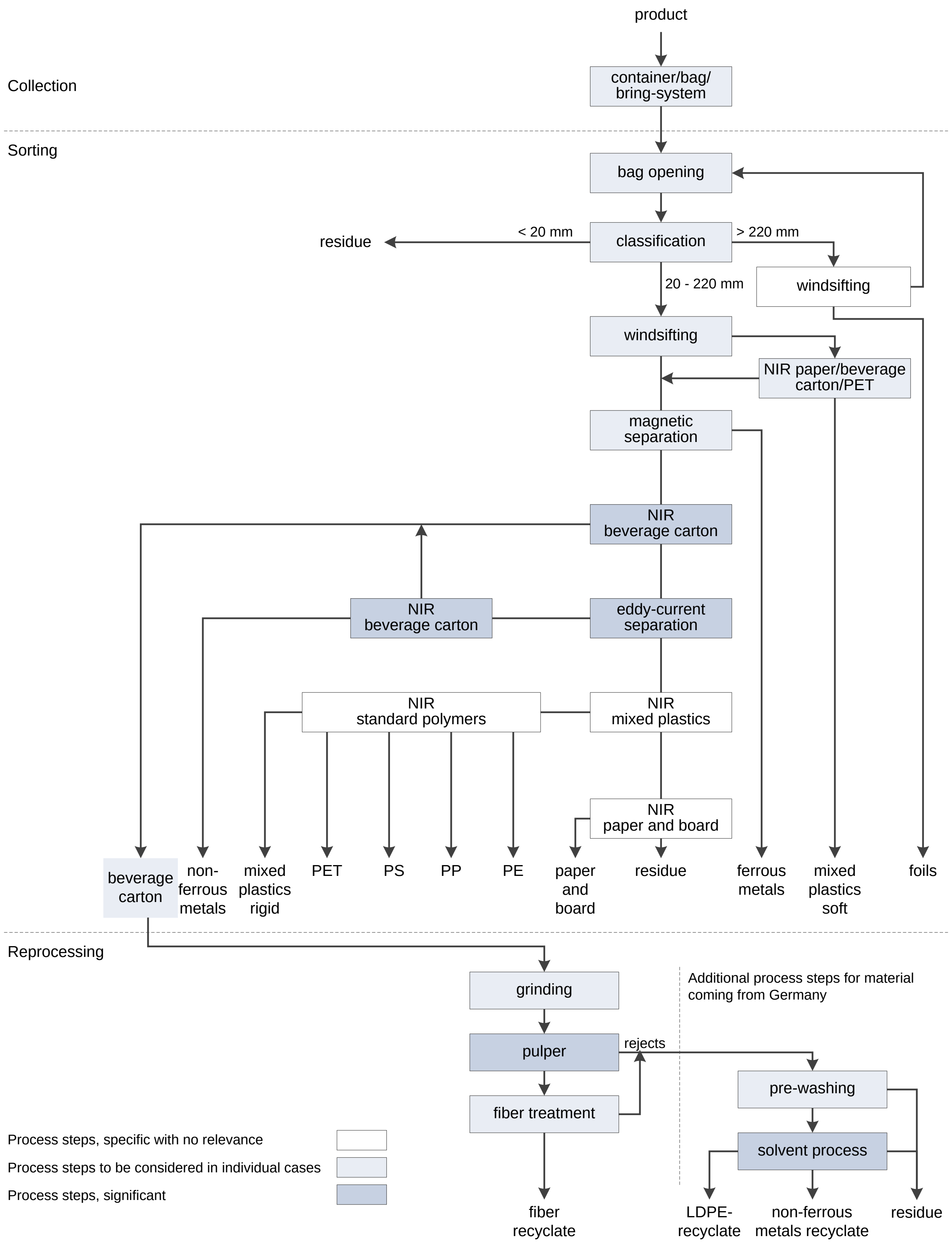
In most cases, mixed plastics are already set up during the sorting process according to the special requirements of these systems; suitable input materials are PS and (mixed) polyolefins, whether flexible, rigid or semi-rigid (HDPE, LDPE, PP). The treatment is achieved in a way that's fundamentally comparable to that of monosorts, namely by grinding, washing, sink/float separation, drying and extrusion with melt filtration. Products (regranulates) are blends e.g. for injection moulding applications.

Accordingly, to assess recyclability, the following process technology is usually required:

- Windsifting in the grain range of 20-220 mm
- NIR detection for paper, tetra and PET in the light fraction of the wind-sifter (cleaning stage)
- Washing and qualified float-sink separation
- Extrusion with melt filtration

4.2.8 Recycling path 8: Liquid packaging boards

Reference scenario recyclability, beverage carton (dated 11/2016)



Collection structures for plastic-coated carton packaging (tetra) can be assumed in the following countries without further assessment:

- EU and Switzerland

Liquid packaging baords are collected together with lightweight packaging in Germany. In most other European countries, there is a comparable allocation (e.g., PMD in Belgium, etc.). As a rule, liquid cartons form a separate sorting fraction within the sorting process, which is generated in high-tech plants exclusively via sorting machines. (Liquid cartons have a specific spectrum in the NIR reflection measurement.)

The fraction "liquid packaging board" is assigned to special waste paper processing lines which are designed for the comparatively long pulping time (approx. 15 min.).

Accordingly, to assess recyclability, the following process technology is usually required:

- NIR detection for liquid packaging (tetra) in the light fraction of the wind-sifter, wind-sifter heavy fraction and in the eddy current separator product
- Pulping process with standard retention time
- Separation of insoluble components by classification

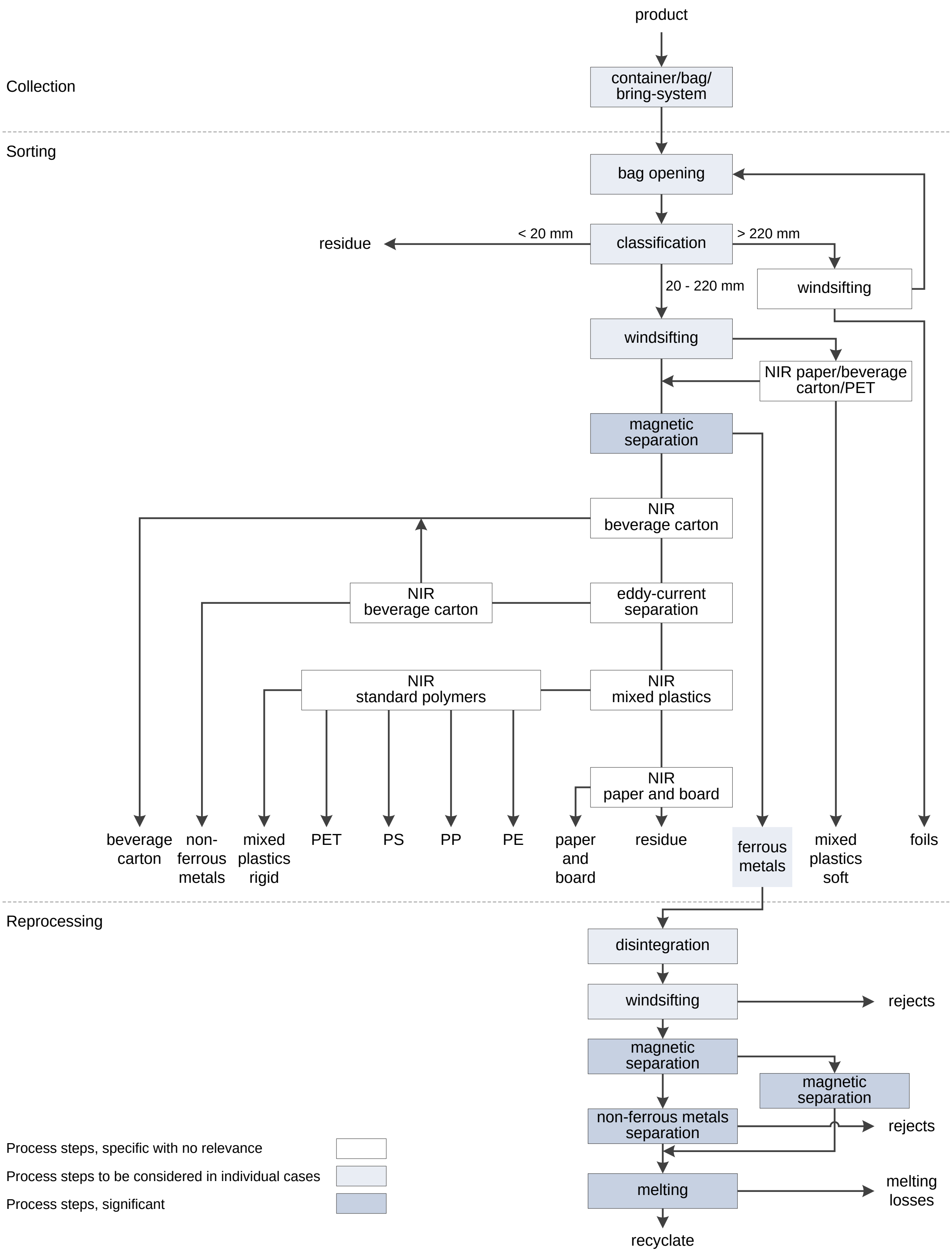
For liquid packaging board from German collections, it should be particularly noted that, in the meantime, a significant fraction of material rejected from the pulping is further processed.

Products of this certified recycling pulping process are aluminum granules and LDPE regranulates, which replace primary virgin material in respective material-specific (high-quality) applications.

As long as the corresponding recycling paths are activated, the prerequisites are also met for the aluminum and LDPE portions of a liquid carton to be classified as recyclable.

4.2.9 Recycling path 9: Tin plate / ferrous metals

Reference scenario recyclability, ferrous metals (dated 01/2013)



Collection structures for tin plate and ferrous metals can be assumed in the following countries without further assessment:

- EU

The recyclability of ferrous metals and alloys via the corresponding recycling path is directly linked to the "ferromagnetic" property of the material. Non-ferromagnetic iron or steel products such as iron castings or high-alloy steels do not satisfy this criterion and are evaluated under path 10, as required.

Current best practice is the use of suspension magnets to sort material with weak-field magnetic separators. Because magnetic separation is generally placed early in the sorting process sequence, the "ferromagnetic" characteristic is considered dominant. Small ferromagnetic components such as, for example, the tinplate of a composite can or the metal hooks of a (plastic) coat hanger are sufficient to transfer the package or product into the sorting fraction "Fe-metals".

Further processing of the sorting fraction generally comprises mechanical secondary cleaning for the separation of organic impurities (paper labels, plastics, residual contents) and of extraneous metals (in particular aluminum).

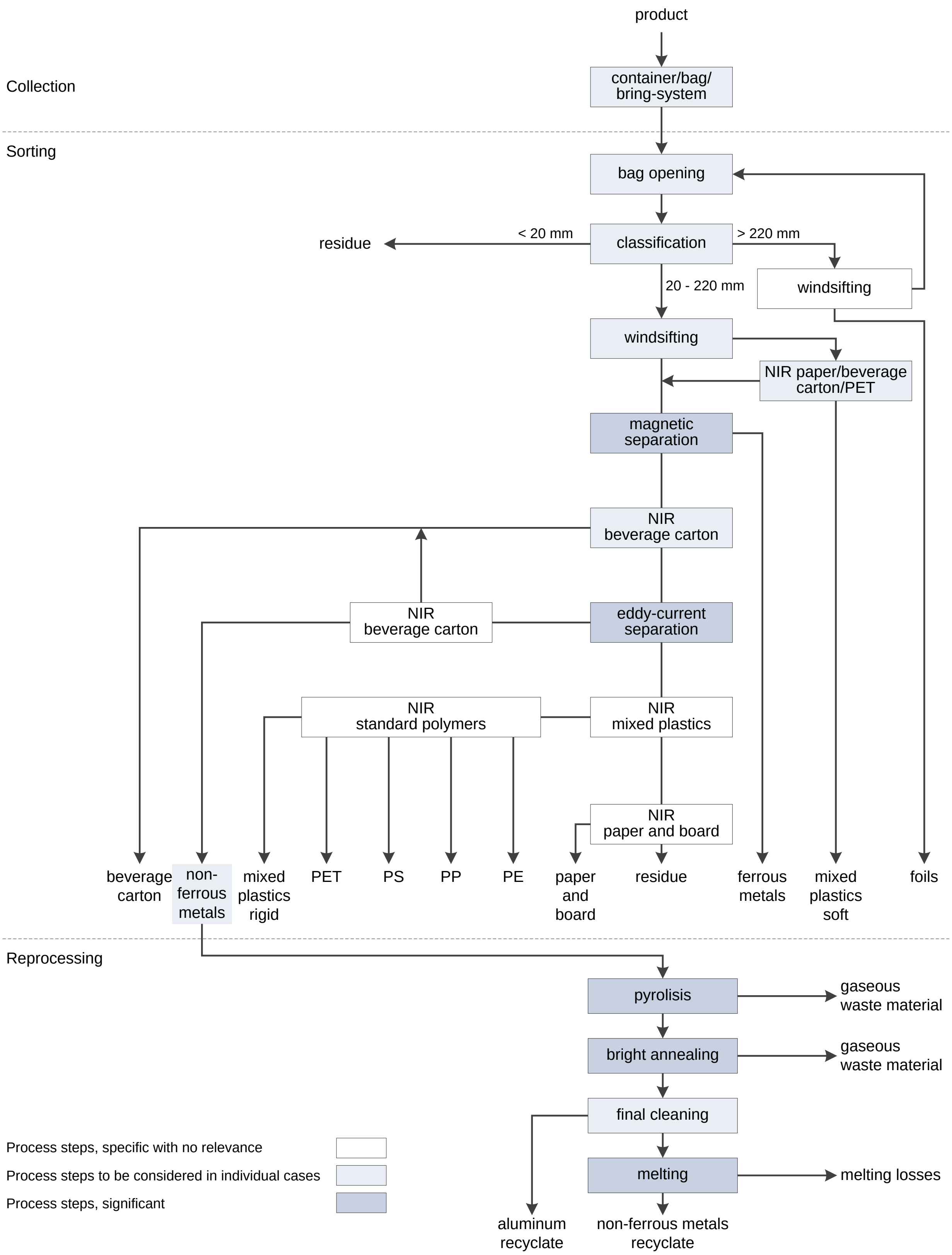
Process steps are disintegration by means of special shredders, such as, for example, the so-called Turbo-Crusher, wind sifting, nonferrous and ferrous separation and a final compacting of the sorted ferrous scrap to appropriately-sized units, which are generally used in steel production within the converter stage.

Accordingly, to assess recyclability, the following process technology is usually required:

- Magnetic separation for ferromagnetic components
- Operation height of the suspension magnet separator 450 mm
- Integration of the entire grain range > 20 mm by return and / or manual sorting in coarse material > 220 mm
- Ferrous metal recovery with magnet and eddy current separation
- Shredder process and subsequent eddy current separation for non-ferrous metal separation

4.2.10 Recycling path 10: Aluminum / non-ferrous metals

Reference scenario recyclability, non-ferrous metals (dated 01/2013)



Collection structures for aluminium and non-ferrous metals can be assumed in the following countries without further assessment:

Collection schemes for post-consumer non-ferrous metal packaging are installed in most European countries. The organisation varies and takes national specialties into account.

The different recycling paths can be classified as follows:

1. Separate collection of drink cans, either via deposit systems (northern countries, Germany) voluntary return systems (central and eastern countries, Turkey) or incentive-based schemes (UK, Ireland, France, Greece, etc.). Especially drink cans and menu trays are part of the separate collection scheme in UK and Switzerland (also tubes and caps).

2. Collection schemes where aluminium packaging is put of the collection scheme for mixed packaging waste together with packaging made of plastic, ferrous metal, liquid packaging board and partly also paper and OCC (Italy, Spain, Germany, Portugal, France, Belgium, Austria). Aluminium packaging is then separated in sorting facilities. In Germany also compounds or composites with aluminium-foil are in scope of scheme. In the other mentioned countries, just packaging where the main component is aluminium like cans and menu trays are in scope.

   The sorting fraction is generated uniformly via eddy current separators, which sort the flow by electrical conductivity. Aluminum is a comparatively good electrical conductor, like copper, so that sorting is carried out with very high efficiency. Since, in particular, mass and format play an overlapping role, the sortability is examined empirically if needed. It is also tested whether the test object reliably arrives at the separating stage after the processes that lie upstream, such as sieving, air sifting and magnetic separation.

   The aluminum fraction is subsequently processed further through pyrolysis. In this process, the material is thermally treated under oxygen-less conditions in order to detach gaseous organic elements, such as plastic coatings, lacquers, residual contents, etc. The portions in question are then deducted for the assessment. Subsequent treatment step is remelting, in which oxidized aluminum is slagged. These losses are also taken into account in the test results.

3. Recovery from MSW (mechanical pre-treatment MBT or MT) e.g. in Netherlands.

To assess recyclability*, the following process technology is usually required:

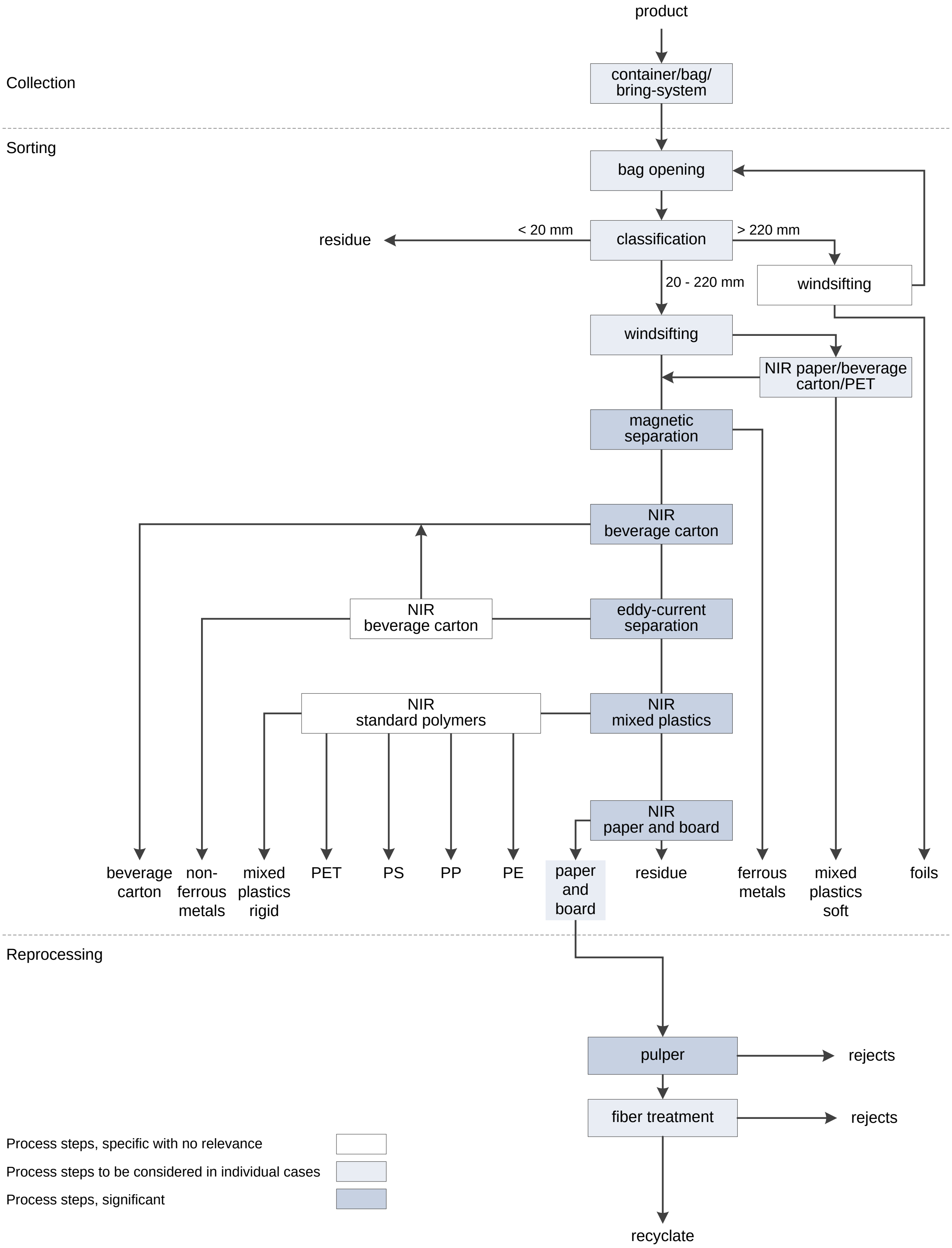
- Eddy current separation for metal components with mixed-pole system and eccentric magnet wheel
- Integration of the entire grain range > 20 mm by material feed-back and / or manual sorting in coarse grain > 220 mm

4. Appendices

* The reference scenario is not applicable for aluminium-recovery from bottom ashes

4.2.11 Recycling path 11: Paper and cardboard composites

Reference scenario recyclability, paper and cardboard composites (dated 01/2013)



4. Appendices

Collection structures for paper cardboard composites can be assumed in the following countries without further assessment:

- Germany

To assess recyclability, the following process technology is usually required:

- NIR detection for paper cardboard and paper and tetra
- Integration of the entire grain range > 20 mm by return and/or manual sorting in coarse grain > 220 mm
- Material solution with sufficient retention time
- Separation of insoluble components by classification

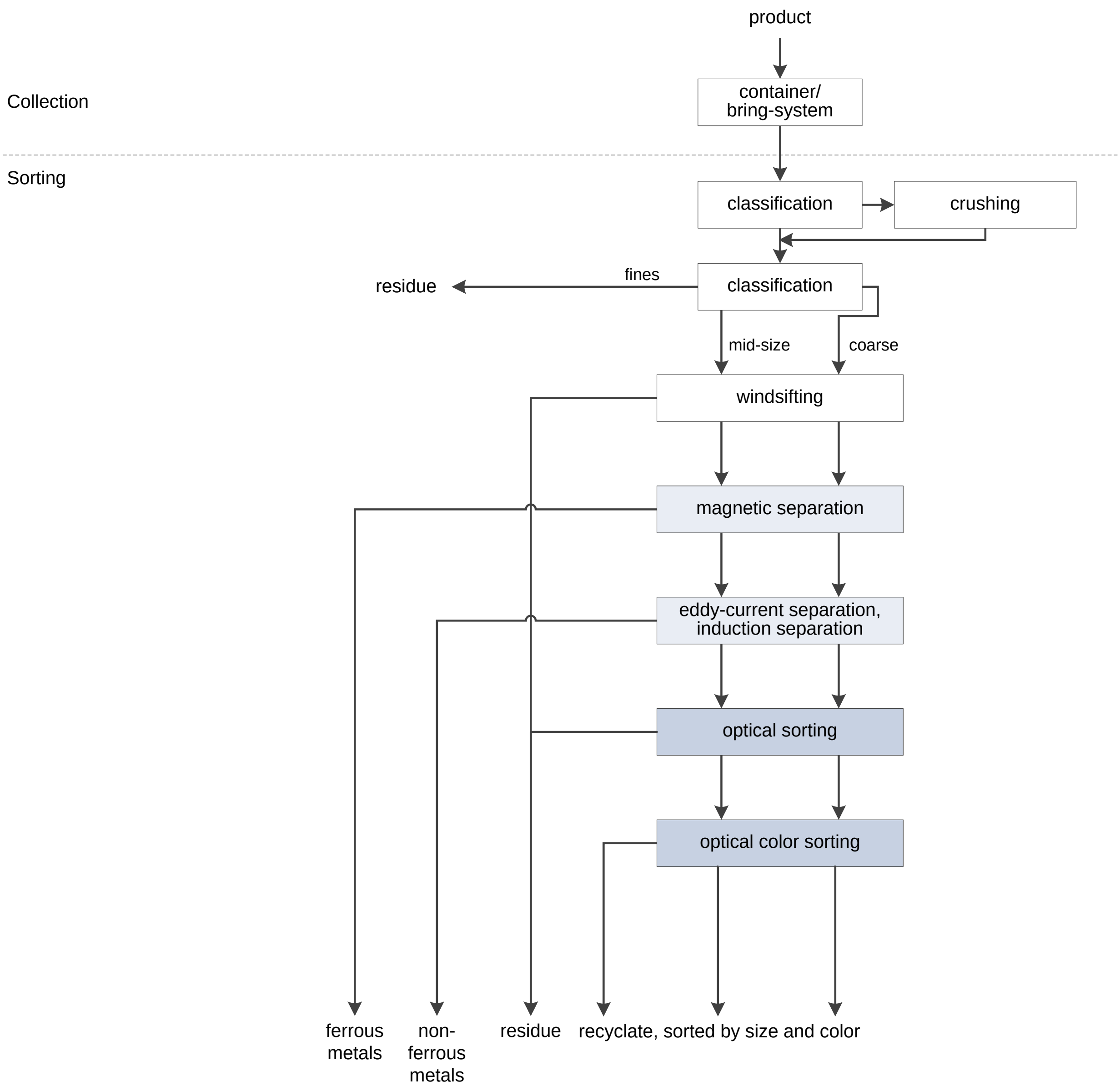
In Germany, paper and cardboard packaging composites are collected together with lightweight packaging and, during the sorting, are apportioned primarily to the sorting fraction "Paper and cardboard from Lightweight Packaging" (fraction number 550).

When evaluating composite packaging on a paper base, it must be taken into account that the secondary material (for example, the tinplate of a composite can, the aluminum foil of a soup bag, etc.) can be dominant in the sorting process and thus force an allocation to recycling paths meant for other material.

The generation of the fraction "Paper and cardboard from Lightweight Packaging" takes place via NIR separation, so that identifiability in the NIR reflection spectrum is required for a determination via recycling path 11. The recyclable fraction in a more narrow sense is, for this recycling path, the fiber fraction; other components are separated as reject. The treatment is carried out in specialized (certified) waste paper processing lines analogous to recycling path 8, i.e. with significantly longer pulping times than in recycling path 13.

4.2.12 Recycling path 12: Glass

Reference scenario recyclability, glass (dated 02/2013)



Process steps, specific with no relevance

Process steps to be considered in individual cases

Process steps, significant

4. Appendices

Collection structures for glass can be assumed in the following countries without further assessment:

- European Union
- Switzerland

Glass is typically collected separately as a mono-flow and processed further in specialized plants.

The block flow diagram in the following figure illustrates schematically the process of a state-of-the-art glass recycling plant. The figure also gives what products can result from such a plant. The exact characterizations and descriptions can be found in the guideline "Quality requirements for glass fragments for use in the glass-container industry" (T120).

Today's existing facilities have only partially incorporated all of the elements necessary to make them state-of-the-art. In the basic procedure, however, standardisation has been reached. This results from the fact that the nationwide collection scheme for glass is largely uniform, and uniform requirements are also placed on the sorted products.

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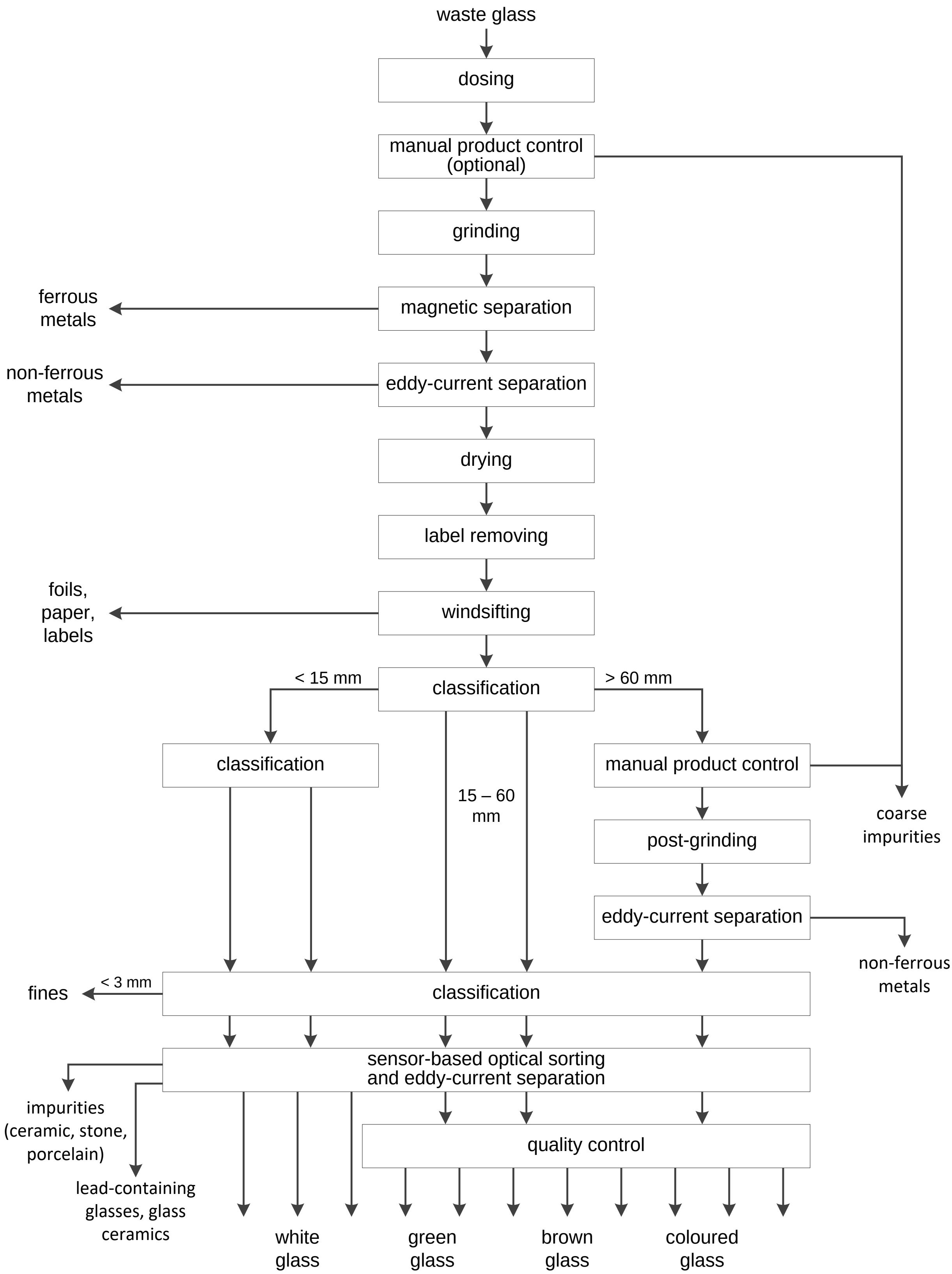


Figure 4: Schematic representation of a state-of-the-art recovered glass processing plant

During plant operating times, both the intermediate storage and the feeding of material into the process are carried out mainly by means of wheel loaders. An even volume flow is decisive for optimum function of the downstream process stages. Therefore, the feeding of the plant takes place via a dosing feeder.

Many processing plants initially carry the input mass flow via a small sorting cabin with one or two sorting workstations. If necessary, coarse impurities materials can be removed from the material flow before the first process stage. This generally serves to protect the subsequent aggregates.

In order to achieve a more uniform grain size distribution, the material stream is ground to a grain size of 10 to 60 mm. Current standards call for impact mills and roll crushers to be used for this purpose. It is important that as little fine grain as possible is produced during the grinding process, since an excessively fine fraction of grain adversely affects subsequent sorting stages.

When choosing the crushing unit, it is also important to ensure that the thick bottoms and necks of bottles, such as those with cork stoppers, are crushed reliably to flat glass shards in order to achieve an optimum size for subsequent process steps.

In general, a second grinding stage is used after a grading of the material flow has taken place. The coarse grain > 60 mm is also ground by means of impact mills or roll crushers and then fed to a new grading stage.

For the separation of all ferromagnetic materials (mainly caps made of tinplate), suspension magnets are used. These separators are installed in a transfer point and the feed belt is designed to be regulated and fast-running in order to minimize misplaced material resulting from the overlapping of particular items. Splitters are designed as rollers that rotate against the conveying direction. In this way, the purity of the metal product can be optimized and clogging can be avoided.

Glass fragments often have a high proportion of labels and coating residues made of paper, metal and plastics. In the optical sorting stage, this can lead to false sorted material, which can then reduce the quality of the final product and cause a loss of glass product.

In label removers, wear-resistant conveyor paddles create a compressed but gentle friction between the glass shards. Speed-regulated drives, adjustable conveying slopes, and conveyor lengths can be used to optimize operating times and thus ensure the full abrasion of unwanted coatings.

Paper fibers, plastic foil, dried food residues and similar light impurities not only reduce the product quality, but also interfere with subsequent sorting stages. In order to remove these contaminants from the material flow, direct or cross-flow wind sifters are used.

4. Appendices

The grain size range is the deciding factor for sorting results in subsequent sorting stages. The material flow is divided into different grain size ranges by means of vibration or flip-flow screens. Generally, several screens are installed one behind the other.

An initial screen separation stage is a proven first step, and causes the material flow to be graded into the grain size fractions 0 mm to 15 mm, 15 mm to 60 mm and > 60 mm. The fraction 0 mm to 15 mm is then subdivided once again into the grain size fractions 0 mm to 3 mm and 3 mm to 15 mm.

All grain size fractions are separately fed to a further grading step before the subsequent optical sorting. The remaining fine grain < 3 mm is then screened out, as it can significantly interfere with the sensitive sensor-based sorting steps.

The coarse grain > 60 mm is often passed through a sorting cabin after the first screening stage. Any remaining extraneous material can then be sorted out of the material flow by hand. Although this sorting station is installed in most state-of-the-art plants, it is usually occupied only when required.

Non-ferromagnetic separators are used for the separation of metallic, non-ferromagnetic components since these can cause undesired discoloration in glass production and can adversely affect quality. Eddy current separation is generally used for the separation of non-ferrous metals.

In addition to eddy current separators, sensor-based sorting units are also used during glass separation for the separating out of non-ferrous metals from the material flow. These units are capable of recognizing metal objects in the material flow starting from a size of 1 mm and, once identified, separate these items by compressed air from the material flow.

For the sorting of shards by color, but also for the sorting of contaminants and heat-resistant glass, ceramics and glass with a high heavy metal content (e.g., lead glass), sensor-assisted sorting units are used in all state-of-the-art systems. In the ultraviolet and visible wavelength range of the light, these detect each shard in the material flow, which is led past detector units along a conveyor trough. The heat-resistant and lead-containing glass is identified by UV sensors and RGB camera systems or X-ray detectors. Within milliseconds, all detected information is evaluated so that, at the end of the conveyor trough, pressure air sensors can clear the identified extraneous material with a jet of air.

Stringent requirements are placed on glass as secondary feedstock, and so regular quality control in modern processing plants is now a necessary part of any state-of-the-art system. Sample quantities for testing can be taken manually. Automatic systems extract, weigh, archive, and evaluate collected data from all process steps independently, thus enabling continuous system and quality monitoring.

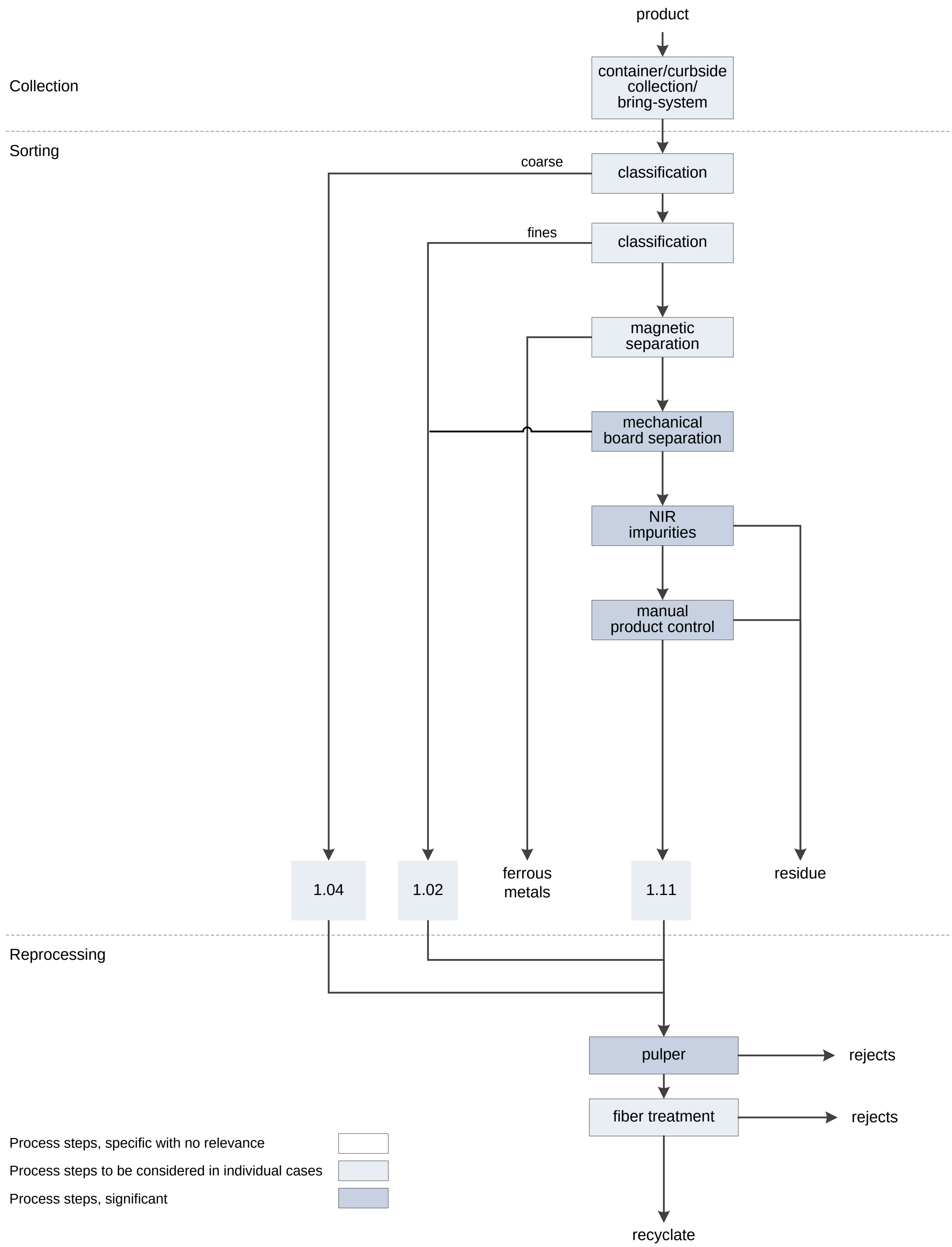
The processed shards are delivered to glass works, where remelting to new container glass takes place. The metal fractions obtained are fed into the metal recycling process. Other separated impurities including special-purpose glass are currently not recycled.

To assess recyclability, the following process technology is usually required:

- High-resolution color detection for glass and ceramics, stone and porcelain with a grain size > 2 mm

4.2.13 Recycling path 13: Paper, cardboard

Reference scenario recyclability, paper and cardboard (dated 02/2013)



Collection structures for paper cardboard are already available in the following countries:

- European Union
- Switzerland

Paper and cardboard are usually collected as a mono-flow separately from other materials. The exception is in France, where packaging paper often is collected in a mixed system (with cans and plastic packaging).

The following figure illustrates schematically the process of a state-of-the art paper sorting system.

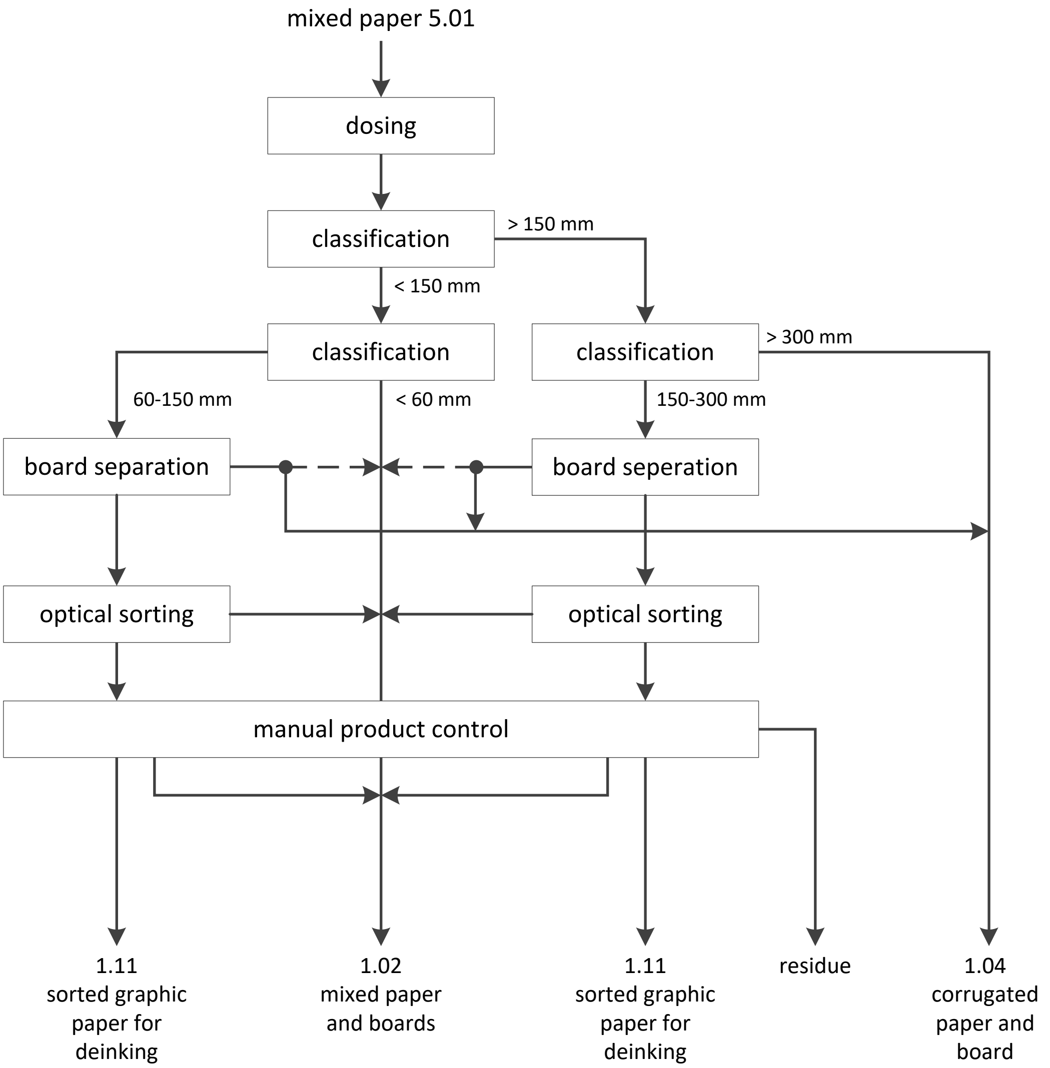


Figure 5: Schematic illustration of a state-of-the-art paper/cardboard sorting system

The figure also shows the common products of a waste paper sorting system. The exact characterizations and descriptions can be found in the "European list of standard grades of paper and board for recycling" (DIN EN 643).

During plant operation, both intermediate storage and the loading of material into the system is carried out by means of wheel loaders. An even volume flow is crucial for optimal utilization of the subsequent process stages. Therefore, the feeding of input material into the system is generally carried out by a dosing feeder, which also slightly loosens the waste paper.

Various types of flat sieves are used in paper sorting systems. Disc screens, star screens, flat screens, roller screens and ballistic separators have proven their worth for these types of applications.

In the initial grading stage, the material flow is divided with a flat sieve. The oversized grain (> 150 mm) made up mainly of large cardboard is fed to a further grading stage with a large screen mesh size. In the overflow, the large (> approx. 300 mm) and stiff cardboard (1.04: corrugated paper and board packaging) are sorted out. This fraction is subsequently placed in a hopper and pressed into bales before loading.

The smaller-sized grain (<150 mm) is also fed into another stage following the first grading stage in order to separate the grain fraction < 60 mm. This material flow (1.02: mixed papers and boards) consists predominantly of smaller paper and cardboard fragments of different paper grades, but also slightly from minor contaminants, such as, for example, glass flakes, paper clips, stones, corks and dust. This fraction can neither be sorted manually nor by means of optical sorting stages and degrades the desired quality of the final product of the deinking material. This product fraction (1.02) is also generally compressed after an intermediate storage stage in a hopper or box before loading.

After the grading stages, the material flows of 150 mm to 300 mm and 60 mm to 150 mm are fed in parallel to further process steps. The separating sections of the grading stages and the number of subsequent parallel sorting lines depend on the capacity of the overall system.

In order to remove the cardboard and cartons still contained in the two material flows, so-called cardboard spikes are used. Paper and cardboard is impaled on belts embedded with nails. Flexible paper is not caught by the nails. At the end of the conveyor belt, the impaled cardboard and cartons are loosened and taken separately from the main paper flow.

The sorted cardboard and cartons are fed either to the corrugated paper and board packaging fraction (1.04) or the mixed papers and boards fraction (1.02).

The material flow of both processing lines which have now been largely freed from cardboard and cartons is then purged of further quality-reducing contaminants by means of sensor-assisted sorting units. The material flow is optimally distributed and separated on the acceleration belts so that the sensor units can detect the near-infrared and visible light wavelength range of each object.

Instantly, the detector unit evaluates the information and passes the command to further separate the localized unwanted components and contaminants from the material flow by means of precise compressed air bursts at the end of the conveyor belt. This separated fraction is also fed to the mixed papers and boards fraction (1.02).

The subsequent material flows are transported to a sorting cabin for quality control. Here, unwanted paper and cardboard components, papers of poor quality, dyed papers, as well as impurities of all kinds can be sorted out. The separated components are either fed to the mixed papers and boards fraction (1.02) or to a separate contaminant/rejects container.

After inspection by the sorting staff, there is left only a high-quality deinking waste paper grade (1.11: sorted graphic paper for deinking) on the conveyor belts. This is stored in hoppers or boxes and generally compressed before loading. Loose loading is also possible.

The individual varieties are sold to paper factories in which wet treatment is carried out. In contrast to recycling path 8, for varieties made from mixed waste paper, pulping is carried out with clearly lower processing times so that heavy-suspended or wet-strength materials are rejected from the fraction.

For France, it should be noted that for the processing of the packaging fraction sorted from the mixed collection, longer pulping times (15 min.) are applied.

To assess recyclability, the following process technology is usually required:

- Mechanic cardboard separation
- Automatic sorting of contaminants
- Manual sorting of contaminants
- Material dissolving solution with sufficient dwell time (mixed paper and boards, type 1.02)
- Separation of insoluble components by classification

4.3 Basic data form

Address

(for certificate)

Article designation:

Article no.:

1. Basic components

What specific basic components is the product made of (e.g. thermoformed tray and sealing foil or cup, sealing foil and cover)?

Basic component	Description	Individual weight in g or relative proportion of the entire product in %	Special features:
Comp.0 (example)	Thermoformed tray	23 g (78%)	-
Comp.0 (example)	Cap, Lid	8 g (22%)	filled (chalk)
Comp.1			
Comp.2			
Comp.3			
Comp.4			

2. Materials and substances

What individual components do the specific basic components consist of (specification of all layers including coupling agent, adhesive, paint, coating, printing, etc. For plastics, please specify the precise type, e.g., PET-A, PE-HD, etc.). For adhesive, additives, printing colors etc., please enclose the safety data sheets.

Comp.0 (example)	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features** (for adhesives, please specify information on water-solubility)
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	
	1	PE	20.0 g		22.0 µm	
	2	Coupling agent	2.0 g		2.0 µm	
	3	EVOH	4.8 g		4.0 µm	
	4	Coupling agent	2.0 g		2.0 µm	
	5	PE	22.0 g		22.0 µm	
	6					
	7					
	8					
	9					
	10					

Comp.0 (example)	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features** (for adhesives, please specify information on water-solubility)
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	
	1	PET	12.0 g / m²		11.0 µm	
	2	Printing color	1.0 g / m²		1.0 µm	
	3	Adhesive	3.0 g / m²		3.0 µm	
	4	Aluminium	20.0 g / m²		7.0 µm	
	5	Adhesive	3.0 g / m²		3.0 µm	
	6	Print	0.02 g / m²		0.02 µm	
	7	PP	45.0 g / m²		50.0 µm	filled
	8					
	9					
	10					

4. Appendices

Comp.1	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features**
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	(for adhesives, please specify information on water-solubility)
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

Comp.2	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features**
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	(for adhesives, please specify information on water-solubility)
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

4. Appendices

Comp.3	Layer / subcomponent		Proportion of the basic component (please complete at least 2 of the 3 columns)			Special features (for adhesives, please specify information on water-solubility)
	Material / substance specification		Weight or surface weight	Density	Layer thickness	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

Comp.4	Layer / subcomponent		Proportion of the basic component (please complete at least 2 of the 3 columns)			Special features (for adhesives, please specify information on water-solubility)
	Material / substance specification		Weight or surface weight	Density	Layer thickness	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

4. Appendices

Comp.5	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features** (for adhesives, please specify information on water-solubility)
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

Comp.6	**Layer / subcomponent**		**Proportion of the basic component (please complete at least 2 of the 3 columns)**			**Special features** (for adhesives, please specify information on water-solubility)
	Material / substance specification		**Weight or surface weight**	**Density**	**Layer thickness**	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

3. Connections of basic components

Basic component no.			**Type of connection (mechanical, fully glued, selectively glued, cladding, laminated, etc.)**	**For adhesives: Water-soluble?**
1	and	2	Selectively glued	No
2	and	3	Mechanical, dispersible	

4. Paper and cardboard containing packaging

Are water-resistant paper cardboard parts included?

If yes, in which subcomponents / layers?

5. Printing colors

Are printing colors or raw materials of the EuPIA exclusion list applied?

If yes, in which basic components?

6. Additives, fillings, barrier layers

If not already provided under no. 2, specify in the following information on additives and barrier layers with reference to the individual components, if applicable.

___

___

___

___

___

Samples

☐ The following number of product samples in enclosed (usually 10) ____

Safety data sheets for the following materials, components enclosed / are subsequently provided

___

___

___

___

___

Certificate

☐ German

☐ English

Contact

If you have questions or require additional information, please contact

Name: ____________________

Contact information: ____________________

____

____

4.4 Certificate template

CERTIFICATE

Recyclability of Packaging

PRINCIPAL
Sample Street 1
D-00000 Sampletown

The company receives the certification of recyclability for the following packaging.

Designation

Packaging designation (Article No. XXXXXXXX)

Test result

Allocation to path/specification:	**Sample Type A, Fraction No. 000** **Sample Type B, Fraction No. 001**
Recycling path:	**Sample Type A, Fraction No. 000** **Sample Type B, Fraction No. 001**
Recyclate (final product):	**e.g. XX-regranulate**

Test standard/scope of application: Catalogue of requirements and assessment of the institute cyclos-HTP (state of XX.XX.XXXX)

In accordance with the test results and the examination document the recyclable percentage of the packaging amounts to:

XX %

This certificate (No. XXX) is valid until the **XX.XX.XXXX** (2 years upon issue). The certificate will lose its validity in case of qualitative or quantitative changes of packaging components.

Place, the XX.XX.XXXX

....
NAME
Publicly appointed and sworn expert of the IHK for packaging waste disposal
Competent authority: IHK Aachen

This certificate (No. XXX) is only valid in conjunction with 3 pages of the related assessment report.

Institute cyclos / HTP

Institute cyclos-HTP GmbH
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Fax: +49 (0) 241 / 949 00-49