FIBRE-BASED PACKAGING RECYCLABILITY EVALUATION PROTOCOL

BETA RELEASE
DECEMBER 2022

4ever green

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1. Executive summary

4evergreen strives to increase the recycling rate of fibre-based packaging to 90% by 2030. In order to support this mission, 4evergreen issues factual guidelines and technical documents alongside efforts aimed at facilitating dialogue and consensus-building among more than 100 stakeholders belonging to the fibre-based packaging value chain. 4evergreen has already published a "Circularity by Design Guideline" and a "Guidance on the Improved Collection and Sorting for Fibre-based Packaging." These guides support the design of packaging destined to achieve the best possible 'circularity performance'. This document is an evaluation protocol that in its current version helps to assess the recyclability of individual packaging and/or materials in standard recycling mill (Part I). It is based on expert opinion and consensus-building, and utilises a vast amount of data from actual recycling tests. This data was reprocessed and calibrated to create the most up-to-date scoring for recyclability of fibre-based packaging. This document covers the evaluation protocol in a 'beta' version relevant to standard recycling mills. Later iterations of this document will include an upgraded version of the Part I assessment, including recyclability evaluations covering other mill types. Nevertheless, this protocol is ready to be used by industrial stakeholders as a preliminary tool for the evaluation of the recyclability within standard recycling mills until the next version of this document is published.

2. Scope of the document

This document describes the assessment procedure and score calculation of the recyclability of individual fibre-based packaging items and/or materials.

- Part I assessment is specific to the recycling process at standard recycling mills and assesses the results of the CEPI recyclability laboratory test method[1]
- Part II (flotation-deinking mill) assessment will be completed in further version(s) of this document
- Part III (specialised recycling mill) assessment will be completed in further version(s) of this document

The evaluation protocol focuses on the recyclability of a fibre-based packaging without considering sorting, collection or the effects of recycling various packaging items together.

[1] Harmonised European laboratory test method to generate parameters enabling the assessment of the recyclability of paper and board products in standard paper and board recycling mills, Short title: CEPI recyclability laboratory test method, Version 2, October 2022

3. General introduction

Consumers are increasingly aware of the environment and the importance of eco-design and recycling in both the goods they purchase and the way they are packaged. Brands and retailers are under pressure to respond to these market expectations. Fibre-based packaging is both a sustainable and 'circular' solution – closing the loop on resources to keep them in use or reuse longer – because it is based on renewable material and has one of the highest recycling rates among all packaging types globally.

Packaging needs to fulfil various functions, such as protecting the contents, communicating information about the products, and facilitating their transportation. Using fibre-based packaging to achieve these different properties may require a combination of materials. The right combination of materials enables benefits such as longer shelf-life, i.e. lower food waste, and more protection against external damage.

While the Circularity by Design guideline published by 4evergreen provide recommendations for the design of fibre-based packaging and address the entire value chain – from manufacturers to retailers, brand owners, product designers and material suppliers – this document enables the harmonised assessment of recyclability as potentially affected by all components of fibre-based packaging. This protocol evaluates the recyclability only by considering if a fibre-based package can be technically recycled applying dedicated repulping and recycling process conditions. The recyclability is assessed typically by applying a defined lab procedure (i.e. Part I, II, III); it does not consider collection and sorting aspects. Recyclability at scale (as defined in ISO 14021) does, however, include aspects of collection and sorting in individual markets – i.e. whether packaging is collected, sorted (where applicable) and finally recycled in a paper or board mill.

Due to the wide variety of fibre-based packaging solutions, adaptations in the recycling processes may be needed to increase the rate of material recovery. Indeed, the amount and variety of fibre-based packaging on the market is continuously growing and becoming more complex. Innovative solutions in the entire value chain are therefore needed to maintain and further increase the recycling rates across Europe.

This document, a beta version of the Evaluation Protocol focusing on the assessment of recyclability in standard recycling mills (Part I), has been developed by the 4evergreen alliance, involving packaging and sustainability experts of companies acting across the entire fibre-based packaging supply and value chain. The primary purpose of this Evaluation Protocol is thus to enable a harmonised, objective assessment and comparison of different fibre-based packaging solutions' suitability for efficient recycling. While the current version only covers the assessment of recyclability using standard mill technologies, future versions currently being developed within the 4evergreen alliance will also include suitability assessments for other processes using different or more advanced recycling mill technologies. Part II is earmarked to cover flotation-deinking mills and Part III will cover specialised recycling mills.

This current beta version of the Evaluation Protocol references the harmonised CEPI recyclability laboratory test method (i.e. 'ref to the standard') describing standardise test procedure that mimics a standard recycling mill setup and resulting data set. In the next version, references to other standardised test methods currently being developed by 4evergreen (Part II – flotation-deinking mill and Part III – specialised mill) will be added.

The data set provided by the test protocol comprises individual parameters, i.e. measurements or baselines for the assessment using this protocol. Part I of the Evaluation Protocol uses data and specific thresholds and limits weighted to reflect what can be recycled using a standard mill technology setup. There are various degrees of complex packaging materials and solutions. This Evaluation Protocol has been elaborated in such a way that there is an acceptable balance between efficiency and quality when the packaging is processed in a recycling mill. This is taking the efficiency of the fibrous material recovery and quality parameters into account.

Any fibre-based packaging assessed as unsuitable for standard recycling mills (i.e. Evaluation Protocol Part I) can potentially be recycled in flotation-deinking mills (Part II), specialised recycling mills (Part III), or even mills that have slightly adapted their process in order to recycle certain types of packaging. Thus, it does not mean that any negative assessment for a fibre-based packaging solution applying the test and evaluation protocol for a standard mill suggests that the packaging is not recyclable at all.

4. Release schedule

The Fibre-based Packaging Recyclability Evaluation Protocol described in this document was developed within the scope of 4evergreen's Workstream 1 – a standing committee set up for an unlimited duration with the objective of delivering a harmonised and publicly available protocol. Over the course of its existence, experts across the entire value chain have collaborated intensely to create a consensus-based protocol with the aim of achieving both broad acceptance and timely delivery, an agile response to the urgent calls within the market for a harmonised recyclability assessment across Europe.

This document aims to provide a solid baseline, thoroughly scrutinised by experts and thus offering immediate value for all stakeholders, and upon which further iterations can expand and improve. This initial version is therefore transparently called a 'beta' to send a clear message to users that the 4evergreen forum has the ambition to make further adaptations and improvements in the future. While this Beta Release is the outcome of a collaboration and consensus building process between more than 75 4evergreen member organisations, the aim is to collect further feedback once the entire value chain starts applying the protocol to various fibre-based packaging items and scenarios. Any feedback is therefore welcome to be shared at 4evergreenalliance@gmail.com and will be considered for future versions.

This beta version of the Recyclability Evaluation Protocol focuses mainly on the evaluation for standard recycling mills (Part I), but also gives a short description of the other available recycling processes: flotation-deinking mills (Part II) and specialised recycling mills (Part III). Future versions of this document due for release in the latter half of 2023 will include an evaluation of the suitability for these processes and others currently being developed within the 4evergreen alliance.

During the consensus-building process, several topics were identified by the experts as key questions warranting further investigation, though not fundamentally undermining the utility of this initial release. These topics have been flagged in an internal 4evergreen development roadmap as potential additions in future revisions. Some of these parked topics include the potential integration of longer pulping times, dissolved and colloidal solids, macro-sticky analysis, reject quality evaluation, stream-specific evaluation, etc.

The 4evergreen alliance has the intention to keep this document up to date and relevant to the industrial reality by considering the need for a yearly revision of the Fibre-based Packaging Recyclability Evaluation Protocol, while simultaneously providing and considering feedback on the underlying laboratory methodologies.

5. Methodology of the evaluation

The fibre-based packaging Recyclability Evaluation Protocol assess the recyclability of a fibre-based packaging product if processed by a specific type of recycling mill. Three types of mills are described: a standard recycling mill (Part I), a flotation-deinking recycling mill (Part II), and a specialised recycling mill (Part III). Depending on which mill is considered for the assessment, the test method needs to be adapted.

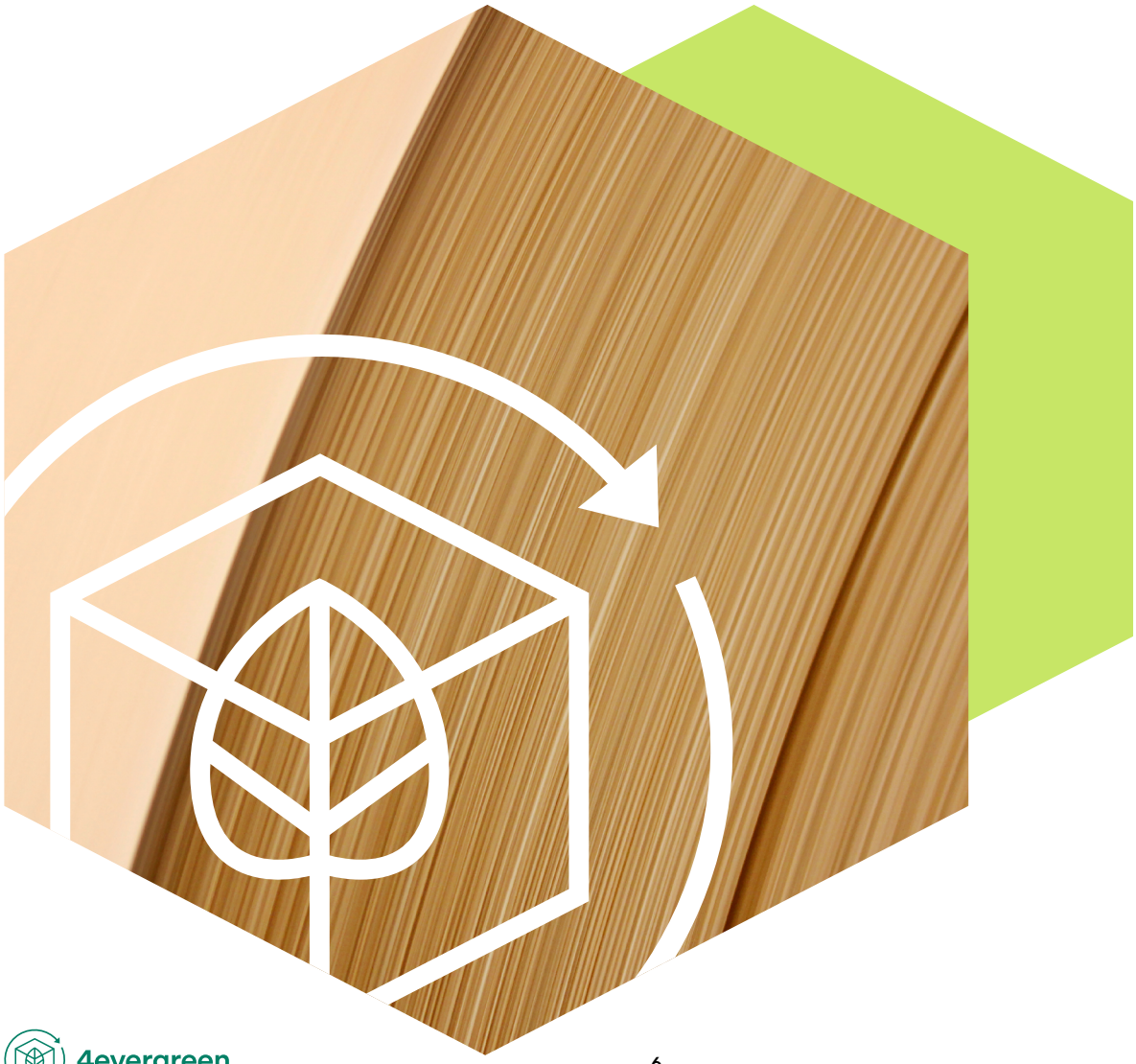
The evaluation of a packaging product in a certain mill type is performed in two steps:

> **Step 1:** Laboratory testing according to the protocol for the chosen recycling mill type.
For a standard recycling mill this is the CEPI recyclability laboratory test method.

> **Step 2:** The results of Step 1 are put into the Evaluation Protocol scorecard and the recyclability score is calculated.

It is important to note that a negative assessment reported for one mill type does not exclude further testing to be performed for another mill type. Recyclability scores derived for one mill type cannot be transferred to other mill types.

Scores range from +100 to -100 points, where the higher numbers indicate better recyclability. The final score result is also placed in several classes to clarify the interpretation of the score. A negative score means the assessed product is not suitable for that mill type only.



6. PART I > Standard Recycling mill

MILL DESCRIPTION

Standard mills typically utilise paper for recycling belonging to the EN 643 grades 1-4.

The standard fibre-based packaging recycling process includes the following steps:

(RE)PULPING

The purpose of repulping is to break down the paper into fibres and other paper components (fillers, inks, varnishes, coatings, etc.). In this step, the paper for recycling is mixed with warm water (35-50°C) of pH 6-8. Standard mills typically operate a low-consistency pulper (4-5% fibre concentration) in continuous mode. Batch pulping may also be used but is less common in the industry. Average retention time in the pulper is 5-10 minutes.

COARSE AND FINE SCREENING

Screening is the process of removing impurities from the pulp, to separate the fibres from contaminants. It is based on particle size and shape difference between fibre and non-fibre components or non-fully dispersed fibre flakes. It can be divided into coarse and fine screening. Coarse screening (often combined with de-flaking) is performed after the pulping step at a medium concentration (2.5-4.0%). The fibre suspension flows through screening holes where large contaminants are retained (holes and slots typically ranging from 2 to 10mm) while fibres can flow through freely. The objective of the fine screening is to remove smaller-sized particles (e.g. adhesives, smaller particles) from the stock. Fine screening is generally done at medium or low concentration (1-2.5%) through slotted baskets (typical slot size 0.15-0.4mm). Screening is often operated in cascaded systems and the recycling mill may have one or more steps of coarse and fine screening in accordance with the process efficiency and target quality of recycled paper.

CLEANING

After pulping, the fibre slurry can be fed into hydro-cyclones to separate impurities that have different densities from fibres. In general, standard mills have higher concentration (3-4%) hydro-cyclones to separate the bigger, heavier contaminants such as staples and small stones. Heavy contaminants of a smaller size (e.g. sand) are taken out by low-concentration hydro-cyclones (0.5-1.5%). In many cases the low-density debris (e.g. expanded polystyrene) are also separated in these hydro-cyclones.

PAPERMAKING

After the screening and cleaning steps, the recovered pulp is mixed with additives to form a papermaking furnish which is fed into a paper machine to produce recycled paper.

NOTE: The above equipment types were included in the lab-scale recyclability test scenario based on their prevalence in European standard mills, according to expert knowledge and data from CEPI – other processes/equipment types, such as de-flaking, are known to be used in specific mills or regions.

LABORATORY TEST METHOD

CEPI's Recyclability Laboratory Test Method (Version 2) applies: *"Harmonised European laboratory test method to generate parameters enabling the assessment of the recyclability of paper and board products in standard paper and board recycling mills."*

This was developed with feedback from 4evergreen to improve the reproducibility and repeatability of the method through detailed descriptions and fine-tuning of the procedures. It defines a laboratory procedure emulating the most relevant process stages (pulping, coarse and fine screening, sheet formation) of a standard recycling paper mill dedicated to recycling the most common standard grades of paper and board without deinking technology or other special features. While relevant, the hydro-cyclone cleaning step is not included in the test method due to lack of suitable equipment in most European labs and might be addressed in future version of the Cepi Recycling Laboratory Test Method.
The testing method provides results relevant to 'process efficiency' (yield, coarse and fine reject counts) as well as to recycled paper quality (visual impurities and sheet adhesion). These results serve as a basis for assessments under Part I of Evaluation Protocol described in this document.

To support the CEPI recyclability laboratory test method several annexes are available:

(a) Flowchart for the recycling test
(b) Description of the plate for evaluating coarse rejects
(c) Decision tree for evaluating the visual appearance
(d) Description of optional thickener
(e) Sheet adhesion test reference pictures of the carrier board, hand sheets and cover sheet
(f) Technical data sheet
(g) Laboratory report template
(h) Detailed work description

RECYCLABILITY SCORE

OUTPUT VALUES OF THE LABORATORY TEST METHOD

In order to calculate the recyclability score, several output values of the lab test are considered. Table 1 shows the output values currently being considered. A detailed explanation of how these values are obtained can be found in the description of the test method.

In addition to the parameters shown in Table 1, other relevant factors have been considered but not yet included in this beta version. Additional parameters (shown in Table 2) might be incorporated in future versions of the recyclability evaluation protocol according to release schedules.

Acronym	Full name	Meaning
CR	Coarse Reject	Mass weight percent of components of packaging material retained on a coarse screen after repulping
FR	Fine Reject	Mass weight percent of components of packaging material retained on a fine screen after repulping and coarse screening
VI	Visual Impurities	An evaluation of the optical purity of the paper. This parameter is evaluated on a hand sheet from the accept fine screening.
SA	Sheet Adhesion	An evaluation of the tackiness of a handsheet from the accept of fine screening.

Table 1. Parameters used for recyclability score calculation

Acronym	Full name	Meaning
DCS	Dissolved and Colloidal Solids	Components that are retained in process water and do not contribute to yield or reject
MSA	Macro Sticky Area	Quantitative assessment of the amount of tacky components originating from paper for recycling which can be analysed from the residues of a laboratory screening
RQ	Reject Quality	Indication for reprocessability of rejects into usable materials/products or potential additional fibre recovery

Table 2. Parameters currently not yet used for recyclability score calculation

SCORE CALCULATION

In order to translate the output values into one final score, the sum of three components is considered: yield, visual impurities and sheet adhesion.

The yield score assesses the amount of fibrous material that can be retrieved from the fibre-based packaging. The visual impurities score assesses the optical quality of the pulp obtained. The sheet adhesion score assesses the potential to form tacky impurities that are detrimental to the paper production process.

For the sheet adhesion parameter a 'knockout' is issued, this means that one result can indicate the packaging product is not recyclable in a standard mill irrespective of the other output scores. Minor adhesion issues (level 2 in CEPI test method) do not have impact on the overall score.

Yield score

The total reject (TR) is calculated according to the method in Equation 1. The total reject measures how much material is screened and approximates the total mass of the packaging product as a percentage that will not be recycled. All terms used in Equation 1 can be found in Table 1 except for α which is a correction factor used to mitigate the impact of errors commonly observed when assessing fine rejects at the lab scale. The value of α is set to *0.9* based on expert consensus. The constant value of α might be changed into a variable taking the fine reject composition into account in future versions.

EQUATION 1

$$TR = CR + FR * \alpha$$

where

- TR is the Total Reject (%);
- CR is the Coarse Reject rate (%);
- FR is the Fine Reject rate (%);
- α is the correction factor.

Complementary to the total reject (TR) is the yield, which defines the percentage of material mass that can be reused in a new fibre product. The calculation is shown in Equation 2.

EQUATION 2

$$Y = 100\% - TR$$

where

- Y is the Yield as mass percentage of material that can be reused (%);
- TR is the Total Reject (%).

For a standard recycling mill striving for high yield, total reject amounts need to be kept to a minimum. This has clear financial, technical and ecological benefits as well and is reflected in the number of points allocated. The calculation for the yield score is shown in Table 3 and is divided into four intervals or ranges. Each indicates an increasing loss of points as the yield is lower and less material can be recovered. A value of 0 is reached at 80% yield or 20% total reject. A visual representation of the yield score intervals as a function of yield is shown in Figure 1. As fewer points are lost when reject amounts are lower, a greater error % on the results in lower ranges ensures the scoring is still reliable.

Yield (%)	Total Reject (%)	Yield score calculation	Yield Score
≥95	<5	Score = 100 – TR * 2	100...90
95...85	5...15	Score = 90 – (TR – 5) * 4.5	90...45
85...80	15...20	Score = 45 – (TR – 15) * 9	45...0
<80	>20	Score = 45 – (TR – 15) * 9	0...-100

Table 3. Overview of the yield scoring calculation within each interval/range and total reject (the score at the edge of each interval is indicated)

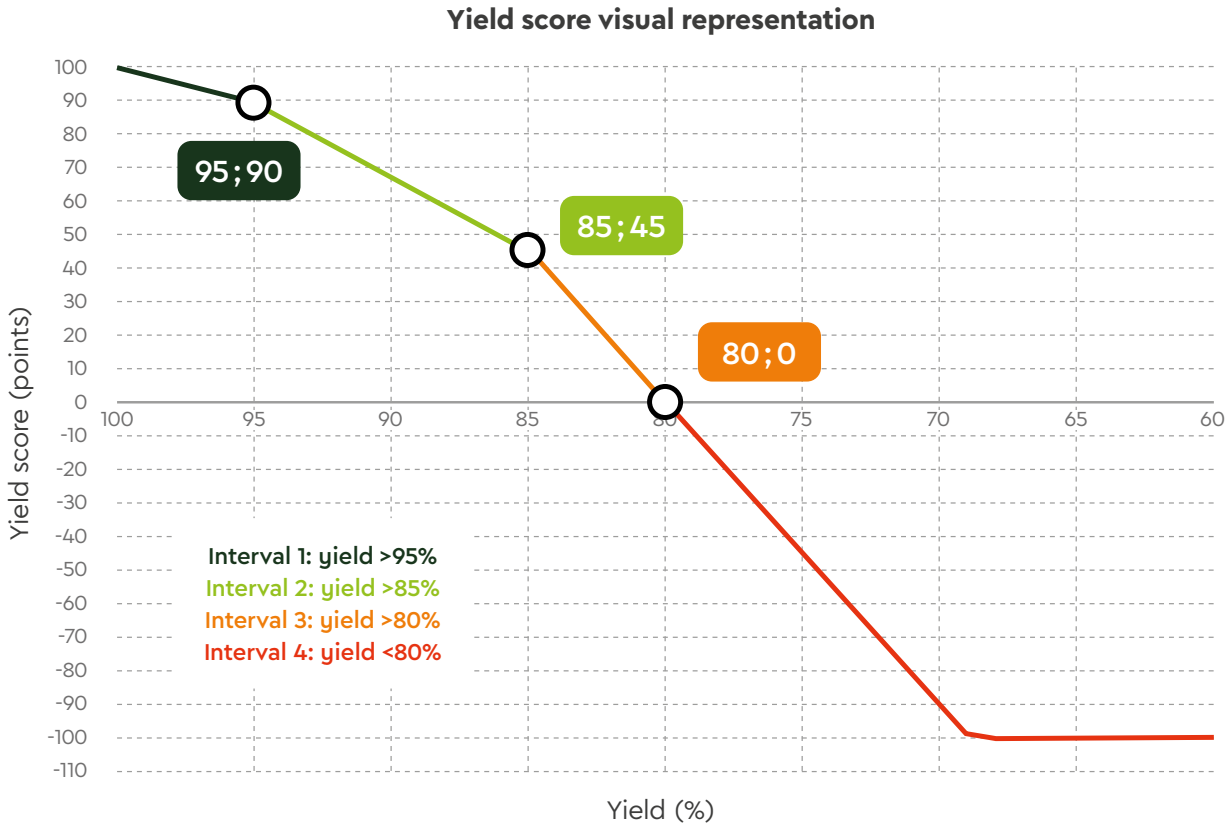
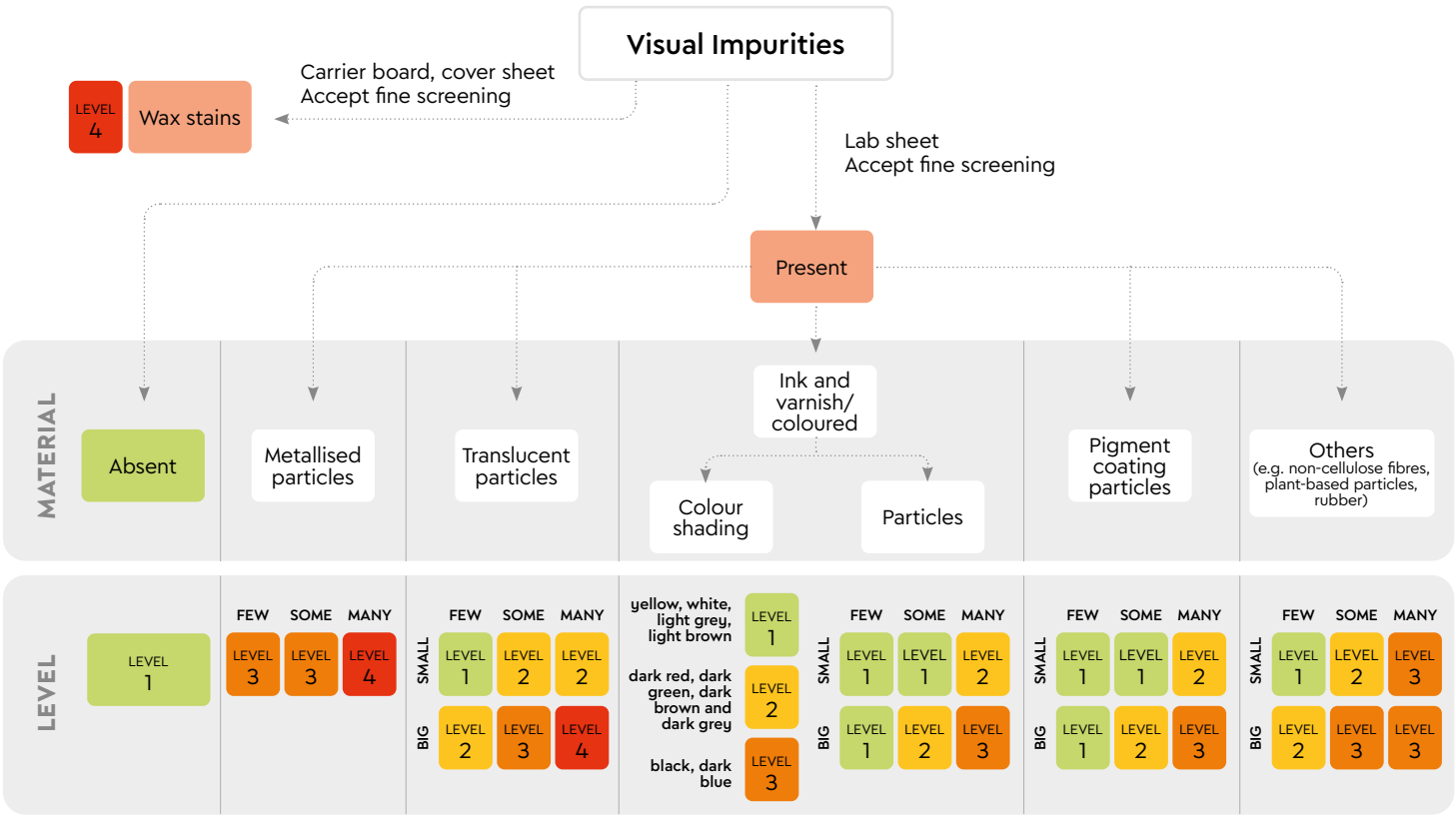


Figure 1. Visual representation of the yield score as function of yield showing the different intervals.

Visual impurity score

For the visual impurities, a qualitative and quantitative evaluation is described in the CEPI Recyclability Laboratory Test Method. The method uses a decision tree (Figure 2) to convert this assessment into a level from 1 to 4. Each level defines a range of visual impurities observed in the pulp, where level 1 is considered to have no visual quality issues and level 4 shows significant issues impacting the optical quality of the pulp.



NOTE: All applicable columns should be evaluated. Worst case level allocation applies.

LEVEL 1 No visual quality issues
LEVEL 2 Minor visual quality issues
LEVEL 3 Some visual quality issues
LEVEL 4 Significant visual quality issues

Visual impurities per hand sheet

Amount	**Few**	**Some**	**Many**
	<10	10 - 100	>100
Size	**Small**	**Big**	**Combination**
	<1 mm	>=1 mm	Consider the worst case level

Figure 2. Decision tree to evaluate the level of the visual impurities.

The four different levels are converted to a visual impurity score, as outlined in Table 4. Note that points cannot be earned but they can only be lost. Specific attention should be given to level 4 as this indicates a severe deterioration in the visual quality of the pulp and results in a significant loss of points. Level 4 is also considered to become a potential 'knockout' for future versions unless otherwise proven during pilot-scale testing. To reflect this severity, a warning statement is given in the score interpretation of the evaluation: *"Level 4 in terms of visual impurities has been assigned to your sample. In the beta version of the Evaluation Protocol, level 4 has not yet been activated as knockout criteria. Once the representativeness of the lab-scale test and Evaluation Protocol is validated in the next version, level 4 could potentially lead to an overall negative assessment of the recyclability in a standard mill (i.e. not suitable for standard mill). Until then, we strongly recommend that you treat the current results with special care. For example, you could consider reaching out to the lab running the test asking for more detailed information and observations."*

Visual impurity level	Visual impurity score
1	0
2	-5
3	-15
4	-30

Table 4. Conversion table for visual impurity level to visual impurity score

Sheet adhesion score

Similarly to visual impurities, sheet adhesion is a qualitative evaluation that is assigned to three possible levels. Level 1 indicates no adhesion issues are observed when using the recovered material. Level 2 is assigned to material that shows some indication of sheet adhesion but likely has a limited impact on the production process. Lastly, level 3 is assigned when sheet adhesion is clearly observed and the recovered material would likely lead to production problems. Given the severity of level 3, it is considered a 'knockout' factor and the total score is immediately set to a negative value, making the tested product unsuitable for recycling in a standard mill. The CEPI recyclability laboratory test method provides details and examples for the level assignment.[2]

In Table 5, sheet adhesion levels are given a final score. As can be seen no points are lost or gained when level 1 and 2 are observed. Given the difficulties of differentiating between level 1 and 2 using the lab-test method, both are set to a score of 0. However, level 2 does alert the packaging designer that there is some granularity in the final product.

Sheet adhesion level	Sheet adhesion score
1	0
2	0
3	Knockout

Table 5. Conversion table for sheet adhesion level to sheet adhesion score

Total score

The final total score[3] is the sum of all the individual scores discussed in this section – calculated based on yield and visual impurities scores and the sheet adhesion evaluation. It can be in the range from +100 to -100 and has been fully implemented into the Scorecard Excel tool provided.
It should be noted that the yield score is the only parameter that has a positive contribution to the total score (above the threshold limit, see Figure 1). The visual impurity score is either 0 or negative and the sheet adhesion is a knockout criteria.

In practice, if a threshold is exceeded or a knockout criterion is triggered, the total score will be negative, resulting in a failed assessment of the fibre-based package.

RECYCLABILITY SCORE INTERPRETATION

The 4evergreen recyclability evaluation protocol provides two major statements, saying that material is either suitable for a standard recycling mill or not. However, it is also meant to support the eco-design process, therefore a more granular description is provided by the total score and the breakdown of this total into its individual components, as shown in Table 6.

As can be seen from Table 6, various factors have a different impact on the total score. This classification is the outcome of an extensive consensus-building process using the latest test data and drawing on best available expertise from 4evergreen. The value ascribed to each score/component is key to implementing efficient eco-design processes and perfecting the circularity of fibre-based packaging.

[2] Harmonised European laboratory test method to generate parameters enabling the assessment of the recyclability of paper and board products in standard paper and board recycling mills, Short title: CEPI recyclability laboratory test method, Version 2, October 2022
[3] Mathematical calculation: Total score = 1/2 (Y + VI + SA -100 + | Y + VI + SA +100|)

Total score	Standard Mill Recyclability	SCORE COMPONENT BREAKDOWN									
			YIELD			VISUAL IMPURITIES				SHEET ADHESION		
			SCORE	DESCRIPTION		LEVEL	SCORE	DESCRIPTION		LEVEL	SCORE	DESCRIPTION
/100	0-100 Suitable for Standard Mill recycling	TOTAL SCORE COMPOSED OF	100 - 90	The method indicates that the packaging is expected not to pose any repulpability issues in the standard mill and is therefore considered **Best in Class**.	AND	LEVEL 1	0	Poses **no visual quality issues**.	AND	LEVEL 1	0	Poses **no adhesion issues**.
						LEVEL 2	-5	Poses **minor visual quality issues** that can be acceptable in the mix.		LEVEL 2	0	Poses **minor adhesion issues** that can be acceptable in the mix.
			89 - 70	The method indicates that the packaging has **minor repulpability issues** that could have limited impact on the recyclability in the standard mill.		LEVEL 3	-15	Poses **some visual quality issues** that can be acceptable in the mix for certain types of production.				
	<0 Not suitable for Standard Mill recycling. Potentially recyclable in other mill types*		69 - 50	The method indicates that the packaging has **some repulpability issues** that affect the process in the standard mill and should therefore not be abundant.								
			49 - 0	The method indicates that the packaging has some **significant repulpability issues** that have a significant impact on the process in the standard mill and should therefore be avoided when possible.		LEVEL 4	-30	Poses **significant visual quality issues** that can be problematic in the mix. Sample is at risk of receiving a KO in future versions of the Evaluation Protocol**		LEVEL 3	KO	Poses **significant adhesion issues** that can have a significant impact on the process in the standard mill
			<0	The method indicates that the packaging has **major repulpability issues** which could stop the process at a standard mill and therefore are not suitable for this mill. It is recommended to evaluate this product with either Part II or III.								

Table 6. Interpretation of recyclability total score and its individual components

* To the extent that the laboratory method is representative. Some standard mills may recycle the same material with better/worse outcomes.

** Warning statement: Level 4 in terms of visual impurities has been assigned to your sample. In the beta version of the Evaluation Protocol, level 4 has not yet been activated as a knockout criteria. Once the representativeness of the lab-scale test and Evaluation Protocol are validated in the next version(s), level 4 could potentially lead to an overall negative assessment of the recyclability in a standard mill (i.e. deemed unsuitable for a standard mill). Until then, we strongly recommend that you treat the current results with special care. For example, you could consider reaching out to the lab running the test asking for more detailed information and observations.

7. PART II > Flotation-deinking recycling mill

MILL DESCRIPTION

Deinking mills have been designed for pulping, cleaning and deinking graphic paper grades, typically newspapers and magazines corresponding to grade 1.11.xx. and other grades defined in EN 643 as intended for deinking.

The deinking process is also capable of processing white or off-white fibre-based packaging paper types if they fulfil the brightness and general quality requirements. In a shrinking graphic paper market, suitable white fibre-based packaging materials could be a potential future fibre source for high-value recycling of white and off-white fibres. Already today, grades intended for deinking contain a certain amount of packaging paper recycled in the graphic paper loop. One reason is that, during sorting, pigment-coated papers show very similar NIR fingerprints compared to coated magazine paper. Any brown or dyed fibres may significantly deteriorate the deinked pulp quality.

LABORATORY TEST METHOD

For assessing the recyclability of fibre-based packaging in a flotation-deinking mill, an adapted test method for fibre-based packaging, based on the INGEDE Method 11, is currently being developed by the 4evergreen alliance. Once the test method is finalised, it will inform the 4evergreen Recyclability Evaluation Protocol Part II and corresponding assessment scheme.

RECYCLABILITY SCORE

Not part of this publication.

8. PART III > Specialised recycling mill

MILL DESCRIPTION

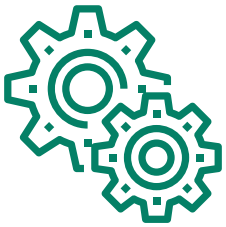
These mills treat a mix of special grades (group 5 of EN 643) but also other groups (1-4 from EN 643). Each recycling mill determines the optimal mix and adds one or more piece of dedicated equipment, such as a horizontal high-consistency drum pulper, a separate batch pulper with longer pulping time, deinking machine, fine cleaners, and hot dispersion, special process and wastewater systems. These specialised recycling mills can treat paper-based packaging that has been layered with non-water-soluble products, such as wax, plastic film or other layers including aluminium, polyester and polyethylene entering the recycling process in homogeneous lots. In order to optimise the recycling process, paper composite packaging, which cannot be handled in standard processes, should be delivered to specialised paper mills in EN 643 identified flows. As in standard mills, the result of the process is also very high-quality fibrous material suspended in water ready for papermaking.

LABORATORY TEST METHOD

Not part of this publication.

RECYCLABILITY SCORE

Not part of this publication.



FUTURE WORK

Not all factors potentially affecting the recyclability of fibre-based packaging are covered in this beta version of the Evaluation Protocol. It is true both for technical parameters but also for the impact that collection and sorting might have on a mixed composition of paper for recycling. Therefore, this document will be reviewed and updated in accordance with user feedback and technical updates in Workstream 1 of the 4evergreen alliance. Apart from the review of the existing scoring and threshold validity, the following non-exhaustive list of aspects shall be examined in future:

- Incorporation of Part II and Part III test and evaluation protocols
- Impact of collection and sorting stream allocation on the potential recyclability of individual packaging items
- Dilution factor to assess how individual components behave in a co-mingled recycling process with other grades of paper
- Impact of dissolved and colloidal solids
- Impact macro-stickies
- Assessment of reject quality
- Impact of food contamination on the recycling process and quality of produced paper
- Verification of the results via pilot testing
- Impact of longer pulping times
- Evaluation of the α factor (correction of fine reject value)
- Tailoring of the scoring to different packaging categories

9. References

- CEPI, Harmonised European laboratory test method to generate parameters enabling the assessment of the recyclability of paper and board products in standard paper and board recycling mills, Short title: 'CEPI Recyclability Laboratory Test Method, Version 2', October 2022, https://www.cepi.org/wp-content/uploads/2022/10/Cepi-recyclability-laboratory-test-method_FINAL.pdf

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10. Appendix

GLOSSARY

Board/Paperboard
Generic term applied to certain types of paper frequently characterised by their relative high rigidity (ISO 4046-3:2016). The primary distinction between paperboards is that they may be single- or multiply, coated or uncoated. It is made from virgin and/or recovered fibres, and has good folding properties, stiffness and scoring ability. It is mainly used in cartons for consumer products (e.g., food, beauty & personal care, healthcare, beverages). Includes solid board, solid bleached board, solid unbleached board, folding box board, white lined chipboard, boxboard or carrier board.

Collection
The gathering of discarded fibre-based packaging and/or other recycleables from various sources (i.e. household, commercial, industrial) which ultimately, directly or indirectly, are destined for recycling at a dedicated plant.

Converting
Manufacture of products by processes or operations applied after the normal paper or board manufacturing process. The operation of treating, modifying, or otherwise manipulating the finished paper and paperboard so that it can be made into end-user products, such as special coating, waxing, printing, and gumming, and envelope, bag, and container manufacturing.

EN 643 – European List of Standard Grades of Paper and Board for Recycling
The European List of Standard Grades of Paper and Board for Recycling gives a general description of the standard grades by defining what they are allowed and not allowed to contain.

Fibre-based packaging
A semi-finished product consisting of at least 50% fibres, potentially with another materials.

Packaging component
Part of packaging that can be separated by hand or using simple physical means. For example, board reinforcement around a yoghurt cup.

Paper
Paper consists mainly of natural fibres and can possible contain other ingredients such as filling material, starch, coating colour including binder as well as additives typically used in the paper industry such as wet-strength agents, sizing agents and water. Paper is usually called board when it is heavier than 220 g/m^2.

Recyclability
Recyclability is the individual suitability of paper-based packaging for reprocessing in the post-use phase into new paper and board. Factual reprocessing means that collection, sorting (if relevant), and recycling take place at scale. Recyclability criteria of materials described in ISO 14021 (where relevant and followed by sorting) into EN 643 grades and final recycling takes place at an industrial scale.

Recyclability at a standard recycling mill
Recyclability considers if a fibre-based packaging can be recycled applying dedicated recycling processes and conditions typically defined in a referenced lab-test procedure (Part I). The assessment of recyclability can differ between Part I, II and III. It does not consider the aspects of collection and sorting, and if the packaging finally is recycled at industrial scale. Beside the recyclability the recycling at scale furthermore includes the aspects of collection and sorting in individual markets, i.e., whether a packaging is collected, sorted (if applicable) and finally recycled in a paper or board mill. There are also economical aspects influencing the recycling of individual packaging.

LIST OF ABBREVIATIONS

CEPI	Confederation of European Paper Industry
ISO	International Organization for Standardization
CR	Coarse Reject
FR	Fine Reject
TR	Total Reject
α	Correction factor
EN643	European List of Standard Grades of Paper and Board for Recycling
pH	potential of Hydrogen (acidity)
WS	Workstream
MSA	Macro-Sticky Area
VI	Visual Impurities
DCS	Dissolved and Colloidal Solids
RQ	Reject Quality

ABOUT 4EVERGREEN

4evergreen is a cross-industry alliance perfecting the circularity of fibre-based packaging to contribute to a climate-neutral and sustainable society. Our goal is to raise the overall recycling rate of fibre-based packaging to 90% by 2030. We bring a particular focus on packaging with a lower circularity performance today, namely the types used for household, out-of-home and on-the-go consumption.

The alliance brings together industry representatives from across the fibre-based packaging value-chain, from pulp, paper and board manufacturers and recyclers to packaging producers and converters, including brand owners, retailers and waste management companies. It also comprises non-fibre material suppliers (e.g., adhesives, inks, coatings), technology providers (e.g., machinery, collection, and recycling solutions), and leading research institutes.

4ever green

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