



# Whitepaper

## Adhesives and Recycling: Strategies for Improvement

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## **Adhesives and Recycling: Strategies for Improvement**

Recycling is a process that converts unusable packaging at its end-of-life into valuable material to be reused in the economic cycle. This process is particularly effective for paper-based packaging, where the fibers can be recovered and used to create new packaging material. Recycling not only helps us conserve natural resources and reduce waste but also contributes to a more sustainable economy, underlining the economic benefits of our collective recycling efforts.

Paper and cardboard packaging have been an essential part of our daily lives for generations. Fortunately, many countries have recognized the importance of recycling them and have established comprehensive systems for collecting them separately from residual waste. This helps conserve valuable resources and plays a vital role in protecting our environment from the negative impacts of excessive waste. Recycling helps minimize our consumption habits' ecological footprint by reducing the need for raw materials.

### **I. Efficient Paper Recycling: Technological Advancements and 'Less is More' Approach Can Overcome Challenges**

Paper and cardboard recycling presents multiple advantages, but it also confronts various obstacles. One of the most significant challenges is sustaining the quality of fibers and efficiently separating non-paper elements. By using technological advancements, a proper packaging design and refining the recycling processes, we can overcome these challenges and enhance the efficiency of the recycling process even further.

Through continuous process improvements and greater consumer awareness, optimal use of materials in the production cycle can be achieved. Packaging manufacturers can also contribute to this effort by reducing the use of non-essential materials while still maintaining the necessary packaging functionality. The "less is more" principle applies here, which means using only the minimal amount of materials required to achieve the packaging function. By using fewer non-target materials, resources can be conserved and the amount of foreign materials introduced into the recycling process can be minimized, which in turn reduces the need for significant effort in removing these materials.

This makes recycling processes more efficient. For example, when the "less is more" principle is applied, screening in paper processing is less burdened with foreign materials.

## II. Target and Non-Target Materials of Recycling

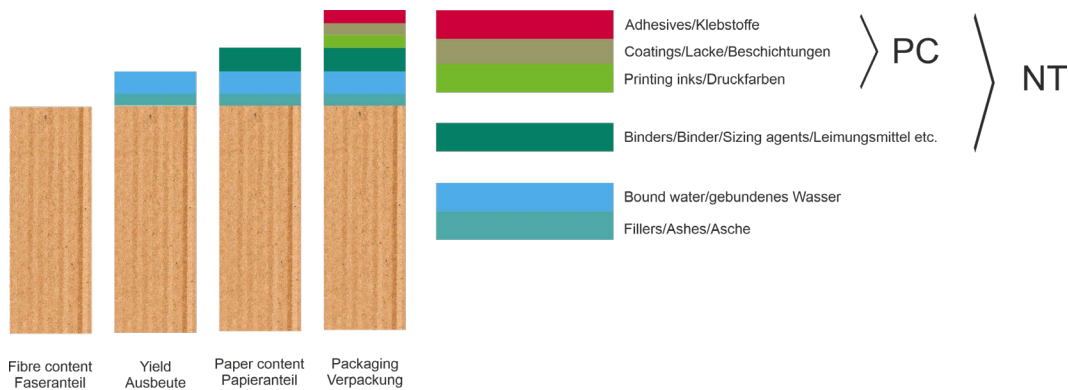


Figure 1 Target- and Non-Targetmaterials, eigene Darstellung nach 4evergreen, 2023

Recycling aims to recover as much paper fiber as possible in the highest quality and with minimal contamination from foreign substances. The target material is the fibers, while other packaging components (PC) such as printing inks, varnishes, coatings, adhesives, and components of the paper coating are non-target materials (NC). These non-target materials need to be removed from the paper pulp as much as possible, which is mostly done by screening.

The screening process in paper recycling involves two critical stages: coarse and fine screening. Coarse screening is the initial phase, aiming to remove larger contaminants that could damage downstream equipment or affect the quality of the recycled pulp, such as large pieces of plastic, metal, staples, and other oversized debris.

Following coarse screening, fine screening focuses on removing smaller contaminants that were not captured during the initial stage, including tiny plastic particles, ink particles, adhesive residues, and other fine debris.

## **1. The role of adhesives in recycling**

Adhesives can affect the recycling process of paper and packaging, potentially lowering the quality of the recycled paper. However, by selecting appropriate adhesives and adhering to specific conditions, adhesives can contribute to sustainable paper-based packaging. They are crucial in reducing the use of substrates and enabling lightweight packaging.

Adhesives are not considered recyclable materials; therefore, it is advisable to use them in moderation, adhering to the "less is more" principle. The amount of adhesive used in packaging is often more than what is needed. The dimensional stability of the packaging and the strength of the adhesive bond in the glued seams set the minimum requirement for production quality. It's important to always ensure the stability and quality of the adhesive bond from a sustainability perspective to prevent damage to the packaged product. In general, the production and distribution of the packaged product consume more resources and have a larger ecological footprint than the packaging itself. If the packaging is open or unstable, the products inside may be damaged or destroyed. As a result, the packaged product's valuable resources would be lost.



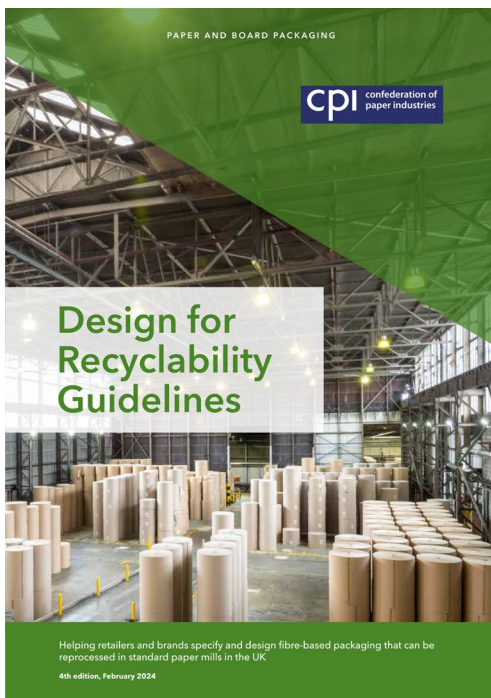
## 2. “Less is more” in the recycling guidelines:

### CIRCULARITY BY DESIGN GUIDELINE FOR FIBRE-BASED PACKAGING

VERSION 2  
June 2023



***“As a general principle, as for all non-target materials of a recycling process, the amount of adhesives used in a given paper or paperboard item should be optimised to the minimum amount required to achieve its function. Doing so will minimise the amount of adhesive that the recycling process needs to handle.” (4evergreen, 2023)***



***“Therefore, the Paper Industry would encourage designers to: minimise the adhesive use where possible; (CPI, 2024)***



**“Optimize the quantities of adhesives to fulfil the expected sealing of the packaging while considering the influence on paper recycling.”**

(CEPI & al., 2020)

FEICA, the Association of the European Adhesive & Sealant Industry, acknowledges the importance of minimizing adhesive consumption but notes that this principle applies to all non-target materials in the recycling process (FEICA, 2023).

The various Design for Recycling Guidelines acknowledge the importance of using adhesives. However, a clear principle in all of these guidelines is that adhesive use should be minimized to only what is necessary for packaging to optimize recycling. This white paper focuses on methods and strategies for achieving this optimal use.



### III. Hotmelt Applications (non-reactive)

Hotmelt adhesives provide the advantage of rapid bonding for paper-based packaging. The bonded joint can bear loads almost immediately, and hot melts bridge gaps better than dispersion glues, making them the preferred adhesive in final packaging.

#### 1. Criteria for the Recyclability of Hot Melts

Even though some recycling guidelines (APA, 2021) may consider hot melts problematic, it is increasingly accepted that they can be easily screened during recycling as long as they meet specific size dimensions and softening temperature limits. Hot melts are not considered problematic in a standard recycling process if they meet these requirements.

The 4evergreen Guideline (4evergreen, 2023), the German minimum standard (Verpackungsregister, 2022), refers to the European Paper Recycling Council's publication "Scorecard for the Removability of Adhesive Applications" (EPRC, 2018), which exempts hot melts from the need for further recycling tests if they meet the specified conditions.

#### **Softening temperature of the adhesive (according to R&B):**

68 °C minimum

#### **Layer thickness of the adhesive (non - reactive adhesive):**

120 µm minimum

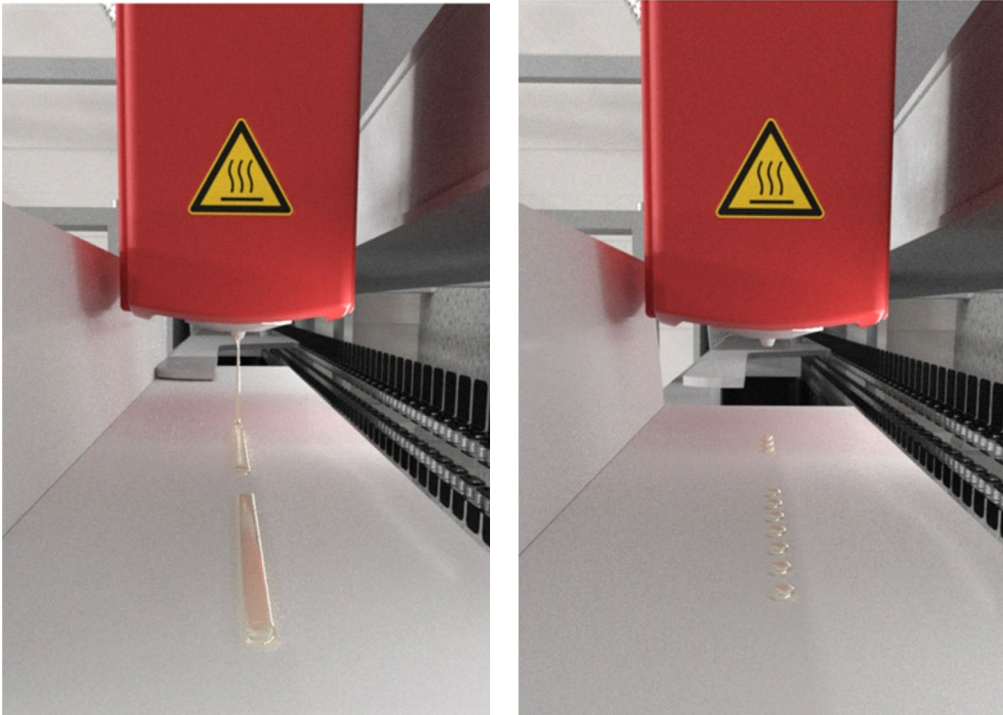
#### **Horizontal dimension of the application (in either direction):**

1,6 mm minimum

The Austrian ARA Design Guideline recommends a deviating minimum horizontal dimension of 2.0x2.0mm (ARA, 2022).

It is imperative to understand that these minimum requirements do not equate to the notion that a greater amount of adhesive is superior. Rather, the quantity of adhesive utilized should be minimized to fulfill only the essential packaging function. An excessive input of adhesive results in the unnecessary inclusion of non-target materials in the recycling process, a heightened CO<sub>2</sub> footprint, and augmented costs associated with adhesive usage.

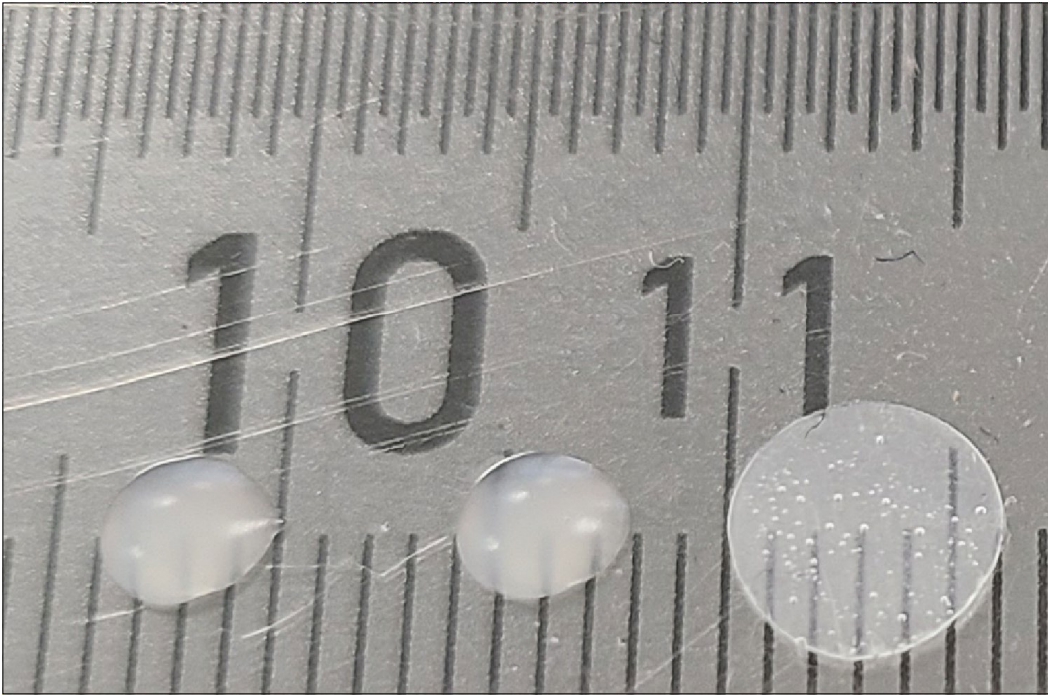
## 2. Effective Strategies for Meeting Minimum Targets While Maintaining Essential Requirements



*Figure 2 Left: Line or bead application; Right: Dot application (dotting)*

The strategy to diminish adhesive usage by 50% entails a shift from continuous line application to dot application, also referred to as dotting. This transition involves substituting the solid line of adhesive with a series of dots, resulting in substantial cost savings and a 50% reduction in the introduction of non-target materials in the recycling process. Additionally, this approach reduces the CO<sub>2</sub> footprint associated with adhesive usage by 50%.

An additional advantage of using a lower input of non-target material is that it reduces screen contamination during the recycling process.



*Figure 3 The applied dots exceed the minimum requirements in horizontal and vertical direction by at least twice. In the unpressed state, the dots have a horizontal diameter of 3-4mm applied and 6mm when pressed, with a thickness of 0.24mm.*

The specifications outlined in the ERPC Code and other relevant guidelines necessitate a minimum size, which is currently being exceeded in the dotting application mode by at least a factor of two. The unpressed dots measure 3-4 mm horizontally, while they measure 6 mm when pressed. In the pressed state, the layer thickness is 0.24 mm, which significantly surpasses the limit value of 0.12 mm. These findings indicate that the hot melt dot application is fully recyclable.

The dot application must effectively serve the packaging function by securely sealing the packaging and safeguarding the packaged goods. It has been observed through customer experiences and studies that an excess of adhesive is typically applied. Heavily surpassing the requirements of the packaging function. The substrate often represents the weakest point in this regard. Furthermore, the dot application can enhance the adhesive bond under specific circumstances by subjecting the initial release force multiple times. The numerous advantages in terms of cost-effectiveness and sustainability in packaging production through dotting warrant an evaluation of the packaging function.

It is important to consider both the advantages and potential disadvantages of dotting. Dotting should not cause the application equipment to wear out prematurely due to the increased number of switching cycles. To prevent this, it is

recommended to use electromagnetically driven adhesive application valves<sup>1</sup>, which are seal-less and can handle at least one billion switching cycles. In practice, they often perform even better. In contrast, the best electro-pneumatic adhesive application valves can usually only handle a maximum of 150 million switching cycles.

Dotting plays a pivotal role in diminishing the influx of non-target materials into the recycling process. The adhesive dots employed comply with the minimum recycling requirements, thereby establishing their full recyclability, obviating the need for recycling tests. Furthermore, this approach yields a 50% reduction in the costs and climate impact associated with adhesive application.

#### **IV. Dispersion adhesives (cold glue)**

##### **1. Criteria for the Recyclability of Dispersion adhesives**

Water-based dispersion adhesives are generally conducive to recycling, provided they are water-washable or water-dispersible. The objective is to eliminate them during the recycling process to ensure their presence in the process water. It's important to note that the presence of water in a dispersion adhesive does not necessarily mean it is washable or dispersible in water. Dispersion adhesives form a closed film within the packaging, which is the focal point of the recycling process. Nonetheless, most dispersion adhesives are amenable to recycling. Consultation with the adhesive supplier is advisable. Fundamentally, the "less is more" principle applies, aiming to minimize the introduction of non-target material into the recycling process to the extent permitted by the packaging's functionality.

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<sup>1</sup> Baumer hhs tesla adhesive applicator valves are a proven example..

## 2. Effective Strategies for Meeting Minimum Targets While Maintaining Essential Requirements



*Figure 4 Efficient Longitudinal Seam Gluing with Side Seam Gluing Solution and Stitching Process*

The assembly of folding cartons and corrugated board packaging at high speeds necessitates an alternative approach to adhesive conservation. In place of a continuous line of adhesive, the stitching process is employed, utilizing a sequence of short adhesive lines. This approach yields a 50% reduction in material usage, thereby diminishing the influx of non-target materials into the recycling process and halving the ecological and economic costs associated with adhesive application.

Research conducted by the PTS (Papiertechnische Stiftung Heidenau)<sup>2</sup> has demonstrated that the utilization of the stitching process for gluing corrugated board packaging does not compromise its packaging function; rather, it tends to enhance it.

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<sup>2</sup> [Papiertechnische Stiftung: Fibre-based research & development | PTS Website \(ptspaper.de\)](https://www.ptspaper.de/)

## **V. No Adhesives**

The option of joining packaging layers by interlocking or inserting flaps completely avoids the use of adhesives, but it often leads to a higher use of substrates. This contradicts the goal of reducing packaging weight, as stated in the Packaging and Packaging Waste Regulation. Even paper-based substrates have an ecological footprint (water consumption, CO2 footprint), despite efforts by the paper industry to reduce this. While there are savings in adhesives, there is a higher consumption of paper- or board substrates. Additionally, the production output of interlocking joints often decreases, and these joints can lead to performance losses and more frequent disruptions in the packaging process. On the other hand, using a small amount of adhesive enables lightweight packaging without sacrificing performance. Therefore, it's important to compare the adhesive process with adhesive-free joining processes, considering performance, ecological, and economic parameters.

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Please don't hesitate to contact me or your sales partner if you have any further questions. We genuinely want to engage in a dialogue with you and are looking forward to an open and constructive exchange. We believe that by considering all aspects along the supply chain, we can successfully transition to an even more sustainable paper-based packaging function.



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