



# Design for Recycled Content Guide

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This Guide supports brands and suppliers who are looking to incorporate recycled content in packaging. The Guide provides practical recommendations to inform strategy and decision making by outlining existing challenges, illuminating areas of opportunity, and dispelling myths about the use of recycled content.

# INTRODUCTION

Creating more sustainable packaging requires a multifaceted strategy to address an array of environmental considerations across the packaging life cycle. A key element of any sustainable packaging strategy is to ensure materials are effectively recovered at the end of their useful life to provide new inputs for industrial or biological cycles.

Recycling is the most prevalent recovery pathway for packaging, and in order to ensure that packaging is effectively recycled, the packaging community must engage on two critical fronts: designing packaging in such a way that it flows optimally through the recycling system, **and supporting end markets for the recycled content created by that system.**

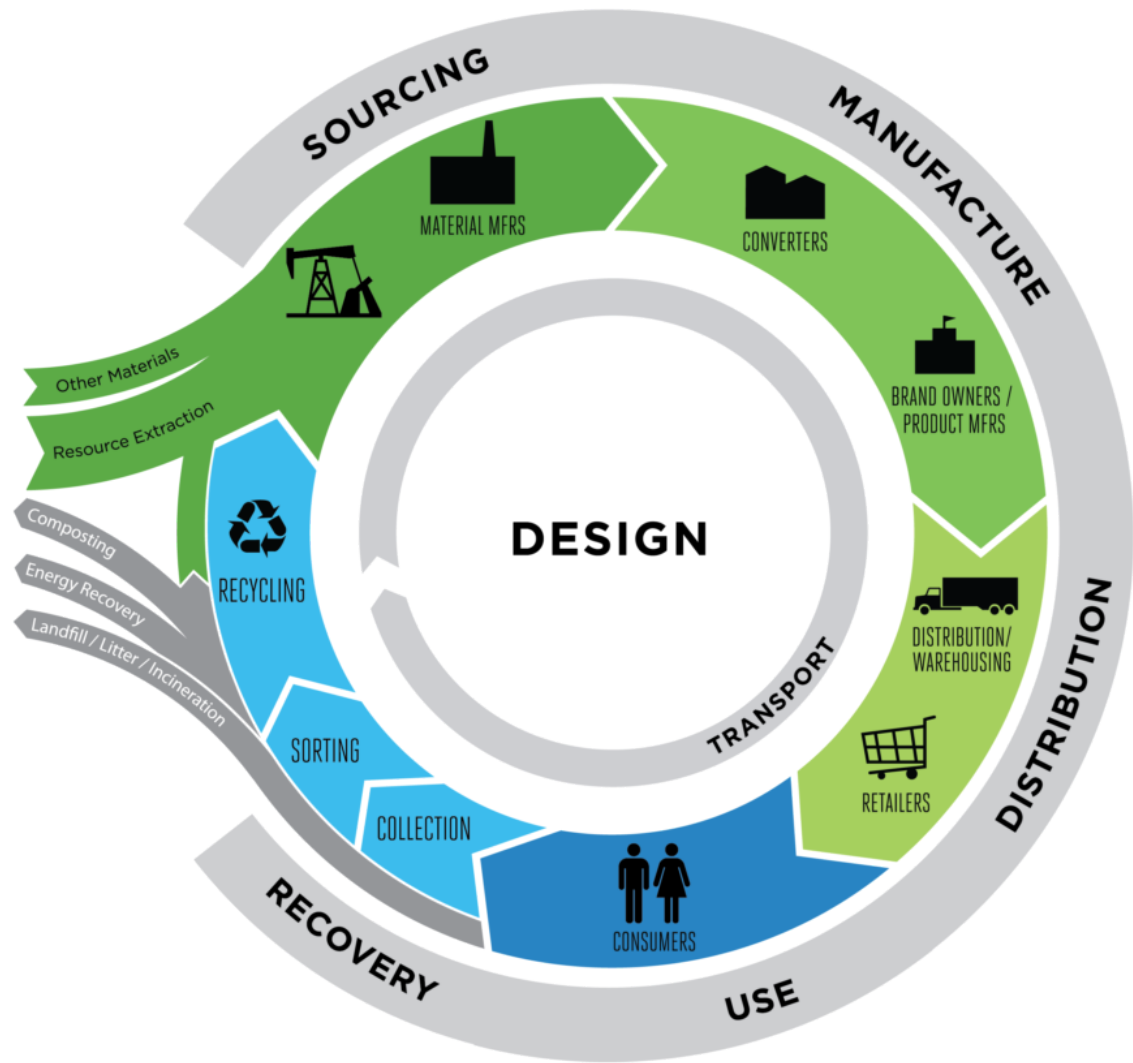
In designing for recyclability, [a package should be designed to flow smoothly through the entire recycling system](#). This means:

- ▶ It is accepted in the recycling collection receptacles available to end users.
- ▶ Waste haulers will collect and transport it.
- ▶ A material recovery facility (MRF) will sort it properly, if it is collected in a commingled mix of materials.
- ▶ Reprocessors will turn it into valuable feedstocks used in the manufacture of new materials.
- ▶ End markets will purchase and use those new materials.

Designing recyclable packaging is critical to creating a supply of recycled materials.

**However, for the recycling system to be robust and healthy, the practice of designing for recyclability must be accompanied by a practice of providing market demand for recycled content.** Packaging producers play a key role in providing market demand by using recycled content in new packaging, “pulling” the recycling system in such a way that matches the “push” of designing for recyclability. Packaging isn’t the only end market for recycled content — recycled content can be used in the manufacture of new durable goods, nondurable goods, and materials for the built environment. While these open loop applications are critical, the demand created when new packaging is made with recycled content from old packaging is major component of the overall landscape of demand for recycled content and it directly applies the concept of circularity to packaging. This “take what you make” attitude helps transform the dialog from recycling as an end in itself, to seeing recycling as a source of feedstock for new resources to be reused and given new lives.

Once packaging is collected, sorted, and reprocessed, circularity is only complete upon the use of that recycled material in the manufacture of a new product or packaging. To that end, this Guide seeks to encourage companies to use more recycled content in their packaging.



## Scope of this Guide

The Sustainable Packaging Coalition developed this Guide to provide information on the key considerations around recycled content and how to design packaging that incorporates recycled content in order to drive demand for recycled materials. The Guide shares insights from experienced users of recycled content across the packaging supply chain to illuminate the opportunities and best practices for using recycled content in packaging. Although non-packaging end markets also play an important role in the circular economy, they are not the focus of this Guide.

To develop the Guide, the Sustainable Packaging Coalition conducted interviews during 2018 with companies across the packaging supply chain, including material manufacturers, packaging converters, brand owners, and retailers. The interviews explored barriers and opportunities to increasing the use of recycled content in packaging. Information collected through these interviews was supported by cumulative knowledge, research, and experiences of the Sustainable Packaging Coalition staff.

The geographic context of the Guide is primarily the U.S. and Canada, although many elements of the guidance are applicable in other regions.

This is a living guide and will be updated regularly. While individual sections can be downloaded, the Guide will be available primarily in a web based format.

# Terminology

The broad term “recycled content” can include both post-industrial recycled content and post-consumer recycled content. **This Guide focuses primarily on the use of post-consumer recycled content.** However, many of the takeaways are also relevant for post-industrial recycled content.

There is a plethora of terms and acronyms used to describe recycled content, including PCR (post-consumer resin or post-consumer recycled content), PIR (post-industrial recycled content), PCW (post-consumer waste), rPET (recycled PET), rHDPE (recycled HDPE), and others.

ISO 14021 defines pre- and post-consumer recycled materials as follows:

**Pre-consumer material:** Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. This can also be referred to as post-industrial recycled content or PIR.

**Post-consumer material:** Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. This can also be referred to as post-consumer recycled content.

This Guide uses the phrase “recycled content” to refer to both post-consumer and post-industrial recycled content. However, it should be emphasized that both the challenges and opportunities surrounding recycled content tend to be more pronounced with post-consumer recycled content, and the Guide is aimed primarily at providing advice on the use of post-consumer recycled content. In instances specific to either post-consumer or post-industrial recycled content, efforts have been made to specify the type of recycled content discussed.



Courtesy of Envision Plastics



# Why use recycled content?

There are number of reasons why using recycled content is beneficial to packaging manufacturers, brand owners, the economy and the environment, including:

- ▶ **Making strides toward a circular economy.** Using recycled content in packaging allows brand owners and manufacturers to close the loop, embodying the circular economy principle of a system that is regenerative and restorative.
- ▶ **Lowering greenhouse gas emissions.** Glass, aluminum, steel, and plastic production processes typically incur lower greenhouse gas emissions when recycled feedstocks are used instead of virgin feedstocks, owing to the fact that the recycling systems that produce those recycled feedstocks are less carbon-intensive than conventional raw material extraction processes and/or the manufacturing processes are less carbon-intensive when recycled feedstocks are used. For paper, the chief greenhouse gas emission benefit owes to the diversion of paper from landfills and avoidance of the methane emissions from the biodegradation of paper in landfills.
- ▶ **Protecting and enhancing the recyclability of packaging.** The recycling system involves a marketplace and, like any market, demand from end users is necessary to ensure viability. If recycled material is not purchased and used in an end market, then the system cannot continue to exist. Specifying recycled content can help ensure that end markets exist and help ensure that the system of recycling is robust enough to support marketing claims of recyclability for packaging.
- ▶ **Meeting expectations from brand owners and retailers.** Large retailers are calling for the use of recycled content and implementation of recycled content goals by brand owners, who are asking the same of their suppliers.
- ▶ **Mitigating reputational risk.** Using recycled content is a meaningful way to demonstrate voluntary responsibility around responsible supply chain practices, sending signals of leadership and reducing the risk of reputational damage from environmental campaigns.
- ▶ **Building brand equity and consumer trust.** [Environmentally aware consumers](#) support companies who implement responsible business practices, and the use of recycled content in packaging creates an opportunity to appeal to them. In addition to brands that specifically target this market segment, mainstream brands also stand to benefit since this market segment is growing – especially among millennials and other younger consumers.
- ▶ **Taking action against packaging pollution.** Litter on land and in waterways is a worldwide environmental issue affecting human health, the wellbeing of land and marine animals, and economic livelihoods including tourism and fishing. When materials are valued at their end-of-life through strong end markets for recycled content, they may be more likely to be collected and recovered and less likely to end up as terrestrial or marine pollution.
- ▶ **Getting ahead of potential regulation.** Companies can preempt and prepare for potential future regulations stipulating mandatory use of recycled content.

There are trade-offs with every decision, and the use of recycled content may not always guarantee improved environmental benefits or tangible business advantages. It is important to evaluate the life cycle costs and advantages of every decision to determine the most effective course of action. Nonetheless, recycled content is an important tool for any company to make their packaging portfolio more sustainable and its importance is expected to increase over time.

## Key Recommendations for Brand Owners

1. **Set recycled content goals.** Brand owners that set goals to include recycled content in their packaging are more likely to succeed in achieving high levels of recycled content usage. Conversely, companies are much less likely to use recycled content when they do not have corporate goals surrounding it. The best goals are publicly disclosed, which ensures transparent accountability; are ambitious, demonstrating a pronounced improvement over current practices; and include a system by which progress is periodically reported. If a brand is not prepared to set an ambitious, publicly-stated goal, brands should form achievable internal goals to match levels successfully adopted by peer companies and attach incentives around attaining those goals. Strong goals are also integrated into corporate business strategy so that decisions on using recycled content are made at the highest level of leadership, conveying to the rest of the business that environmental practices are just as important as financially-driven practices.

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*“The best way to get buy-in is through objective-setting, so that it doesn’t have to be [about] individuals or separate teams. Once we set objectives, we deliver on those results.”*

*– Brand Owner*

**2. Align leadership, procurement, sales and marketing teams around recycled content.** Brand owners are most likely to be successful using recycled content when leadership is supportive and marketing, procurement and all other teams are aligned around this objective. The procurement team needs to be educated on technical and performance considerations of recycled content and how that relates to performance requirements related to their products, so that they are equipped with the right tools and messages when working with suppliers. Sales and marketing need to be fluent in the message the brand wants to convey to customers and consumers and realize that in some cases, packaging made with recycled content may have a unique story, aesthetic, and value proposition that their teams must support. In addition to setting ambitious goals and getting strong leadership from the top, a best-in-class strategy involves embedding recycled content goals directly into professional development plans and individual performance objectives.

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*“If you build [the use of recycled content] into your culture, then you don’t have to persuade people at the project team level [to support it]... But if we do have exceptions or have items that don’t meet our [recycled content] guidelines, then it goes all the way up to our VP to make sure we’re doing the right thing from a sustainability lens.”*

*– Brand Owner*

**3. Adjust specifications to accommodate higher levels of recycled content.** Though it’s not uncommon for recycled content to meet stringent specifications, brands with rigorous specifications for qualities like color, performance, and aesthetic qualities may need to make adjustments in order to use higher levels of recycled content. This is especially true for paper and plastic packaging. When assessing recycled content specifications, brand owners and converters should think about meeting the requirements of the application rather than matching the specifications of their current supply of virgin material, keeping in mind that some virgin material may have characteristics that have been designed to provide benefits for certain applications but are irrelevant for the application at hand. Virgin specifications may be useful in providing an orientation of the material requirements, but should not be used as a baseline from which to assess recycled content specifications. It should also be noted that some aesthetic considerations made for on-shelf presence are irrelevant for sales through fast-growing online channels.

**4. Work with suppliers that support your use of recycled content.** Brand owners that work closely with their suppliers, cultivating long-term relationships based on trust and testing for continuous improvement, have more success in incorporating higher levels of recycled content successfully into their packaging. Suppliers may be hesitant to try recycled materials in their equipment at the risk that it will not perform well or will require them to invest in additional equipment, take additional steps, or change processes which may impact their costs and time. Brand owners must work closely with their suppliers to analyze if they can or are willing to support their journey in using recycled content. If suppliers are hesitant, then assure them you will work closely with them to test materials and partner on the learning curve. If a supplier pushes back too much, consider working with a supplier that will act as a partner on a shared journey towards using more recycled content.

**5. Develop dedicated strategies to manage recycled content costs.** Depending on the material and market conditions, using recycled content may come with additional costs. While it must be appreciated that procurement teams are under immense pressure to reduce costs, a strict

lens of cost reductions will not push the market to develop or support cost stabilization. Leadership companies identify unique ways to manage costs in order to support their continued use of recycled content. This can include considering added costs as an investment in upgraded packaging, or even reducing costs elsewhere in product or packaging portfolios and using those savings to offset price premiums associated with recycled content. It is also important to establish long-term contracts with credible, committed suppliers that allow them to better control costs over time, rather than relying on short-term contracts based on current market prices.

**6. Be an ambassador for recycled content.** Consumer confusion around what recycled content is, confusion of this concept with other sustainable packaging characteristics like recyclability, as well as a general lack of resonance with consumers are often cited as deterrents. Brand owners and retailers can be ambassadors for the use of recycled content by educating consumers about its benefits and in turn, helping to create more consumer preference for recycled content. Optimal consumer communication requires a consistent, slow-building industry message, which will occur over time as more companies venture into this territory. Brand marketing has an opportunity to showcase the commitment to more sustainable packaging and should work to gradually tell this sustainability story across many different channels.

## Key recommendations for suppliers

- 1. Work with brand owners to test recycled content materials and don't be afraid to challenge customer specifications.** Some brand owners are revisiting their strict specifications to learn where they can be relaxed to incorporate more recycled content. Suppliers should not be afraid to reach out to their customers about specifications and challenge them on the necessity of stringent specifications.
- 2. Take advantage of demand for recycled content as a competitive strategy and invest in needed equipment to support it.** As more brand owners set goals around using recycled content, and as government agencies consider instituting mandatory recycled content minimums, being able to provide customers with advice, technical support, and quality supply will give a competitive edge to your business. Investing in the right equipment that allows use of recycled content is an investment in the future success of your organization.
- 3. Be methodical and transparent in your sourcing and tracking of recycled content inputs.** Customers want to be able to report the exact percentage of recycled content that ends up in their products and this transparency depends on their suppliers. It is up to manufacturers and converters to track this material from its source and communicate it to customers.
- 4. Invest in long-term relationships with customers.** The use of recycled content in packaging is a journey on all ends of the supply chain. Working closely with your customers to provide detailed information and technical support will enable you to establish long-term, stable relationships built on trust.

## Making recycled content claims to consumers: What you need to know

If a company communicates to a consumer that its package is made using recycled content, that constitutes an environmental marketing claim. In the United States, the Federal Trade Commission (FTC) governs the appropriate use of environmental marketing claims and has issued its [Guides for the Use of Environmental Marketing Claims](#) (more commonly referred to as "*the Green Guides*") to help marketers avoid consumer deception. Recycled content claims should be made in accordance with the *Green Guides*.

In order to claim a package is made with recycled content, one must substantiate that claim with supporting data. For items that are partially made of recycled content, the brand should clearly and prominently qualify the claim to avoid deception about the

amount or percentage, by weight, of recycled content in the finished package. For full details see [Guides for the Use of Environmental Marketing Claims](#), Code of Federal Regulations, Title 16 Part 260, Section 13. § 260.13.

In Canada, very similar legal guidance applies. See [Environmental Claims: A Guide for Industry and Advertisers](#), developed by Competition Bureau of Canada and Canadian Standards Association pursuant to the Competition Act, the Consumer Packaging and Labelling Act. § 10.8.



*“Marketing teams are always keen to put environmental claims on-pack. With proper substantiation, navigating the FTC’s guidance for recycled content claims is much easier than it is for many other types of environmental claims. Our marketing team appreciates ‘easy’ claims.”*

– Brand Owner

## THE PATH TO USING RECYCLED CONTENT

Not all journeys to incorporate recycled content into packaging are the same. If your company is new to using recycled content, or evolving to use more recycled content, here are some key considerations as you move through the journey:





# ALL PLASTICS



## Environmental benefits of recycled plastic

Using recycled plastic is a multifaceted opportunity to decrease the environmental impacts of plastic packaging. The recycling system that creates recycled plastic is almost always less energy and greenhouse gas-intensive than the conventional fossil resource extraction, refinement, and manufacturing processes that create virgin plastic. Using recycled plastic inherently decreases consumption of fossil resources over the packaging life cycle, since the fossil feedstocks used to create virgin plastic are not attributed to recycled plastic. Lastly, the system of plastic recycling is gaining increased emphasis as a strategy to prevent the mismanagement of plastic packaging waste that results in plastic pollution in terrestrial and marine environments. The use of recycled plastic creates market pull for these materials and is critical to ensuring that system remains robust and effective.

## General guidance for using recycled plastics

Each type of recycled plastic carries its own set of characteristics and considerations, which are covered in detail in other sections. However, there are some common themes that are broadly applicable:

**The common assumptions surrounding recycled plastics should be challenged.** There are many common misperceptions related to recycled plastics, including safety and cleanliness, consumer acceptance and understanding, dramatic losses of performance and aesthetic qualities, and lack of return on investment on the price premium associated with many recycled plastics. While many assumptions may be grounded in a kernel of truth, the level of mistrust surrounding recycled plastics is undue and in many cases, outdated. When presented with these types of descriptions of recycled content, asking for data or examples can be useful to understand whether or not the concerns are valid.

**Experimentation and incremental increases are important strategies for using recycled content.** Instead of approaching suppliers with a request for a specific percentage of recycled content, brands should aim to incorporate as much as possible while balancing trade-offs around performance, aesthetics, and cost. After taking a first step to introduce a small percentage of recycled content, experimentation should be used to determine the optimal level. This stair-stepping approach is also preferential to suppliers as they navigate the learning curve, allowing them to get the processes under control and make needed adjustments.



*“You don’t want to go from 0% to 100%. You want to dip your toe in the water and gradually go in.”*

– Plastics converter

*“It takes time. Often it’s a ramp up... it’s not a switch that just turns on... [Our customer] didn’t come to us and say we want to convert this one bottle to PCR in three months. We were able to look at their whole product line, as well as some products in development, to identify some low hanging fruit with them first, while we got creative [on other challenges].”*

– Plastics converter

**Don’t rely on your existing supply chain partners to say what is possible in all instances.** Some converters may be reluctant to use recycled content, citing reasons ranging from odor in the processing to an aversion to equipment adjustments. In contrast, other converters have made substantial capital investments to accommodate recycled content and are trusted sources of expertise. Conversely, some brand owners may have false assumptions about recycled content, so suppliers should leverage their expertise to both broaden and clarify the set of options available for brands. The best way to broaden perspectives is to work together creatively, using curiosity to learn what possibilities innovation might unlock, and maintaining an openness to new forms of supply chain collaboration.



*“In general, the converters don’t [proactively] bring [us] these types of technologies and options. We have much more luck with raw material suppliers coming to us and then us pushing it through the supply chain. The suppliers of recycled content come to us to tell us and educate us about their product and then we push it through to our converters, because converters have silos full of virgin. They don’t want to bring in new materials if they don’t have to; they want to simplify their supply chain. So it’s not something that they will readily offer up as options unless we’re pushing for them. We try to **pull through the supply chain instead of having it pushed from our converters.**”*

– Brand Owner

## Supply and demand of recycled plastics

In general, only **the higher quality recycled plastics have substantial end markets in packaging** — mostly high grade recycled PET and HDPE — **and there is not enough supply available on the market to meet current demand** for these materials. Conversely, there is surplus in supply of lower grade recycled plastics currently on the market (lower quality PET or HDPE and other plastics). More demand is needed for all recycled plastics to help drive more collection and better quality.

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**Key initiatives for building demand for recycled plastics:**

- ▶ The Association of Plastic Recyclers' (APR) [Recycling Demand Champions](#) program gathers industry commitments to increase use of recycled plastics, including use of recycled plastics in "Work In Process" (WIP) items such as crates, pallets, totes, drums and trash cans. These WIP items represent opportunities for use of lower grade recycled content that is more challenging to incorporate into consumer-facing packaging. APR provides a [vendor list](#) of WIP products using recycled content. In the program's first year, it [increased](#) demand for recycled plastics by nearly 7 million pounds.
- ▶ More Recycling's [Buy Recycled Products Directory](#) is an interactive, online directory that highlights consumer products currently using post-consumer resin as part of an industry-wide effort to help stimulate demand for recycled content. The directory includes criteria for being included as well as a performance meter.

## Success Story



# Unique feedstocks for recycled content plastics: ocean bound plastics

Every year, 8 million metric tons of plastic ends up in our oceans, and that figure could increase by tenfold over the next 10 years if actions are not taken. The majority of this, referred to as "ocean bound" plastics, comes from mismanaged waste from [within 30 miles](#) of a waterway or coast. Plastic found in the ocean and plastic bound for the ocean (on beaches or near waterways) has become an environmental poster child for the need to improve recycling systems and end markets for plastics. Some suppliers and brand owners have committed to sourcing ocean-bound plastic for reuse in their products and packaging as recycled content.

Envision Plastics has committed to recycling 10 million pounds of ocean bound plastic over two years. To date, Envision Plastics has recycled five million pounds of HDPE, working with coastal organizations to collect packaging waste before it enters our waterways and shipping it to Envision Plastics' plants where it is processed using its patented Deodorized Resin™ technology to clean and remove odors. Envision Plastics has had numerous partners use its OceanBound Plastic in consumer products and packaging. Earlier this year, ViTA debuted a hair care line using the first bottle made from [100 percent OceanBound Plastic](#).

This unique source of feedstock for recycled content gives suppliers and brand owners an opportunity to showcase their role in mitigating the risk of mismanaged plastic waste, and also demonstrates how recycled content can have a **story that appeals to consumers**. It helps consumers understand recycled content and empowers them to feel they are helping solve the marine debris problem with conscious purchasing choices. Tamsin Ettefagh, Vice President of Sales and Purchasing at Envision Plastics, said at the 2018 Plastics Recycling Conference that one of their customer's products in an OceanBound Plastic bottle was so successful that "it sold out in seven minutes."



## Cost of recycled plastics

High quality recycled plastics often come with a price premium compared to their virgin counterparts. Prices fluctuate greatly and some recycled plastics — particularly those with suboptimal technical and aesthetic characteristics — can be supplied at a cost advantage. It is also important to consider that the use of recycled plastics may introduce added processing costs, especially when there are stringent specifications

for performance and aesthetics that must be met. **Companies that excel in using recycled content consider any added costs as an investment to upgrade their packaging**, finding justification within the robust business case for using recycled content.

A lack of long term contracts in material procurement can lead to price volatility and inconsistencies for recycled plastics, **which creates market uncertainty and discourages investment. Strategic partnerships that increase the length of contracts between MRFs, recycled plastic recyclers, converters, and brand owners can be used to negotiate stable, lower prices on recycled content.** This strategy has been successfully used in other commodity markets where long-term contracts specify payment of a fixed margin above the cost of production and all parties involved benefit from predictable pricing. Long term contracts can also help create demand stability for recycled plastics that in turn helps encourage investment.

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*“In terms of demand, how are you going to support the resin? [It’s important] for us to understand the quantity and the longevity [before] being able to enter into a relationship with a customer... if it’s someone that just wants one truckload of a particular type of resin in a particular type of color, and it doesn’t exist today, and so therefore they’re just going to move on, then it’s probably not worth our time or their time. We have the most successes where we work together with companies that have ongoing demand and the commitment to enter into a relationship with us, and collaborate and solve problems together.”*

- Plastics Recycler

*“[Developing a certain package with recycled content] can take six months, 12 months to develop. But once you get it, then you can maybe start getting the price advantages. But you have to really make the commitment; you’re going to have to go all-in and it’s going to be a multiyear effort; it’s not something where you’ll throw it on the shelves in three months and then get out of it immediately if it didn’t work for you.”*

- Plastics Converter

*“There’s an opportunity to do some long-term contracts potentially that some companies have success with, and that can help the procurement situation for both the recycled content provider as well as the company. So I think that that’s an opportunity that we’ll be looking at in the future.”*

- Brand Owner

## Success Story



# Embedding recycled plastics into the business: Seventh Generation

Seventh Generation has successfully navigated many of the challenges associated with recycled plastics, including their practice of allocating product and process cost savings to help pay for recycled content in their packaging.

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*“Instead of taking dollars in [process and/or product] cost savings and just driving them right to the bottom line, which is what most traditional companies would do, we try to roll cost savings into packaging improvements or product improvements and maintain margins where they are. That helps us pay for sustainability.”*

- Derrick Lawrence, Director of Packaging Development



Seventh Generation has a corporate-level commitment to use recycled content, and all departments are on board with the strategy. They have strong relationships with their suppliers and educate their sales teams around technical specifications so they can work with suppliers to get advancements.

Seventh Generation communicates to its customers about recycled content. Their products have a logo embossed on the front of most bottles that says “100% RECYCLED BOTTLE.” The back label of the bottle explains what that means.



Incorporating recycled content into packaging has been a long journey for Seventh Generation. The company began by using HDPE and has progressed to almost 100% recycled content in most of their HDPE and PET bottles today. In addition, the company brought polypropylene closures made of 100% recycled content to the market and recently launched some of the first flip top closures made of 100% recycled polypropylene. Seventh Generation is also exploring the use of recycled polyethylene in LDPE films.

## Processing of recycled plastics

Adding recycled plastic to existing manufacturing processes isn't always straightforward. Recycled resins don't always act like virgin resins. The melt flow rate, an important indicator of the behavior of plastic in converting processes, can differ between virgin and recycled batches of the same polymer type, which introduces unwanted complexity. Even high quality recycled plastics can display inconsistent flow behavior, which is generally attributed to contamination within the recycled feedstocks. Investment in new or upgraded processing technologies and adjustments to equipment is a necessary and worthwhile investment to meet growing demand for recycled content.

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*“As conversion technologies improve, like with blending or quality processes, we will be able to use more and more recycled content and still meet the demands of the end users.”*

– Plastics Converter

*“Manufacturing challenges with recycled content aren't insurmountable, so we have to overcome challenges. But there can be challenges with running higher recycled content on a manufacturing line. We have to prioritize the time that is spent to qualify materials. Since we run high volume, high speed lines, if the recycled content lends itself to a defect on that line, then we may have shut downs on the line – and that's a problem. So what we do is a lot of quality assurance and work up front to qualify and adjust our systems to accommodate that variability. That takes time and resources, so if making recycled content a reality is a priority for the business, there needs to be direction [from leadership] to the manufacturing team.”*

– Brand Owner

# Performance of recycled plastics

Virgin plastic and recycled plastic rarely perform the exact same way. Contamination from other plastics in the recycled feedstock is the chief influencer, but colorants and additives in plastic packaging can also act as contaminants in recycled plastics. This can result in differences in a recycled plastic's performance, including characteristics that affect sealing or structural integrity. However, there are solutions available to help manage many of the performance differences between recycled and virgin plastics.



*"We will never be able to compete with perfect, and it's not fair or a realistic expectation."*

- Plastics Recycler

**There are tools to assess the performance of recycled plastics.** There are well-established technologies that evaluate the quality of recycled plastics using physical, chemical or other tests. One of the most effective methods to check the quality of a recycled plastic involves running a small batch of extrusion blown-film. In a film format, the material can be checked for stability, bubbles, gels, color, odor, strength and other quality measurements. Any poor-quality material can be discarded or blended with a better performing material, depending on the end use application.

**Techniques exist to improve performance of recycled plastics, including resin compounding, blending of various grades of a resin and introduction of performance additives.** Performance additives include but are not limited to: antioxidants, UV absorbers, anti-block agents, colorants, fillers, and impact modifiers. These additives can increase performance and reduce defects like gels, brittleness, and odors. Some of these technologies are well-known in polymer engineering yet have not been widely adopted when using recycled plastics.

## Featured innovation: Water-based heat sealants

Water-based heat sealants may alleviate issues related to heat sealing recycled plastics, a common problem due to the different melting points of recycled resins. These products are beginning to enter the market and can be explored as a way to increase the use of recycled plastics while minimizing performance challenges.

# Aesthetics of recycled plastics

Color consistency and color matching are common challenges in using recycled plastic, since brands tend to implement very stringent color requirements for packaging. Unlike virgin plastics, which initially do not contain pigments, recycled plastics are derived from mixtures of materials that may contain a wide range of pigmentation. Brands interested in using recycled plastics must manage their expectations and commit to finding ways to work with the color variations present in recycled resins.

White or lightly colored recycled plastics may take on an off-white color. Clear recycled plastics may take on a somewhat yellowed appearance due to the reheating process, or a cloudy appearance due to contamination in the recycled feedstock. Natural, white or lightly colored recycled plastics can be adjusted by adding colorants to match brand colors, however, their new color may appear less vibrant than virgin material colored with the same colorant. Mixed-color streams of recovered plastics can typically only be recycled into dark, opaque colors.



*"Typically, recycled materials are darker, grayer, or have some tint to them and that tint is not always consistent from batch to batch."*

- Plastics Recycler

While these challenges are more pronounced with higher levels of recycled content, **there are numerous examples of plastic packaging containing upwards of 30% recycled content with no or negligible aesthetic deficiencies.** That percentage can be considered a general threshold above which aesthetic challenges should be expected to be more noticeable. While transparency may be critical for some applications, it is also important to note that the use of opaque plastic packaging allows for higher percentages of recycled content with fewer color challenges.

Progressive brands accept color variations that consumers can see, setting expectations with marketing departments and communicating variations through consumer messaging. This is easiest to implement in a new product line, a new brand, or a rebranding, in which alignment of expectations and strategy may be performed at the start. If the entire organization is aligned around recycled content, then discussions on color and modifying specifications become easier.

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*“Color is a conversation that has to happen between your sustainability group, your marketing group and your executive level. It all boils down to where [your culture] places value.”*

– Plastic Recycler

Other design strategies to navigate these variations include using recycled content in applications and products where color is not of such high importance, such as trash bags, inner layers of multi-layer rigid containers, or other areas the consumer does not see, like applications in which the material is hidden behind a label. Concerns about color matching across products and units are more relevant for packaging on retail shelves than for online retail, and so online products may be an easy area to initiate higher levels of recycled content. **Additives, such as specially formulated brighteners or clarifiers, can counteract the cloudy appearance typical of recycled resin.**

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*“Color doesn’t need to be as big of an issue as I think that industry perceives it to be. The color challenges can be overcome.”*

– Brand Owner

## Food contact for recycled plastics

Despite common misperceptions and skepticism, many recycled plastics meet the required quality for food, beverage and pharmaceutical applications. Most plastic recyclers providing recycled plastic for food-grade packaging applications have successfully petitioned for a “letter of no objection” (LNO) from the FDA, which provides assurance that the recycled plastic is safe for food-grade applications. It is important to note that the FDA does not test the recycled resin, and it is therefore up to individual recyclers to ensure their feedstocks and processes will consistently produce food-grade resins. There are mechanisms comparable to the FDA LNO in other countries.

Some producers of recycled plastic for food-grade applications restrict their feedstocks to post-commercial or post-industrial plastics that were previously designated as food-grade. Any added colorant must be individually compliant with FDA requirements, so clear plastic is commonly used for recycled food-grade resins since it is easiest to add a colorant that is known to be compliant to a clear recycled plastic.

Another approach to including recycled plastic in food packaging is to limit the use of recycled plastic to the inner layer(s) of a multi-layered construction, with an innermost virgin layer acting as an effective functional barrier. However, it may be necessary to demonstrate that the barrier will protect foods or drugs from unwanted migration.

Unfortunately, skepticism and misperceptions around the safety of recycled plastics for food and drug applications are common. Changing minds internally about the safety of food contact recycled content may be a hurdle, but it is important to gather support from within the organization for recycled plastic. Sharing information with others about the FDA’s process for issuing LNOs and the process used by suppliers to ensure food contact safety may be helpful.

### Emerging innovation: chemical recycling

Many of the considerations for performance, processing, and aesthetics of recycled content plastics are the unavoidable result of mechanical recycling. While there are many opportunities to improve the existing mechanical recycling systems and recover more recycled plastics of higher quality, other technologies will also play a role in the future recycling system. **Chemical recycling shows significant promise in solving many of the quality issues the system faces today surrounding recycled plastics since it is able to remove contaminants like additives and pigments and in some applications it can deconstruct a polymer to its original monomer, achieving virgin-like quality.**

There are varying definitions of chemical recycling, but the majority of research classifies it as either 1) purification, 2) decomposition, or 3) conversion. Different polymers require different technologies, and that may mean that chemical recycling becomes more of a reality for some plastics or within certain contexts but not for others. There are currently several brand owners and converters investing in different chemical recycling technologies as a long-term strategy to increase the quality of recycled plastic. Some of these examples are provided in the following sections.



## POLYETHYLENE TEREPHTHALATE (PET)

### Key takeaways

- ▶ The use of recycled PET is common in the marketplace, and there are examples of PET packaging using 100% recycled content. However, current availability of supply may limit the number of PET packages that can use high percentages of recycled PET.
- ▶ PET is generally regarded as an easy starting point for brands interested in using recycled plastics.
- ▶ PET is widely accepted in recycling systems and has higher collection rates than many plastics, providing a regular flow of feedstock for recycled PET.
- ▶ There is heavy competition for the highest quality, food-grade recycled PET, resulting in higher prices. Lower quality PET is more available and more likely to be available at a cost advantage.
- ▶ There are no significant performance challenges when using recycled PET, owing in part to the fact that unlike other plastics, the intrinsic viscosity of recycled PET can be upgraded to near-virgin levels.
- ▶ There tend to be aesthetic challenges related to the clarity of recycled PET and challenges related to achieving consistent color. Quality and consistency of recycled PET varies regionally, depending on the recycling infrastructure and the characteristics of the incoming PET stream available to the recycler.





## Environmental benefits of Recycled PET:

Using recycled PET can provide significant reductions in greenhouse gas emissions during manufacturing. Replacing virgin PET with “solid-stated” recycled PET pellet may reduce greenhouse gas emissions by [about half](#).

## Supply and demand of recycled PET

### What you need to know about PET recycling

PET is widely accepted in municipal recycling programs. Supply availability still has room for improvement, however, since only about [30%](#) of PET bottles and jars and 24% PET containers and packaging overall are recycled today.

Some PET bottles are subject to container deposit legislation (“bottle bills”) in [10 U.S. states](#). This system helps to promote higher collection rates in these states, enabling a cleaner and more consistent supply of PET for recyclers that in turn supplies consistent, high quality recycled PET.

Recycling for PET thermoforms is less widespread than PET bottles.

The majority of recycled PET in packaging goes towards clear applications, most of which require food-grade material. Demand for recycled PET is primarily influenced by the soft drink and bottled water markets, which commonly use small-to-moderate percentages of recycled PET and exhibit growing demand for recycled PET.



Some non-bottle rigid PET packaging applications provide significant markets for recycled PET, but exist in lower volumes than bottles.



There is heavy competition for supply of high quality, clear, food-grade PET. Conversely, there is ample recycled PET on the market with suboptimal characteristics, such as recycled PET that is colored or imperfectly translucent, or recycled PET that is not suitable for food-grade applications. There may be under-leveraged opportunities for use of lower grades of recycled PET in packaging.

As a market for recycled PET, packaging competes primarily with carpet, textiles, construction materials and strapping markets. More recycled PET is directed to carpet and textiles than packaging, in part because the manufacturing process for polyester fiber is more technologically and financially conducive to using recycled PET with specifications that would present challenges in packaging applications. Carpet and textiles are the principal end market for cheaper, colored (typically green) PET.

### Success Story



## Recycled PET in film labels

UPM Raflatac has developed a breakthrough PET pressure sensitive label face and liner composed of 90% post-consumer recycled content (PCR), an industry first. These rPET label materials, produced from bottle flake, are suitable for use in label decoration for brand and end-user packaging. UPM Raflatac developed this technology because it saw the opportunity to answer packaging sustainability needs expressed by brand owners. This represents a new packaging market for recycled PET.



## Cost of recycled PET

The cost of recycled PET is highly variable, based on both fluctuating virgin prices as well as varying costs associated with processing recycled PET that reflect regional differences in recycling infrastructure and contamination levels. Brands should expect to encounter some challenges around procuring recycled PET at their desired quality and price, given the intense market competition for clear, quality recycled PET.

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*“The market for rPET varies, so you have to be willing to ride the waves. There's gonna be times when the price is good, and there's gonna be times where the price isn't.”*

- PET Converter

## Processing of recycled PET

Degradation occurs during mechanical recycling of PET when it is shredded and exposed to high temperatures. The presence of common contaminants in the PET recycling stream, such as PE, PVC, and adhesives can exacerbate degradation effects and cause a loss of average molecular weight or intrinsic viscosity. This in turn can result in recycled PET with suboptimal mechanical properties. However there are many existing strategies to manage this, such as the intensive cleaning and drying of PET flakes before extrusion and diligent sorting of impurities.

## Performance of recycled PET

Recycled PET functions well in terms of performance, with few tradeoffs relative to virgin PET. There may be additional testing required for some containers with heavier load bearing requirements, since the strength of recycled PET may be less than that of virgin PET due to different processing considerations. However, in general there are no notable performance drawbacks to using recycled PET.

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*“[A common misunderstanding is] the performance aspect... a misconception for brand owners saying incorporation of recycled content - even from a consumer standpoint - means creating a lower grade product, which doesn't have to be the case.”*

- PET Converter

There are no significant performance challenges when using recycled PET, owing in part to the fact that unlike other plastics, the intrinsic viscosity of recycled PET can be upgraded to near-virgin levels. This is because PET is a polycondensation polymer whose molecular chain length can be repaired in a solid-stater to create better strength in the material.

## Aesthetics of recycled PET

**Discoloration is the principle aesthetics concern when using recycled PET**, since clarity is seen as an important quality for most PET packaging. Use of recycled PET in higher percentages can result in yellowing or a “haze” that creates challenges for packaging applications in which clarity is prioritized. In general, however, **recycled PET can be used at levels up to 25% without any noticeable difference**.

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*“Haze is going to be your first and foremost problem with the clear material. From a performance standpoint, I think you can tolerate a lot more than what you can from an aesthetic standpoint.”*

– PET Converter

**Some companies have been able to use 100% recycled PET with visual aesthetics that are virtually indistinguishable from those of virgin PET.** The translucence of recycled PET is highly dependent on the quality of the specific feedstock used. By working with suppliers to use the highest quality recycled PET available on the market, brands can avoid many of the concerns around aesthetics. It is commonly believed that the best material comes from states with bottle bills.

Alternatively, **companies can achieve higher levels of recycled PET usage by relaxing their aesthetic specifications and making different design decisions in order to successfully incorporate recycled content**, allowing them to use a broader PET supply.

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*“It can go both ways: you can look at it from a clarity perspective and accept lower amounts of recycled content because you know that’s the product look that you’re going for, or you can adjust your product look, your specifications, you can accept a little bit more haze, a little bit more yellowing, if you want that higher level of recycled content...Yes, some defects are going to be present, but are they present enough and strong enough to really make a noticeable change to the product in the consumer’s eyes?”*

– PET Converter

**Brand and marketing professionals play a key role in creating specifications that allow for the desired level of recycled PET usage.** It is critical to develop a brand proposition that aligns with any visual aesthetic considerations existing within the available supply of recycled PET. Many brand owners have successfully done this.

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*“[Using recycled PET] leads to a variation in the color of the bottle, probably not noticeable to the average person, but traditionally that has been against brand design guidelines. Every bottle has to be the exact same color. I could see some changes here where a green bottle says, ‘Sorry, our color may change from time to time based on the recycled content.’”*

– Brand Owner

## Managing the aesthetic qualities of recycled PET

Unilever brand *Love Beauty and Planet* uses 100% recycled PET in its bottles, even if it means they look less than perfect. Although using 100% recycled PET increased the aesthetic challenges, the brand insisted on it. Love Beauty and Planet worked with its suppliers to ensure there was no compromise on functional performance, and the brand chose to embrace the variations in color and transparency.

*"We realized that just because the bottle isn't as perfectly transparent as virgin PET, it doesn't mean it isn't as beautiful or unique."*



### Success Story

## Leveraging package design to manage recycled PET aesthetics

Procter & Gamble navigates the aesthetic issues of recycled PET in their Cascade Rinse Aid product line by creatively designing the *product* color to work well with recycled PET color variations. Recycled PET can display discoloration and inconsistencies from batch to batch, and the slight yellow tint of a recycled PET container can alter the appearance of the product's color. For example, a yellowish PET container can make a purple liquid product appear more brown — a major challenge for brand and marketing professionals. However, the specific blue-green color chosen for Cascade Rinse Aid is not perceivably different when seen in a container with a slightly yellow hue. Through experimentation, P&G found the right color that successfully circumvents the primary aesthetic challenge of recycled PET, enabling higher use of recycled content.





## Key initiatives in chemical recycling for PET

Chemical recycling is a promising development for very high quality recycled PET that is virtually indistinguishable from its virgin counterpart. While technology for chemically recycling PET has been around for many years, this has recently gained significant traction in the industry with notable investments that aim to bring this technology to an industrial scale that provides a cost effective, quality product.

[Loop™ Industries](#) already has developed a technology allowing for all types of waste PET plastic to be upcycled into high purity, food-grade PET plastic. Loop entered into a multi-year supply [agreement](#) with PepsiCo in 2018 that will enable Pepsi to purchase production capacity from Loop's joint venture facility in the United States and incorporate Loop™ PET plastic, which is 100% recycled material, into its product packaging by early 2020. PepsiCo has identified Loop™ PET as a commercially viable technology to expand the amount of recycled content in its product packaging and help meet its sustainability ambitions and consumer needs.

Similarly, [DEMETO](#) is developing a microwave-based process intensification process that can depolymerize PET on an industrial scale, invented by Swiss company [gr3n](#) with funding from the European Union's Horizon 2020 research and innovation programme. DEMETO is planning to validate their technology in the next few years and to have an industrial-scale reactor working by 2021. Coca Cola has joined Demeto's [Advisory Board](#) and hopes to start introducing this recycled material into their supply chain within five years. Chemical recycling processes are also being explored for polyester textiles, which [hold promise](#) for developing new recycling methods for PET packaging.



## HIGH-DENSITY POLYETHYLENE (HDPE)

### Key takeaways

- ▶ Recycled HDPE is widely used, with many proven examples on the market, including containers with very high levels of recycled HDPE and negligible performance or aesthetic deficiencies.
- ▶ Challenges surrounding recycled HDPE center around performance and aesthetic issues, notably reduced stress crack resistance, visible imperfections, and difficulty achieving a bright white appearance. However, there are many design choices that can mitigate

these challenges.



## Environmental benefits

By switching from virgin to recycled HDPE pellets, preliminary findings from [one study](#) show potential greenhouse gas emission reductions in the range of 65 to 70%.

## Supply and demand of recycled HDPE

Most recycled HDPE is made from used milk, water, juice, cosmetics, hair care, household cleaner, and detergent containers. This recycling stream is divided into two main categories of recycled HDPE: “natural,” which is partially transparent and made predominantly from milk jugs, and “mixed color,” made predominantly from opaque, colored HDPE bottles. The greatest demand is for natural recycled HDPE, even for applications that will be made opaque and colored, since natural recycled HDPE is more conducive to adding color. The overall demand for recycled HDPE is believed to be increasing, but currently supply constraints are not regarded as a significant impediment to business.

### What you need to know about HDPE recycling

There is a steady and stable supply of recycled HDPE, due in part because HDPE containers are widely accepted in recycling programs and converters have developed processes and quality controls that enable them to supply consistent streams of recycled HDPE. There is room for improvement however, since only about 30% of natural colored HDPE bottles and 16.4% of HDPE containers overall are recycled today and made available as a feedstock stream for recycled HDPE.

## Cost of recycled HDPE

Natural recycled HDPE is more expensive and tends to be priced higher than its virgin counterpart, while mixed color recycled HDPE may come at a similar or less expensive price compared to virgin HDPE. As with all recycled content, price fluctuations should be expected and any price premiums should be considered investments in more sustainable packaging.



*“I’m always seeing an increase in demand by new people coming in thinking that that’s what they are going to do. A lot of them get sticker shock when they find out that recycled resin costs them more than virgin resin, so it’s up and down, and I would say that overall the movement keeps growing in recycled.”*

- HDPE Recycler

# Processing of recycled HDPE

One central challenge converters face when using recycled HDPE is the presence of EVOH, which is used as an oxygen barrier in many HDPE containers. EVOH burns at a lower temperature than HDPE, and some reprocessors report that burnt EVOH may stick to the extruder or the die heads of blow molding equipment, particularly carbon steel. As it builds up over time, it may show up as black specks in the recycled HDPE or as die lines on recycled HDPE bottles. Furthermore, when the residue sticks to die plates, it can alter the shape of pellets. Nylon, though less prevalent than EVOH in the HDPE recycling stream, may cause similar issues. However, others report that additional data is needed to substantiate these concerns.

Challenges surrounding injection molding of recycled HDPE can arise due to lack of total uniformity in recycled HDPE batches, including inconsistent granule sizes, the presence of colorant or other additives, and contamination from other plastics. Some converters are fearful that recycled HDPE might damage their molds, while others have figured out how to make the process work.

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*“At the beginning it was a challenge to find partners even willing to run recycled content. That’s less of a problem now in bottles, but it’s still an issue with injection molding components. Those manufacturers are extremely sensitive to the materials they run through those molds. They are very expensive molds in general so they don’t want to take any risk.”*

- Brand Owner

Recycled HDPE suppliers stress that brands should be open to experimenting and working with their converters to find the right technical process for incorporating recycled HDPE. It is also important to emphasize that the quality of recycled HDPE varies by plastic recycler, so **brands should work closely with all their suppliers (both plastic recyclers and converters) to manage potential processing issues.**

## Performance of recycled HDPE

The principle performance challenge of recycled HDPE is stress cracking, particularly for larger bottle sizes (over 50 ounces). This requires producers to be careful about the design of the bottom radius of larger bottles. When molding bottles, converters may incorporate different flash pocket designs, where extra plastic is included on a molding along the parting line, to help increase the stress crack resistance in those areas.

## Aesthetics of recycled HDPE

The main aesthetic challenge of recycled HDPE is color consistency, as it may be difficult to consistently achieve a specific brand color. This challenge is particularly present when using mixed color recycled HDPE, which can carry pronounced variations between batches. The use of natural recycled HDPE helps alleviate this challenge since it is more conducive to colorant, but even natural recycled HDPE should be expected to exhibit slight variabilities from batch to batch. Brands willing to use darker colored recycled HDPE, for which there is typically low demand, can expect lower prices for recycled HDPE while helping to drive the market for this segment of the HDPE recycling stream.

In addition to color, very high levels of recycled content may lead to visual imperfections like black specks. As with most considerations related to recycled content, it is important to find a supplier who will work with you to navigate the immense variability in the characteristics of recycled HDPE and help you find a resin that meets your needs.

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*“We’ve got a supplier now that is able to give us a very bright base resin color that is closer to a virgin, and so our color is a little bit better, we’re running whites and yellows and oranges, some of those really light colors, actually looking very good.”*

- HDPE Converter

Brands that embrace the unique aesthetic qualities of recycled HDPE can showcase their support of sustainable packaging. If there are clear company goals around using recycled content, then there may be an opportunity to proudly display the visual imperfections as a sign of the brand's commitment to sustainability. In the realm of paper packaging, for instance, there is widespread acceptance of, and even preference for, the uneven "recycled brown" appearance. **Forward-thinking brands can consider visual imperfections in recycled HDPE containers as a similar symbol of sustainable packaging.**

“One customer wanted a 100% recycled content HDPE bottle and we told them there would be black specks, and they said, ‘that’s okay’ because it was part of their brand. When consumers see that, they’ll know that it really does have recycled content.”  
 - HDPE Converter

Brand owners may also choose to use a higher level of recycled HDPE in the middle layer of a bottle, if the converter has the capability to create tri-layer blow molded containers. When this is possible, moderate levels of recycled HDPE can be used – confined to the middle layer – allowing the exterior layer to be virgin resin.

### Success Story



## Recycled HDPE for white bottles

In 2016, Seventh Generation rolled out a new 100-ounce laundry detergent bottle made from 80% recycled HDPE, 17% bio-based HDPE and 3% colorant. Derrick Lawrence, Director of Packaging Development for Seventh Generation, explains that the 80% level of recycled HDPE was derived from extensive testing. They learned that stress crack resistance became too low when recycled HDPE exceeded 80%. Through a process of trial-and-error they determined the maximum optimal level of recycled HDPE. To navigate challenges related to visual aesthetics, they used a high quality natural recycled HDPE to which they added white colorant. Although the resulting color is not perfectly bright white, they noted that this product is typically not shelved next to competing bright white laundry detergent bottles at retailers and therefore has minimal risk of appearing comparatively “dingy” to the consumer.





# POLYPROPYLENE (PP)

## Key takeaways

- ▶ The PP recycling system is still developing, but there is significant demand for recycled PP and there are strong efforts to provide that supply. The availability and quality of recycled PP will likely trend in a favorable direction.
- ▶ Today's challenges revolve primarily around supply availability, color deficiencies, and brittleness. However, additives can correct some of the mechanical property issues.

## Environmental benefits



Preliminary results of one study found that by replacing virgin PP with recycled PP, greenhouse gas emissions during manufacturing can be reduced in the range of 65 to 70%.

## Supply and demand of recycled PP

### What you need to know about PP recycling

The supply of recycled PP is hampered by the relatively low recycling rate of PP, which currently stands around 8%.

Historically, many MRFs have sorted PP into a mixed plastics bale, which has limited commodity markets in the United States and, prior to the Chinese import restrictions introduced in 2017, was largely exported. Other MRFs have created a dedicated PP stream, and more MRFs may be doing so in today's marketplace in response to a declining prevalence of mixed plastic bales.

PP caps and closures are an important constituent of the PP stream available for recycling. Their small size renders them difficult to capture when they are alone in recycling systems, but when caps and closures are attached to containers they can be removed and sorted by plastic recyclers. The proliferation of “caps on” messaging has been an important initiative for PP recycling.

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*“It’s only been recently, with the ‘caps on’ initiative, that polypropylene has been more widely collected and sorted and processed. Supply is improving.”*

– Brand Owner

Although recovery rates are low, millions of pounds of recycled PP are available, and that supply is generally believed to be stable or growing. However, it has been outpaced by demand, particularly for food-grade recycled PP and clear recycled PP.

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*“We have seen tremendous growth in polypropylene. People want it.”*

– PP Recycler

*“We’re just not seeing it as available as we’d like to.”*

– Brand Owner

The bulk of the recycled PP supply comes from residential recycling of dairy product tubs like yogurt, sour cream and margarine, as well as caps and closures that have been separated from other bottle resin streams. Additional supply is sourced from non-residential streams, including institutional cafeterias and hangers from retail clothing locations. **The biggest potential for growth is in collection and reclamation of the residential stream**, and there are some observations that supply availability is improving and will continue to do so.

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*“When we started seeing some packaging conversion to polypropylene, the phone started ringing more and more asking for polypropylene. That opened us up to be able to make a significant innovation and investment. We were able to work with our MRFs and ask them what it would take to source-separate that.”*

– PP recycler

**Food-grade recycled PP is available but in very limited volume.** There are a few, large suppliers who have a letter of no objection (LNO) from the FDA for recycled PP. Other smaller suppliers are able to provide food-grade recycled PP sourced from niche streams of material such as hangers from retail operations, which are very consistent sources of material that provide high quality recycled PP, but are limited in volume. The remaining opportunity to provide food-grade recycled PP most likely lies in bigger and better recovery of PP through residential recycling programs.

## Cost of recycled PP

Prices for recycled PP have historically been volatile, despite growing demand. This reflects fluctuating virgin PP prices, against which recycled PP prices are often linked, as well as the new capital expenditures required by MRFs, plastic recyclers, and converters in order to supply

growing volumes of recycled PP. High quality recycled PP is not always available at an attractive price but in some cases is available at prices similar to virgin PP. As with all recycled materials, the use of long-term contracts help support price stabilization.

## Processing of recycled PP

Inconsistencies in the physical properties of post-consumer PP may impact its behavior in converting operations, which can affect a converter's ability to work at the same scale and speed as they can with virgin resin. For example, using injection molding with recycled PP is difficult due to its lower viscosity, which causes it to fill molds slowly. The use of additives and the practice of blending recycled PP with virgin resin may alleviate some of these inconsistencies.

## Performance of recycled PP

Because recycled PP has a higher melt index, it is more appropriate for injection molding than thermoformed applications. **The chief deficiency in the performance characteristics of post-consumer PP is greater brittleness**, causing challenges in certain applications with higher vulnerability to cracking, such as closures and containers with sharp corners and notches. There are ample applications that can tolerate moderately increased brittleness, including containers with more rounded corners and non-hinged caps. Even in components with tighter tolerances, like hinged caps, shoulders, edges, and corners, the performance deficiencies of recycled PP should not automatically be considered prohibitive, as it is not uncommon for conventional performance specifications to be unnecessarily stringent.

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*"[Recycled PP] can be more brittle, but... we just understand that we're sacrificing a little bit of performance... **a lot of these caps are over-designed anyway**. So we're not really seeing increases in consumer complaints but we know that from a technical standpoint it performs a little less. But it performs good enough."*

– Brand Owner

Some companies have shown success using recycled PP even in these more challenging applications.

### Success Story



## Recycled PP in closures

Some converters have been reluctant to run recycled PP through injection molding due to historical issues with the quality of recycled PP. This, accompanied with concerns of hinge resiliency, have limited the use of recycled PP in dispensing closures. By designing with the performance of recycled PP in mind from the start, TricorBraun was able to [produce](#) a closure made of 100% post-consumer recycled PP with hinge performance close to virgin PP for Seventh Generation's liquid dish soaps.



One of the challenges in developing this 100% recycled content cap was identifying a consistent stream of recycled PP that would perform as well as virgin PP. The stream used for this cap is primarily recycled PP clothes hangers.

TricorBraun and Seventh Generation worked very closely together to conduct trials of various hinge designs in pilot tools prior to commissioning a production tool. The confidence the molder gained in doing this has led them to incorporate 100% recycled PP in additional dispensing closures.

## Success Story



# Recycled PP in new alternative packaging formats

Berry Plastics and Burt's Bees™ raised the bar significantly on the use of recycled PP in squeezable tubes, bringing to market the first commercialized squeezable tube with 60% post-consumer recycled PP. The maximum amount of recycled content for this line of tubes, excluding the closure, varies from 57% to 62%, depending on the tube diameter and length. Berry uses up to 53% recycled content in the body of the tube and up to 75% recycled content in the tube shoulder.



## Aesthetics of recycled PP

The principle aesthetic challenge of recycled PP is its ability to be colored. Most recycled PP available is gray or a darker color, which inhibits the ability to create lighter or brighter colors in new products. Natural and colorable post-consumer PP is available, but in smaller volumes and generally at a higher cost. However, technologies that improve colorability are quickly evolving and new strides are being made. Since demand for recycled PP is new and growing – as well as the associated growth within the PP recycling stream – advancements should be expected at a relatively high pace.



*“Color is really interesting; it can kill the conversation before it even starts. We will get phone calls about applications and it could be spot on every other technical aspect of the resin, and meet all the relevant qualifications, but if it’s not white, they hang up the phone or report back to their team, ‘Oh, it doesn’t exist yet.’ But for the brands who have made that commitment to work with us to come up with creative solutions, one false assumption is that we cannot meet your color goals. We can, in many instances. Never say never!”*

– PP Recycler

*“You’re not going to get a white polypropylene recycled content. You’re just not. If we could source separate white or natural polypropylene for you, you wouldn’t want to pay for it. So there are still a lot of gaps out there as far as demand goes.”*

– PP recycler

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“Everywhere we’re using recycled content in an injection molded application, it’s a black application. Brand customers sometimes want to use recycled content in non-black, or lighter colored injection molded applications and [we have] to have a tough conversation with them.”

– PP Converter

Some companies have rebranded the color of their caps and closures to darker colors, which enables higher use of recycled PP. Since natural recycled PP tends to be gray, any darker color makes color matching much easier. Those who use recycled PP in their caps should publicize their efforts to let consumers know when recycled materials are being used.

Beyond the issue of the color itself, there is an issue of inconsistency in color. As with most post-consumer recycled resins, **appearance tends to vary from load to load** – it may be lighter or darker. To successfully implement recycled PP usage, **there must be acceptance of these inherent aesthetic deficiencies and a cultural willingness to work within the confines of darker colors and slight variabilities in those colors.**

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“I think [marketing is] willing to try different colors, or maybe add pearlescence or something. I think the team is willing to look at redesign of color.”

– Brand Owner

## Game-changing innovation: purification of recycled PP

As a response to growing demand for post-consumer recycled PP and the aesthetic and performance deficiencies of the available resin, Procter & Gamble teamed up with PureCycle to launch a new technology innovation in 2017. PureCycle’s process “purifies” recycled PP using a unique set of mechanical and thermal processes to remove odor, contaminants and most color, generating a recycled PP with properties much more similar to virgin resin.





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*“We started acknowledging that we really can’t work very well with the recycled polypropylene material that’s available. There didn’t seem to be any good industry solutions to making a better quality of polypropylene just through mechanical recycling and sorting. Chemical recycling, where you take it back to the monomers is certainly a possibility, but then you have to re-polymerize it. So in a life cycle analysis you get into some losses there because you’re basically going through the process to make polypropylene again. That’s why one of our scientists developed the PureCycle process... it’s just a way to remove all of those impurities – the color and other additives. The technology itself has been proven.”*

– Brent Heist, P&G

P&G noted that it would have been great to develop this technology for internal use only, for use in their own packaging, but there is a need to achieve market scalability for these technologies in order to improve financial viability. It was determined that the best way to achieve access to the broadest market of recycled PP was to license the technology out to a third party. The PureCycle process has been licensed to PureCycle Technologies who are scaling up the process for commercial production. This means that others in the PP market can take advantage of this new innovation – not just P&G. The feasibility of commercially scaling this technology has yet to be proven, but it could be a significant innovation.



## POLYSTYRENE (PS)

Key takeaways

- ▶ The use of recycled PS in packaging is limited.
- ▶ There are examples of small-volume rigid PS product lines containing 100% post-consumer recycled PS, but in general it is uncommon for rigid, expanded and extruded foam PS packaging to contain more than 25% post-consumer recycled PS.
- ▶ Post-industrial recycled PS is commonly used in levels up to 20% and is often self-generated by the converter.
- ▶ The largest barriers preventing wider use of post-consumer recycled PS include lack of supply (since PS is not widely recycled) and lack of food-grade recycled PS.
- ▶ There are some technical performance limitations when post-consumer recycled PS is used in expanded PS (EPS). It is more difficult to include post-consumer recycled PS in EPS applications compared to rigid and extruded foam PS applications.
- ▶ Post-consumer recycled PS presents some aesthetic drawbacks — most notably yellowing — but these drawbacks are not pronounced when post-consumer recycled PS is used at levels around 25% or below.



## Environmental Benefits

Companies using recycled PS have **estimated** their recycled content usage results in a 15 to 20% greenhouse gas emissions reduction compared with using entirely virgin content. Although PS is not widely recyclable, using recycled PS content allows PS to participate to some extent in the circular economy.

## Supply and demand of recycled PS



## What you need to know about PS recycling

Only a very small percentage of PS packaging is recycled and made available for use as recycled PS. The EPA [estimates](#) that 5.4% of post-consumer PS packaging is collected for recycling annually, which equates to about 30,000 tons. Other PS recycling streams exist, but the construction and demolition recycling stream is the only other stream of significant volume. PS in that recycling stream often contains fire retardants, rendering it unsuitable for use as recycled PS in new packaging.

Rigid PS containers and trays are accepted in the majority of U.S. consumers' recycling programs; in contrast, EPS packaging is only accepted in a small minority of consumer-facing recycling programs. EPS presents challenges in the recycling stream because of the limited end markets for recycled EPS, its propensity to fragment and contaminate other material streams, and its extremely low density, which restricts the weight of material that can be transported within a unit shipping volume. Most successful EPS recycling programs involve densification, in which a specialized piece of equipment grinds and melts EPS to reduce the density by a factor of around 50. The material properties of the densified PS are suitable for the manufacture of new durable and nondurable goods, but not new packaging.

Post-industrial recycled PS is widely generated by converters and often used within those converters' operations. There are markets for post-industrial recycled PS, including the construction products industry, which provides demand for post-industrial recycled EPS. The supply of post-consumer recycled PS is limited, and while demand is believed to exceed supply, currently there is not overwhelming demand for post-consumer recycled PS in packaging.

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*"[Some] consumers love it... 'cause, you know, it's like, 'Hey, there's 20% post-consumer EPS.' Some of them think that's really cool, other people don't want it."*

- PS Converter

*"Very, very few [inquiries from brand customers about recycled PS]."*

- PS Converter

A significant portion of post-consumer recycled PS is directed to non-packaging applications, such as insulating materials in building construction, molded picture frames, and receipt roll cores.



The EPS Industry Alliance estimates that in 2012, over half of the combined amount of post-consumer and post-industrial EPS collected for recycling was used in packaging applications. The EPS Industry Alliance estimated that post-consumer EPS constituted about 40% of the combined amount of post-consumer and post-industrial EPS recycled, and it is reasonable to assume that the amount directed to packaging applications was overwhelmingly post-industrial, not post-consumer.

**There are extremely limited quantities of food-grade recycled PS**, which originates in source-controlled recycling streams such as used polystyrene apparel hangers and post-commercial foodservice trays. While assurance of food contact safety can be provided by strict source control, it can not be provided by demonstrating the recycling process removes contaminants in the way it does for other polymers. The conventional testing protocols for determining food-grade characteristics are not well suited for polystyrene because the tests use solvents to separate known chemicals of concern, and these solvents will dissolve PS. Accordingly, there is no pathway for the use of PS packaging collected in commingled residential programs to be used in new food-grade packaging.

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*“If you were to take that exact same [testing] process and those exact same solvents and chemicals and try to do that with polystyrene, the test just doesn’t work – those same chemicals dissolve polystyrene ... so that’s why we don’t see curbside collected, commingled polystyrene coming back on the market with an FDA LNO.”*

– PS Manufacturer

## Success Story



### Recycled PS hot cups

The EcoLid® 25 is a recycled content hot cup lid made from 25% post-consumer recycled PS by Ecoproducts. In addition, Ecoproduct’s BlueStripe™ cutlery is made from 100% post-consumer recycled PS.



## Cost of recycled PS

As a feedstock, post-industrial and post-consumer recycled PS often comes at a price advantage. However, the costs to manufacture new products using recycled PS are higher than manufacturing using virgin materials, such that the net cost of using recycled PS tends to be close to that of virgin PS.

## Processing of recycled PS

Besides the very rare instances in which 100% recycled PS is used, recycled PS must be blended with virgin resin, which adds one or more extra steps to the process. Recycled PS can be blended in during virgin PS resin production, or it can be blended with market-ready virgin PS by either the manufacturer or converter. Of these different pathways, blending resins at the most upstream portion of the supply chain, during virgin PS resin production, adds the most cost but produces the most consistent material.



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*“Putting recycled content through your reactors is a very expensive way to mix recycled content. There’s no reason for 20% PCR polystyrene to go through our reactors – it doesn’t need to react again – it’s already been made into polystyrene – it’s just costing energy and space for it to go through the reactor again, but the reason we do that with our technology, is it could get a homogenous single pellet solution for our customers.”*

– PS manufacturer

If recycled PS is blended further downstream by either the manufacturer or the converter, they will need to have the appropriate metering and mixing equipment, which may be capital intensive to buy and install.

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*“If we did this, we would want to do it on a really large scale... we have 19 different machines in our plant... so you’d have to buy 19 of these devices that meter and put that material back in... that’s just not something we’ve ever gone down the road with, it’s just been economically infeasible for us at this time.”*

– PS Converter

Once the necessary metering and mixing equipment is in place, a converter can use both post-consumer and post-industrial recycled content, including their own internally generated regrind.

In EPS applications, there is skepticism that post-consumer PS is pure and consistent enough to create a suitable feedstock.

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*“I don’t know that [using post-consumer PS in new EPS manufacturing is] possible. It would have to be ground up, it would have to be melted, it would have to be pelletized – you’d have to run it through a heat element on a pelletizer – you’d have to repelletize the bead back down to the size of a grain of sand, then you’d have to put it into some sort of a pressure vessel where you could re-impregnate the bead with pentane gas. I just don’t think that process is anywhere happening. You’re just going to introduce a foreign material into your original bead, and try and hope that it molds well into the shape.”*

– PS Converter

#### **Key initiative in chemical recycling for PS**

Chemical recycling offers some potential for the future of recycling polystyrene. Some recyclers, notably Agilyx, have a process for transforming polystyrene to the styrene monomer through a chemical recycling process. While this technology is still nascent and requires scaling before it offers potential as a widespread solution, it is noteworthy because the process removes contaminants and impurities that are not removed by conventional mechanical recycling. The resulting styrene monomer is indistinguishable from its virgin counterpart. These recycling processes tend to use both post-consumer and post-industrial polystyrene as feedstocks, and require careful tracking of material flows.



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*“The technology is fantastic. If it winds up being economical, it would be a great way to recycle polystyrene. One challenge will be that it’s going to be difficult to track. It would have to be a batch process for one to be able to track and make a claim about recycled content. With continuous process manufacturing, it’d be near impossible to account for.”*

– PS Converter

## Performance of recycled PS

The physical properties of recycled PS are different than those of virgin PS, which can prevent usage of recycled PS in high amounts. In extruded foam and rigid applications, the principal consideration is molecular weight, which is reduced when PS is recycled.

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*“We can control the molecular weight of 100% of virgin, but when you put 20% post-consumer in, 20% of it we’re not controlling. That’s why we limit it to 20% – because at least we can control the other 80% If you have any performance loss in foam, you might need to make your foam a little more dense to offset those losses.”*

– PS Manufacturer

In EPS applications, the principal consideration is the ability of recycled PS to bond and create a durable structure that won't experience failure. All trade-offs in performance can generally be managed by limiting percentages of recycled PS, — especially post-consumer recycled PS, — to 25% or less.

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*"You have to have fusion between the beads... the original pentane is what's making the bead expand and it melts it and it adheres to the bead next to it and it creates that fusion, whereas the other stuff, it's not going to create good fusion between the individual beads. You would have bad fusion... you would lose some of your properties."*

– PS Converter

## Aesthetics of recycled PS

As with all recycled plastics, recycled PS may display some aesthetic deficiencies, particularly when post-consumer recycled PS is used. The extent of those deficiencies depends on the percentage of recycled PS used as well as the specific source of the material. The principal consideration is color, as recycled PS can exhibit more pronounced shades of brown and yellow. However, aesthetic trade-offs differ with different applications of recycled PS, and they are generally regarded as more pronounced in rigid and EPS applications than in extruded foam applications.

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*"That bead can look a little bit dirty, a little bit yellowed. After it goes through that process, it's not as pristine and white as the normal EPS."*

– PS Converter

*"Foam is a little more tolerant to color ... if you have our [recycled] pellet sitting next to virgin polystyrene pellet, you can see the off-color, but when you foam it, you don't really notice it, so that is a strength. Our pellets are a little dingy, but when you foam it you get a clean-looking product."*

– PS Manufacturer

A willingness to tolerate — or even embrace — aesthetic deficiencies is nearly always needed when pursuing the use of post-consumer recycled plastics, and polystyrene is no different. Packaging applications like protective EPS shapes, or other applications in which PS is not directly or indirectly in contact with food, are likely the best opportunities to use post-consumer recycled polystyrene with minimal risks of adverse effects from the aesthetic deficiencies.

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*"It depends who you're working with and who you're dealing with. Some of our customers probably wouldn't think it's a big deal, but there are other customers... if you see dirty beads, like anything that looks like dirt, anything that looks like mold, they will reject that so fast it would make your head spin."*

– PS Converter

*"Some...people love it, they think it looks great, they're proud to say that it's... post-consumer EPS that's being used."*

– PS Converter



*“You have to have the right customer that’s open to this, to say I don’t really care about the aesthetics of it, I just want it to do its function.”*

– PS Converter



## POLYETHYLENE (PE) FILM

### Key takeaways

- ▶ Recycled PE film as a feedstock carries its own unique considerations because the way it is collected and recycled differs somewhat significantly from the other materials in this Guide.
- ▶ Incorporating recycled content into PE films can be challenging from processing, performance and aesthetic perspectives — but the area is ripe for innovation and growth.
- ▶ Because materials generally have to perform at a higher level in film applications than in rigid applications, and because the material properties of the recycled PE film stream are heterogeneous, the opportunities and challenges in this space are not yet in clear focus.



### Environmental benefits

Using 30% recycled content in PE films has been [estimated](#) to reduce energy consumption by a quarter and reduce greenhouse gas emissions by over a third during manufacturing.



## Supply and demand of recycled PE in film applications

Most recycling streams provide opportunities for a particular packaging format to be recycled into a new version of the same format – for example, recycled PET for bottles is primarily sourced from used PET bottles, and recycled aluminum for cans is primarily sourced from used aluminum cans. Comparatively, this system rarely exists for PE films. Recycled PE film can be used in rigid applications, and recycled rigid plastics can also be a feedstock for PE film applications.

### What you need to know about PE film recycling: Collection

There are two main ways that recycled PE film feedstock is sourced.

**One way that PE film gets recycled is through the Store Drop-Off recycling stream.** Consumers may recycle PE film packaging (i.e. HDPE, MDPE, LDPE and LLDPE), including many bags, wraps and films, by taking them to retailers that participate in the Store Drop-Off program. Frequently these drop-off locations for PE film are bins located near the front of grocery stores. The Store Drop-off system began because PE films cannot be recycled through traditional residential curbside recycling programs. However, films are not collected through the Store Drop-Off at very high volumes. According to a [study](#) by Closed Loop Partners, citing research by RSE USA, 7% of retail bags and 3% of PE film packaging that are available for recycling are returned to stores for recycling. **Currently, the majority of material that is collected via Store Drop-Off is recycled into rigid plastic applications like lumber and railroad ties.**



Given the rise of corporate sustainability goals to lower carbon footprints, film packaging is poised to continue its fast growth within packaging. **Store Drop-Off is the only way for consumers to recycle flexible packaging today, so many brands' goals are tied to the success of the Store Drop-Off stream to ensure this material is recycled.**

The second way that PE film feedstock is sourced is through a robust “post-commercial” recycling stream, which is still officially classified as “post-consumer”, however, because the end user is a business. The post-commercial recycling stream handles a much greater volume of material than the Store Drop-Off stream.

In this system, various retailers, distribution centers and businesses that use a PE film (e.g., LDPE stretch wrap around pallets or PE bags holding products) collect and bale up the material in their “back-of-house”, selling that material to the same recyclers that process Store Drop-off film. For retailers who also participate in Store Drop-off, they often bale the front-of-house material together with their back-of-house material before sending it to reprocessors, so that the reprocessor receives a blend of materials from both the general public and the business. This post-commercial recycling stream provides an important quantity of material for PE film recyclers and is often cleaner and more consistent in density (because it’s predominantly LDPE) than the Store Drop-Off material.

### What you need to know about PE film recycling: Reprocessing

The way that reprocessors recycle PE film differs somewhat from rigid plastics, and the technologies that different PE film recyclers use to process this material are different from each other. As a result, there are various potential end uses for the material. One way that recyclers differ in processing this material is through the dry process versus the wet process. In the dry process, the most widely used by PE film recyclers, the equipment used can remove some contaminants from the material, but certain packaging characteristics like inks, labels or food contamination are not removed as effectively. In contrast, the wet process is able to remove more contaminants but increases the cost of the reprocessing. There is currently a debate in the PE film reprocessing industry about how the various end markets for recycled PE film should influence how we recycle them. Some PE film recyclers say that they would consider investing in a wash process if demand for that higher quality material existed.

As companies like [Avangard Innovative](#) and [UPT Group](#) are making investments in the future of film-to-film recycling, there will likely be broader possibilities for the future of this material so long as demand for it either remains steady or grows.

As with other resins, the potential future of chemical recycling casts an interesting light on the future of PE film reprocessing and notions of what might happen with this feedstock in the coming years. Chemical recycling deconstructs a polymer to its original monomer, which removes impurities. As a result, the performance, processing, and aesthetics of recycled PE film might be improved as this technology evolves and scales.

Incorporating recycled content into PE film is somewhat unique among recyclable materials because the recycled content you include in film doesn’t necessarily need to come from films — it could come from recycled rigid plastics for some applications. While the most prevalent form of recycled PE in film applications originates from previous post-commercial film applications, rigid HDPE containers like milk jugs can also be used as a feedstock for new PE film — although that is less common.

### Success Story



## Nike Bag to Better Program

Nike has created a closed loop film-film recycling system, taking the films from their Distribution and Return Centers (DCs) and recycling this material back into their orange retail carry out bags.

In order to make this a reality, Nike had to know the percentage of contamination and types of contaminants in their DC film in order to correct for this at their DCs and enable them to reuse it in other applications. Nike achieved this by installing baling systems in their centers and working with their film bag supplier, Roplast, to inspect all bales through a detailed process that includes sorting, itemization and a detailed log of contamination weight and type in order to better understand their content, make changes at the DC, and adjust their own plastic film channeling at the centers to ensure the film quality meets reprocessing requirements. This system has enabled a constant feedback loop between Roplast and Nike’s DCs. Currently Nike shopping bags are made with a certain percentage of these Nike-reclaimed film materials, including Nike innerpack bags, stretch film, other shopping bags, as well as a percentage of other certified post-consumer resin sources and Roplast’s own reclaimed and recycled post-consumer material.





According to Roplast, “Nike is a strong example of an informed brand that understands the complexities of the issue. Nike’s Bag to Better program stands as a proof of concept for closed loop use of recycled content in plastic film, but it is clear that a brand must be dedicated to make this work and must partner with an equally dedicated and flexible supplier.”

Recycled PE film is used in applications such as trash bags, thicker commercial film, sheeting and bags. The highest demand for recycled PE material for use in film applications is for natural and white colored PE material, but there is a very limited supply of this available on the market. There is, however, a surplus of grey material. There has been much less demand for recycled grey PE film material for reuse in packaging. There is therefore an opportunity to incorporate higher levels of recycled content by using grey material in colored bags and films rather than producing clear or white bags and films.

Given the uncertainty created in recycling based on China’s 2018 import ban, increasing demand for recycled materials is more important than ever, especially if brand owners want to still be able to call certain materials recyclable. For PE films, this is especially true. **According to More Recycling**, before trade restrictions went into place, 52% of films were shipped to China. For this reason, creating a stronger “pull” or demand for PE film is critical at present, and will be into the foreseeable future.

#### Key initiatives to improve end markets of recycled film

**CEFLEX** is a collaborative initiative of a European consortium of companies focused on improving design, collection, sortation, processing and end markets for all films (not just PE film). CEFLEX is working to develop design guidelines for flexible packaging, facilitating technologies and identifying end markets.

**New End Market Opportunities (NEMO)** by the Plastics Industry Association is developing an end market tracking roadmap, conducting a literature review and testing the use of PE blends in novel applications.

**Materials Recovery for the Future (MRFF)** aims to characterize the flexible packaging stream and associated end markets based on bale specifications and technology. MRFF created an end markets productions facility map and plans to conduct a pilot for curbside collection of flexible films.

# Cost of recycled PE film

There is a need for more recyclers to be willing to work with recycled PE film in order to obtain economies of scale. While processing technologies for recycled film may add some costs, this would decrease with commercial adoption.

## Processing of recycled PE film

Films are somewhat more difficult to make than rigids because they are so thin — resin has to perform at a higher level in this application. As a result, technical challenges are much more pronounced when adding recycled content to PE films.

Because there is a diverse set of inputs in the post-consumer PE film stream, reproducers typically need to develop new specifications for each batch of recycled content PE. HDPE, LDPE and LLDPE are all in the PE film stream, but each type (i.e. density) has a different melt index than the others and requires different processing considerations. To account for these batch differences, heat-level adjustments can be made during the conversion process. If these adjustments are not made, then different melting temperatures between the different films in the batch can result in blemishes such as bubbles or gels. In processing, extrusion can have filtration issues since recycled content alters the properties of film viscosity. Blockages can occur from different additives present in the film.

It is important for manufacturers to test recycled content film materials to work out issues that may arise in reprocessing. **Converters should do due diligence with trials and scale ups, understanding that machine modifications could be required to ensure success.**

The processing of recycled PE film is an area ripe for innovation. Potential opportunity areas include:

- ▶ Virgin resin or additive innovations to improve performance characteristics as part of a blend;
- ▶ Recycling technologies to improve the quality of the pellet;
- ▶ Sorting technologies to make the densities of the materials within the stream more predictable or segmented; or
- ▶ Conversion technologies to better manage the differences in densities or batches.

### Success Story



## Recycled PE film

**Roplast** has transformed their manufacturing process to integrate recycled content and reduce the amount of virgin film material used in producing new film products. Under strong leadership driven by this purpose, the company started changing its operational procedures to accommodate the transition to a focus on recycled content in PE film instead of virgin. This included revising specifications for machines and batch tests, requiring Roplast to take on additional costs. **Roplast works closely with their salespeople and customers, recognizing that this is a cultural shift** and that all the players need to be informed of and understand the different specifications for recycled content. The company currently uses 30% post-consumer content in their PE films on average, with a goal of 50% recycled content use by 2020.

## Performance of recycled PE film in PE film applications

There are some technical, performance and aesthetic challenges that currently get in the way of getting robust levels of recycled PE film back into PE film today. For example, using recycled plastics in PE film applications can result in holes (called voids) that can lead to tearing. Bubbles or gels, as discussed previously, can also be a performance challenge. **Brands interested in using recycled content in PE films should be aware of the limitations of doing so and start the process by preparing a list of their performance goals for the end product.** Because of these performance challenges, less demanding or thicker film applications like [trash bags](#) may be an ideal place for recycled PE film today.



*“Our problem has been getting a good enough quality recycled content that we would use at a higher level in films. Any gels or voids in that film cause a pretty severe performance failure, whereas we can accept some gels in a bottle because the thickness is thousands thick and there’s material behind that helps support the structure. In a film that’s not the same case. We just haven’t yet found the right supply of film to be able to take care of that stuff.”*

– Brand Owner

## Success Story



# Recycled plastic in PE film

Amcor developed and produced an all PE stand-up pouch with 20% post-consumer recycled PE for Method's dishwasher detergent called Power Dish. Recycled HDPE from bottle feedstock was used, which was key to Amcor's success because this provided a uniform feedstock. The use of recycled PE, along with the fact that the pouch is recyclable via Store Drop-Off, means the new pouch has a carbon footprint that is up to two-thirds less than the package it replaced.



## Success Story



# Leveraging post-consumer agricultural film as PE feedstock

Through the acquisition of Command Packaging and Encore Recycling by Delta Plastics in January 2018, two companies came together with a shared vision of recycling agricultural plastic previously going to landfills. Delta Plastics produces plastic irrigation tubing for farming fields, recycles it and makes trash can liners containing upwards of 97% post-consumer material under the brand [Revolution Bag](#). Similarly, Command Packaging makes plastic carryout bags and determined it was important to ensure post-consumer recycled material was put into those bags by creating [Encore Recycling](#) that [recycles](#) agricultural plastics on the West Coast. Command's reusable [smarterbags](#) contain minimum 20% of the agricultural post-consumer recycled PE.



## Aesthetics of recycled plastic in PE film applications

A higher percentage of recycled content generally leads to bumps in the film. Because of the presence of bumps, printers may say that they cannot achieve the same quality for printing on film packaging or labels that are high in recycled content as they can for virgin films and labels. It's unclear whether there is an opportunity for innovation to overcome this challenge, or whether the requisite print quality should perhaps be reexamined by brands.

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*“We don't have much leverage to push back on [recycled content in films impacting print quality]. We're not the expert on sourcing those materials and printing on them. And so we kind of take it at face value.”*

- Brand Owner

In films with high levels of recycled content, color is a limiting factor. Colored recycled plastic is more affordable and more widely available than natural or white recycled plastics. Co-extrusion allows manufacturers to bury colors, using white skins on the outside. This creates a duller white, but still a white film color that brands can use to display product marketing.

While some companies perceive the aesthetic qualities of recycled PE film to be less preferable, **other companies embrace the aesthetic imperfections in recycled content film and see it as unique.** For example, Novolex's [“Gray is the New Green”](#) marketing campaign seeks to reframe the sustainability value of grey, buff or blue plastic bags because those darker colors signify higher recycled content to consumers.

**In order to incorporate more recycled content in PE films, brands must be willing to make some compromises on aesthetics, specifically, by accepting colors other than bright white.** Brands and marketing managers should consider the potential opportunities in using recycled content in films. Moving away from packaging that is white and shiny can differentiate a brand on the shelf and be a gateway to discussing recycled content with consumers. There are also creative possibilities of darker or off-white packaging made from recycled content.





# ALL PAPER



## Environmental benefits of using recycled fiber

Packaging is an important end market for a recycling system that diverts paper from landfills and avoids methane — a potent greenhouse gas — generated when paper biodegrades in landfills. Recycling one ton of paper reduces greenhouse gas emissions by one metric ton of carbon equivalent (MTCE) [according to the U.S. EPA](#).

It is important to note that, from a macro perspective, both virgin and recycled fibers are necessary to support an overall system of sustainable paper usage. The paper recycling process inherently degrades the physical properties of fibers, so new virgin fiber must be continually introduced in order to create a system of paper usage that may be indefinitely sustained. Responsible fiber sourcing practices should always be implemented when using virgin fiber.

## General guidance for using recycled fiber in all paper packaging

There are three major steps in the creation of paper packaging: pulp production, papermaking, and converting. Recycled fiber is created in the pulp production stage at recycled pulp mills, where recycled inputs are exclusively used to make recycled fiber, contrasting with virgin pulp mills where virgin inputs are exclusively used to make virgin fiber. Papermaking operations are often integrated with pulp production, and will

make products primarily with their own pulp. Many paper mills will also routinely buy some pulp from the open if a customer requests virgin or recycled fiber that cannot be supplied by the paper mill's integrated pulp mill. For example, a paper mill integrated with a recycled pulp mill may purchase and use virgin fiber from a peer company's virgin pulp mill, while a paper mill integrated with a virgin pulp mill may purchase and use recycled fiber from a peer company's recycled pulp mill. Other paper mills are not integrated with pulp production and they always buy pulp on the market from both virgin pulp mills and recycled pulp mills. Converters may or may not be vertically integrated with paper and/or pulp mills. As a result, some converters supply more virgin paper packaging than recycled, some supply more recycled paper packaging than virgin, and others are more accustomed to supplying paper packaging with a range of recycled fiber percentages.

**The ability to introduce or increase the use of recycled fiber in most packaging applications is largely controlled by a supplier's access to recycled paper.** Suppliers that are vertically integrated with virgin pulp and paper mills will need to source recycled paper from outside their own operations, which can add complexities and costs.

## Supply and demand of recycled fiber

**Overall demand for recycled fiber for use in paper packaging is generally believed to exceed supply.** The supply of recycled fiber is constrained by the number and capacity of recycled pulp mills rather than the supply of recycled inputs to those mills, but a growth or contraction in the supply of recycled inputs does result in construction of new mills or idling of existing mills. Because mills are monolithic, capital-intensive investments, these responses to market conditions tend to be slow and made with caution. As the domestic supply of paper recovered for recycling has ballooned as a consequence of the Chinese solid waste import restrictions introduced in 2017, investment has been made in building new domestic capacity for producing recycled fiber, which can require several hundred million dollars worth of investment per mill.

The supply of recycled inputs for pulp mills is controlled by the recovery rate of used paper products, which has been stable and experienced moderate year-over-year growth. Post-consumer recycled inputs are classified into a variety of streams, including old corrugated containers (OCC), old newsprint (ONP) and residential mixed paper (RMP). Post-commercial OCC is the predominant source of recycled fiber, providing most of the recycled inputs available to mills. Mills often source a varying mixture of post-consumer and post-industrial fiber based on current market price and availability, which frequently fluctuate.

When used paper products are collected for recycling, recycled pulp mills provide demand in a number of competing markets, including non-packaging markets like towel and tissue and various grades of printing paper. These markets are both domestic and abroad, and a large percentage of recovered paper products are exported. [According to the American Forest & Paper Association](#), about 62% of used paper products recovered in the U.S. is retained domestically, with 36% directed toward the production of new containerboard (the precursor to corrugated packaging), 12% used in the production of new boxboard, and the remainder directed to non-packaging markets.

The average proportions of virgin and recycled fiber vary widely across different packaging formats. It's common to find paperboard products that contain 100% recycled fiber (i.e. cereal boxes), while corrugated products more commonly contain levels closer to 50%, and bleached (white) packaging grades tend to be primarily made from virgin pulp.

## Cost of recycled fiber

Like all recycled materials, recycled fiber can exhibit pronounced price fluctuations. Generally paper packaging made with recycled fiber comes at a cost advantage. These fluctuations vary over time and geography, depending on the demand for paper products, the availability of a supply of recycled fiber, and the specific application or use of paper.

This is a rare challenge, but box and carton converters who may or may not be vertically integrated with the paper mills from which they source, could incur costs if they were designed to convert virgin paper and must modify their processes in order to use recycled paper. Costs may also be incurred when a supplier who is vertically integrated with virgin pulp and/or paper mills must source recycled paper from outside their own operations.

## Processing of recycled fiber

### Pulp Production

Within the recycled pulp mills, each mill has different capabilities to handle the non-fiber components of recycled feedstocks, such as adhesives, clay coatings, plastic coatings, dyes, foils and other metallization, inks, overprint varnishes, starch, waxes, and wet strength additives. Removing and filtering these materials before or during the repulping process can require extra steps, including the need for special screens to eliminate impurities and sometimes costly disposal of unusable contaminants that get into the system.

### Papermaking



Because some paper mills are integrated with pulp mills, they are set up, in terms of equipment, technology, and process flow, to make paper from the recycled or virgin fiber produced by the pulp mill with which they are integrated. Many of the paper mills integrated with virgin pulp production have not invested in equipment that would allow them to use recycled fiber. Other paper mills have been able to add dedicated recycled papermaking lines or expand their capacity in such a way that allows them to source from both virgin and recycled pulp mills, however most paper mills that are vertically integrated with virgin pulp mills prefer to work with virgin fiber. Other paper companies are vertically integrated with both recycled and virgin pulp mills, and their paper mills are more likely to be able to produce both virgin and recycled paper. Geographic proximity is important, though. A paper company may operate both virgin and recycled pulp mills, but if one type of pulp mill is in closest proximity to the paper mill, or if the papermaking operations are integrated within the pulp mill, there will be limited flexibility in the type of fiber used.

### Converting

Most converters are able to process paper with anywhere between 0% and 100% recycled fiber, but processes must be adjusted to accommodate different percentages of recycled fiber and increases in recycled fiber usually correspond with slower processing speeds and increased requirements for quality assurance. This challenge is minimal for the converter, but a significant change in the quantity or quality of recycled paperboard should be tempered with this understanding.

## Performance of recycled fiber

The primary performance consideration of recycled fiber is strength. Each time paper is recycled, the fibers shorten during repulping and the cell walls and fibrils (bonding sites) collapse during the drying process. This reduces the natural bonding capacity and flexibility of the fibers. Strength-enhancing treatments such as starches or dry strength resins may be needed to compensate for this effect.

Fibers that are too short and/or weak to be used are typically screened out and discarded, and the amount of 'recycled fiber yield' from this screening process differs in various paper grades. For instance, many grades of printing paper require longer and/or stronger fibers in order to achieve a smooth, uniform surface with optimal print properties, which results in a greater portion of shorter and/or weaker recycled fibers being screened out and discarded during papermaking. By contrast, many packaging applications don't have such high processing requirements and tend to be more amenable to using recycled fibers. Unbleached packaging grades are generally considered to be a preferable application for recycled fiber compared to high grade printing papers, since a higher overall percentage of recycled fiber can be utilized.

Concerns related to strength of recycled fiber in packaging are pronounced in applications with high levels of recycled fiber and high structural or load-bearing requirements. When high levels of recycled fiber is used in these heavier duty packaging applications, it may be necessary to use more fiber to get to the same performance characteristics as would be provided by virgin fiber. This use of additional material has trade-offs that should be understood and taken into account. **High levels of recycled fiber are best suited for packages that do not have significant weight-bearing requirements.**

**Increased strength for packages containing recycled fiber may be achieved by addition of starch, resins, and other strength additives, as well as blending in an optimized amount of virgin fiber.** It is also important to note that the specific strength of any recycled paper is variable and dependent on the feedstock used. For instance, OCC generally contains longer fibers than RMP and ONP, so recycled pulp mills that use more OCC as a feedstock will produce a higher grade pulp that will make stronger paper.

As with all packaging design choices, it is critical for brand owners and suppliers to have a clear understanding of performance requirements of recycled materials and ensure that the choices they made meet the needs of the package. **Building collaborative working relationships between brand owners and suppliers can help ensure usage of optimal levels of recycled fiber while meeting performance requirements.**

### Success Story

## Embedding recycled fiber into the business

LUSH has a strong preference for recycled content and has **developed long-term relationships with its paper suppliers. Lush has also ensured that their procurement representatives are educated on technical considerations around paper mills and performance specifications,** enabling them to be able to collaborate with suppliers to make recycled fiber work for their packages.

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“We let companies know recycled content is what we need, because it is our company mission and we want to partner with like-minded suppliers. They know it's our line in the sand and in the end they figure out a way.”

– Karen Moll, Gift, Print and Packaging Buyer at LUSH



## Aesthetics of recycled fiber

Recycled fiber may introduce a number of aesthetic challenges, but none are considered to be severe enough to prevent the use of recycled fiber in packaging. Higher percentages of recycled fiber may make it more difficult – but not impossible – to achieve white or brightly colored packaging, since many blends of recycled fiber produce a grey or brown color, but as with performance, the visual appearance of recycled fiber depends largely on the feedstocks used by the recycled pulp mill. For instance, when more office paper is used in the feedstock mix at the pulp mill, the resulting recycled fiber will be lighter in color and less dull in appearance. Recycled pulp mills can employ de-inking processes to achieve a lighter colored fiber that appears brighter and more vibrant. Paper made with these lighter and brighter recycled fibers may also be used as an exterior layer, with more aesthetically-challenged, dull recycled paper hidden beneath. Beyond brightness and whiteness considerations, it's also important to note that recycled fibers exhibit greater variability in appearance, although the use of additives including dyes, pigments and optical brighteners to compensate for these variations is common practice.

Ultimately, brands should also consider whether bright white is absolutely necessary, and consider relaxing specifications when it is not. Pivoting from white to brown paper packaging enables greater opportunities to increase the usage of recycled fiber.

## Food contact and recycled fiber packaging

The FDA's food additive regulations permit pulp from recycled fiber to be used in food-contact articles provided that recycled paper does not contain any poisonous or deleterious substances that may migrate to food as described in 21 CFR Part 176B.

In order to meet FDA requirements, pulp mills will have to demonstrate that their process is able to effectively remove any unwanted substances present in their incoming feedstock stream that might then migrate from the fiber into food. Depending on the processing capabilities the pulp mill has in place, the mill may place restrictions on the types of paper products allowable in the incoming feedstock stream they to make food grade pulp in order to avoid any treatments and coatings containing unwanted substances that cannot be removed by the mill's process. Brand owners wishing to use recycled fiber in food grade paper packaging should work with their suppliers to ensure that the recycled pulp mill's testing and process produces pulp that meet food safety requirements.

Even if the paper itself has not been demonstrated to be FDA-compliant, certain coatings can also be applied to the paper package and serve as a barrier between non-FDA-compliant paper and food contact point, if it is proved that the coating can prevent migration of poisonous or deleterious substances and that the coating itself has no ingredients of concern.

The Recycled Paperboard Technical Association [Chemical Testing Protocol for Food Contact Paperboard Made from Recycled Fiber](#) is a voluntary mechanism to identify the presence of unwanted substances in recycled paper, including polychlorinated biphenyls (PCBs), heavy metals, volatile organic compounds, pesticides, and phthalates among others, providing assurance for the use of recycled paperboard in food contact products. The list of potential impurities identified for testing is under constant review.

A recent and still evolving issue is the presence of Per- and Polyfluoroalkyl Substances (PFAS), which are primarily used in grease-resistant and moisture-resistant coatings on foodservice paper packaging. PFAS exist in short-chain and long-chain forms, and while long-chain PFAS were voluntarily phased out once the EPA designated them as persistent, bioaccumulative toxins, short-chain PFAS remain widely used and have come under increasing scrutiny as similar toxins. Ultimately, it is not yet known if short-chain PFAS are of significant toxicological concern. Currently, the best way to know if recycled paper contains PFAS is to commission a test from an independent lab to identify the presence or absence of fluorine. A useful resource to understand considerations around PFAS is the Center for Environmental Health's publication [Avoiding Hidden Hazards: A Purchaser's Guide to Safer Foodware](#).

## Success Story



### Using recycled content in food-contact paper packaging:

Starbucks has been bold about using recycled fiber in direct food contact packaging in its iconic coffee cups. Starbucks has a goal to double the recycled content, the recyclability, and the reusability of their cups by 2022. The company announced a new [collaboration](#), called **Cup to Cup: Closing the Loop**, which aims to create a system in which used Starbucks cups are sent to Sustana, who will repulp them using their proprietary repulping technology, then send the recycled fiber to WestRock, who will manufacture 100 percent recycled, FDA-compliant cupstock, which is finally sent to Seda to manufacture new cups allowing Starbucks cups to re-emerge as clean, safe fiber used to make new cups.







# PAPERBOARD

## Key takeaways

- ▶ 100% recycled paperboard packaging is common in the marketplace and generally in high demand.
- ▶ Challenges around using recycled fiber in paperboard revolve primarily around strength in larger boxes and boxes with heavy weight requirements as well as aesthetic characteristics like whiteness, brightness, and printability.
- ▶ To navigate these challenges, brand owners and suppliers should work together to optimize packaging specifications.
- ▶ The ability to introduce or increase the use of recycled fiber is largely controlled by the type of mills available to the converter. Some suppliers may not have a supply of recycled paperboard available.



## Environmental benefits

For every ton of virgin paperboard that is converted to recycled board, one ton of recovered fiber is [kept out](#) of municipal landfills. This, in turn, reduces the amount of methane created in the landfill and further decreases greenhouse gases in the atmosphere.

## Supply and demand of recycled paperboard

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## What you need to know about the recycling stream for paperboard

Recycled pulp mills supplying paperboard makers typically use a mixture of corrugate (OCC), residential mixed paper (RMP), post-industrial paperboard scrap, and minor amounts of other paper recycling streams. These collective inputs have historical recycling rates of greater than 70%.

Since the Chinese solid waste import restrictions introduced in 2017, there has been a domestic surplus of OCC and RMP. Recycled paperboard mills provide an important end market for both these streams — particularly RMP — however, most recycled paperboard mills are believed to be operating at full capacity and near-term investments into new recycled paperboard mills are not expected.

Demand for recycled paperboard is believed to exceed supply. Many brand owners are challenged to secure a stable supply of 100% recycled paperboard, even with a willingness to shoulder a cost premium, and as a result, paperboard is often procured with a blend of recycled and virgin fiber. It is possible to incorporate higher levels of recycled fiber when developing relationships with mills and converters that have the equipment necessary to incorporate recycled fiber.

## Cost of recycled paperboard

As is the case with all packaging materials, the price of recycled paperboard fluctuates and may come at a cost advantage or disadvantage depending on market conditions. It is common to procure recycled paperboard at a cost advantage, and when recycled paperboard comes with a cost disadvantage, it should not be expected to be a large difference in cost. Cost is typically not considered a significant barrier to the use of recycled paperboard, although this depends on the application and associated performance needs.

## Processing of recycled paperboard

As with all paper packaging, the ability to introduce or increase the use of recycled fiber is largely controlled by the mill types available to the converter. While a converter can source from any mill, some mills are not as accustomed to using recycled fiber, and converters may therefore be restricted in terms of regional, cost-effective availability of recycled fiber. Converters may also be restricted by the design of their equipment, which is typically optimized for the particular characteristics of their primary supply of incoming paper. If a converter's processes are not optimized for recycled paperboard, they may experience disruptions to the die-cutting, folding, box setup, and gluing processes, since the characteristics of recycled paperboard are different and more variable than those of virgin paperboard. However, many converters routinely run multiple types of paperboard in their plants and have learned to adapt to the different qualities of recycled paperboard.

## Performance of recycled paperboard

High recycled fiber usage may result in reduced strength. Typical paperboard packaging applications like cereal or tissue boxes do not need to accommodate high weight requirements, and most paperboard applications are suitable for the use of recycled paperboard regardless of any reductions in strength.



Larger-sized boxes, however, can present challenges, as these can bow inwards, often necessitating the use of inner dividers to prevent caving. Corner stacking and panel strength are areas that may also experience challenges, and in some cases it may be necessary to increase the material basis weight, which can introduce trade-offs. When the amount of material must be increased, companies should consider using a life cycle assessment tool to help inform decisions.

Recycled paperboard may exhibit lower surface strength, which can result in paper delamination from glues when the glue pulls the fiber and puts stress on the fiber seams. The use of cold glues may be preferable for recycled folding cartons since they involve more time to bond parts together compared to hot glues. However, when facing a gluability question, the best course of action is to request answers and recommendations from your adhesive/glue suppliers.

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“Certainly its performance is a little bit lower in certain areas but it is **not something that we considered inferior for the most part – just different.**”

- Brand Owner

**Additives can help address a variety of strength issues.** When strength is deficient, introducing a strength enhancing adjunct, such as a starch or dry strength resin, can help. The same dry strength additives used to ensure that virgin paperboard meets strength requirements will similarly increase recycled paperboard strength.

**To make sure the strength of recycled paperboard suits the purpose, companies can conduct machine testing.** There are well-established mechanical tests and industry standards to evaluate a full variety of paperboard packaging performance requirements like strength, glueability, and barrier property testing.



To make sure the strength of recycled paperboard suits the purpose, companies can conduct machine testing. There are well-established mechanical tests and industry standards to evaluate a full variety of paperboard packaging performance requirements like strength, glueability, and barrier property testing.

Some recycled paperboard suppliers find creative ways to achieve compression strength specifications without increasing the overall packaging weight, such as increasing the amount of fiber in carton corners while reducing the amount of fiber in carton walls. Food-grade recycled paperboard is widely available and widely used. The principal mechanism for assurance of food quality is the Recycled Paperboard Technical Association's [Comprehensive Program for Food-Contact Paperboard/Containerboard Produced from Recycled Fiber](#), which provides a standard through which mills can give assurance that all substances of concern are removed.



## Further Guidance for Using Recycled Paperboard

The Recycled Paperboard Alliance offers a guidance resource for packaging professionals who are considering using 100% recycled paperboard. The [100% Recycled Paperboard Conversion Guide](#) answers common questions about removal of metals and other contaminants, the advantages of recycled paperboard, and how to make recycled paperboard visually appealing.

The Recycled Paperboard Alliance offers its RPA-100% Certified trademarked symbol for brands to communicate to consumers that their paperboard features 100% recycled fiber. The RPA-100% Certification symbol not only was reviewed by the Federal Trade Commission that governs environmental marketing claims, but also serves as a certification that coated and uncoated recycled paperboard (CRB/URB) has been sourced from audited mills, providing an additional layer of sourcing assurance.

## Aesthetics of recycled paperboard

Recycled paperboard is typically brown or light grey on the non-printed side. Compared to its virgin counterpart, aesthetic challenges for recycled paperboard include difficulty achieving whiteness, brightness, and printability.

Paper mills can influence the whiteness of recycled paperboard by adjusting the mix of feedstocks used to produce recycled fiber. In general, the use of ONP and OCC as inputs will decrease whiteness while the use of office paper and white materials like milk cartons will increase the lightness of the pulp and ability to produce whiter packaging while using recycled fiber.

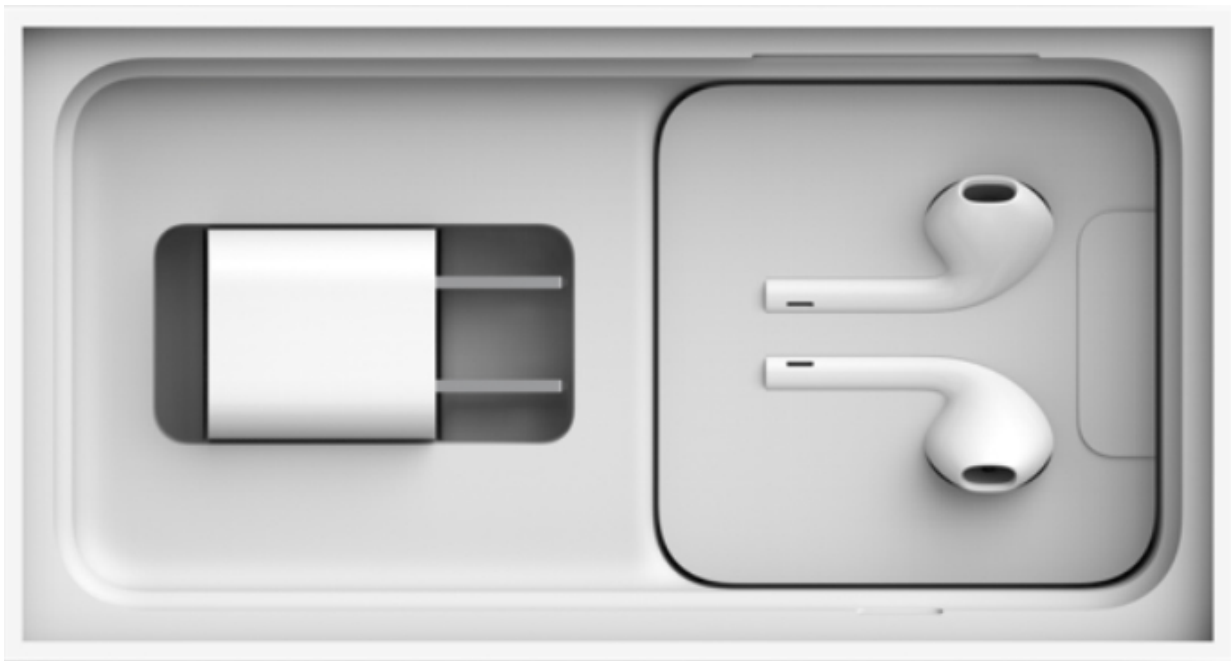
Beyond adjusting the composition of incoming material, there are processes that may be used to improve whiteness, including the use of multistage cleansing processes that utilize optical brightening agents, as well as the use of white pigmented coatings that have been specifically formulated for whiteness and brightness. In addition, techniques like litho labeling or litho laminates involve making a composite box in which whiter fiber surrounds an inner layer of darker fiber, creating a whiter surface and circumventing the aesthetic deficiencies of the majority of recycled fiber used in the box.

### Success Story



## Using recycled content in white paperboard packaging

For Apple's iPhone 7, a paperboard-based solution was developed that leveraged a functional set of folds and cuts to elegantly secure the EarPods and cable. Apple found that the outer iPhone packaging box used significant amounts of virgin fiber-based solid bleached sulfate (SBS). With the launch of iPhone 7, a layer of SBS was replaced with recycled paperboard, which contributed to an overall increase of recycled fiber in the package of approximately 30 percent compared to the iPhone 6.



An inability to achieve a white or bright color should not necessarily be a deterrent for brands in using recycled paperboard. Brand owners should consider challenging the assumptions around aesthetic specifications and adapting them in order to use recycled fiber.

Recycled paperboard may exhibit challenges related to print quality, owing to dust created when recycled paperboard runs through converting equipment or when the moisture content of the recycled paperboard is too high. Printability may be improved by applying coatings designed to increase ink absorption and holdout. Ultimately, the best way to achieve the required or desired print quality is to **ensure there are clear lines of communication between the brand owner, printer, converter, and paper mill**, particularly if these functions are not integrated or controlled by a single supplier.



#### Key takeaways

- ▶ Corrugated containers often contain large amounts of recycled fiber. 100% recycled corrugate is available and widely used.

- ▶ The use of recycled fiber in corrugate does not create significant impacts on aesthetics or performance, with some exceptions in boxes with very high weight performance requirements.



*“Cardboard is the big success story in recycled content.”*

– Brand Owner



## Environmental benefits

Using recycled fiber in corrugate diverts used paper products from landfills, which reduces landfill methane generation and avoids greenhouse gas emissions.

## Supply and demand of recycled corrugate

### What you need to know about the recycling stream for corrugate

The principal feedstock stream for new corrugated containers is OCC, and the vast majority of corrugated containers can be and are recycled. Corrugated containers are the most recycled type of packaging, with a recycling rate routinely over 90%. Much of the OCC stream has traditionally originated as back-of-house material from manufacturing, retail, or distribution centers. However, the rise of e-commerce and increasing generation of corrugate waste by residential consumers is changing this landscape, shifting the generation of corrugate waste from commercial locations to residential locations. It has been reported that this shift is impacting OCC quality, since these materials are commingled with other materials and sometimes get wet or dirty in residential recycling streams, decreasing their value and hurting overall recycling system profitability. The Chinese solid waste import restrictions introduced in 2017 have caused a massive disruption in the market for OCC, but the market is believed to be stable and not in danger of collapse.

The amount of recycled fiber in corrugate can vary from 0-100%. On average, corrugated boxes contain 48% recycled fiber, which primarily originates from post-industrial and post-commercial OCC recycling streams. **Corrugate represents the largest single domestic end market for recycled fiber**, with 36% of recovered paper products going to make corrugated sheets and boxes.



Most e-commerce orders are shipped in corrugated containers which on average [contain 48% recovered fiber content](#).

**Percentages of recycled fiber in corrugate can vary over time and region, depending on the cost and availability of recycled fiber.** Some suppliers may be vertically integrated, with box plants sourcing exclusively from the supplier's recycled paper mills, while other suppliers' box plants fluctuate their sourcing from virgin mills and recycled mills, depending on their level of mill integration and market conditions. Because of this, there is a consistent, set percentage of recycled fiber in some corrugated containers and a highly variable percentage of recycled fiber in other corrugated containers. In regions with low availability of recycled fiber and high availability of local virgin fiber, recycled corrugate may be unavailable or uneconomical.

Demand for recycled corrugate is believed to be growing. Compared to other materials, there may be supply assurance challenges with recycled corrugate, since fiber markets fluctuate and many suppliers cannot guarantee a consistent, fixed percentage of recycled fiber.

## Cost of recycled corrugate

Cost is not typically considered a barrier to the use of recycled corrugate, but fiber markets are notoriously volatile, and like all materials, pricing should be expected to fluctuate.

## Processing of recycled corrugate

There is no widely accepted maximum level of recycled fiber that impacts machinability during conversion and typically only minimal adjustments would be required to use high levels of recycled fiber.

## Performance of recycled corrugate



*"The quality is just as good! If you have the right processing technology, you can make a product that performs equally with virgin fiber and be very competitive in price."*

Recycled corrugate can meet the same performance standards as virgin corrugate, with some exceptions for corrugated containers with substantial load-bearing requirements. In applications with very high strength requirements, recycled fiber may be optimized to lower percentages.

In some cases, the amount of recycled fiber used to meet strength requirements may exceed the amount of virgin fiber that would be used to meet the same strength requirements. Brand owners should be aware that packaging weight may be increased when recycled fiber is used, particularly when that conflicts with goals or strategic priorities around reducing packaging weight. Although heavier corrugated containers may increase environmental impacts during transportation, it should not be viewed as a deterrent for using recycled corrugate. As with all packaging materials and formats, brand owners and suppliers should work together to understand specific thresholds for packaging specifications and ensure that corrugated containers are not subject to overly-stringent specifications.

Creative solutions can be employed to accommodate reduce strength. For example, **finding the right corrugated flute technology** can achieve the required strength without increasing the amount of material required.

## Aesthetics of recycled corrugate

Recycled fibers produce a brown color that has become widely recognized and in some cases desirable for marketing and brand purposes. This brown color can slightly impact print quality.

Compared to virgin corrugate, untreated recycled corrugate generally exhibits a slightly uneven and inconsistent appearance, containing variable shades of brown and punctuated specks of darker colors. It is common to dye recycled fiber to give it a more consistent shade of brown, when such consistency is desirable. Recycled corrugate may be modified to increase whiteness and brightness, but the heterogeneities tend to be retained. Print quality on recycled corrugate may experience deficiencies compared to virgin corrugate, however, many corrugated applications, such as shipping containers or mini-flute corrugated sheets, are suitable to remain unbleached and do not require high print quality.



## Key takeaways



- ▶ The glass recycling process does not cause any inherent degradation of material properties and recycled glass is virtually indistinguishable from virgin glass.
- ▶ It is possible to use high levels of recycled glass without any performance or aesthetic issues.
- ▶ There is limited supply of recycled glass available due to low recycling rates of used glass containers and high transportation costs. However, there are key regional differences in supply that should be considered.
- ▶ The amount of recycled content in glass containers varies widely geographically and is influenced by regional recycling rates and transport costs.
- ▶ It is challenging for brand owners to receive information regarding the exact percentage of recycled content in their glass containers because historically that information has not been requested of container manufacturers or tracked.



## Environmental benefits

According to the [Glass Packaging Institute](#), each ton of glass recycled offsets the need for 1,300 pounds of sand, 410 pounds of soda ash, 380 pounds of limestone and 160 pounds of feldspar. It also reduces energy consumption and greenhouse gas emissions during manufacturing. For every six tons of cullet used, a ton of carbon dioxide is **reduced**. GPI notes, "A relative 10% increase in cullet reduces particulates by 8%, nitrogen oxide by 4%, and sulfur oxides by 10%."

## Supply and demand of recycled glass

The Glass Packaging Institute estimates that glass containers manufactured in the U.S. contain an average of 33% recycled glass or "cullet" from a mixture of post-industrial and post-consumer sources, although specific usage varies considerably geographically. It is technically possible to make glass containers using at least 95% cullet, though challenges exist including supply availability, cost volatility and the relatively wide availability and inexpensive nature of competing virgin feedstocks.





*The Montana Standard*

Glass that is collected for recycling and prepared for use in new containers or other products is called **furnace-ready glass cullet** or **furnace-ready cullet**. Cullet is defined as “[recycled broken or waste glass used in glassmaking](#),” and furnace-ready cullet must be “[uniform in size, free of contaminants and often sorted by color](#).”

Furnace-ready cullet is produced by a glass **beneficiator**, which is a specialized facility that removes additional contaminants and sorts glass by color and size. Glass containers collected for recycling in commingled residential programs typically undergo beneficiation following preliminary sortation at a MRF.

Glass container manufacturing is the primary market for cullet, but it competes with a number of other end markets, most notably fiberglass insulation. Fiberglass insulation is the [second largest market for recycled glass](#), owing in part to the [LEED](#) standard for sustainable buildings giving credits for the use of recycled glass in fiberglass insulation. Other end markets for recycled glass include roadbeds, abrasive agents, and alternative daily cover at landfills.

Supply availability of recycled glass varies by region. Because glass is heavy and transportation costs are high, **recycled glass is typically used within a few hundred miles of where it is collected**. The availability of recycled glass depends on proximity of glass beneficiators and the regional recycling rate of used glass containers. It is commonly believed that states with container deposit legislation generate the highest amounts of quality recycled glass, since glass containers are not commingled with other materials when they enter the recycling stream and therefore are less prone to becoming contaminated.

#### **What you need to know about glass recycling**

Only an estimated [33%](#) of glass containers are collected for recycling. After collection, supply is further limited due to the fact that **not all of the glass that is collected is then available as recycled glass for use in containers**. Since the onset of single stream recycling collection in the 1990s, glass has become more contaminated by paper, organic waste and other materials that enter the recycling system, sometimes rendering it too contaminated to be cost-effectively processed into furnace-ready cullet. In addition, some glass breaks into pieces too small for glass recyclers to use. These fine broken glass particles are commonly put toward other uses, like alternative daily cover at landfills or non-container markets.

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“The problem is that most of that glass that the consumer does throw back in their bin does not make it back to people that make glass bottles.”

– Brand Owner

#### Key initiative for building supply of recycled glass

**The Glass Recycling Coalition** is a membership organization that collaborates across the entire glass supply chain to “ensure all glass containers are continuously recycled to the highest and best use, maximizing economic, environmental and social benefits.” The Coalition believes that recycled glass is a high value material in the circular economy and that recycling glass conserves natural resources.

#### Success Story



### Improving the supply of recycled glass and reuse in packaging: Diageo

Diageo's **Glass is Good®** recycling program encourages bars, restaurants and other customers to sign up to have their used glass containers collected for recycling. The sorted glass is then transported to Glass is Good grinding sites, set up and run by local cooperatives, who grind it into cullet and store it. The cullet is then sent to glass container manufacturers who use it to manufacture new bottles. Diageo buys these bottles, made out of their own packaging, and uses them to package new products.



Diageo

It is often challenging for brand owners to receive information regarding the exact percentage of recycled glass in their containers. Theoretically, there is no insurmountable obstacle prohibiting tracking of the exact quantities of recycled glass inputs, since glass container manufacturers tend to use batch processes, but there is a lack of industry standard practices for doing so. **Brand owners should work with their suppliers to encourage better tracking of this information. For instance, supply contracts could include a formal accounting of cullet in the procurement phase.**

## Cost of recycled glass

Virgin glass feedstocks are often cheaper than cullet, [depending](#) on the region and commodity market conditions. However, because the use of cullet reduces the amount of required energy during manufacturing, as described in more detail below, using cullet decreases some manufacturing costs.

## Processing of recycled glass

Glass container manufacturers realize pronounced processing benefits when using cullet. **The lower melting temperature of cullet reduces the required furnace temperatures, which extends the life of glass container manufacturers' furnaces as well as reduces energy use.** Energy usage [drops](#) about two to three percent for every 10% of cullet used in the manufacturing process. **Since virgin glass is made from more caustic raw materials, the furnaces are subject to less corrosion when cullet is introduced to the mix.** Glass container manufacturers may use increased levels of cullet as a strategy for reducing maintenance costs and prolonging the life of an aging furnace.



*“Glass also has some natural benefits for incorporating recycled content because of the positive impacts to furnaces. The challenges are more in [increasing the quantity of] collection.”*

- Brand Owner

## Performance of recycled glass

Relative to other packaging materials, recycled glass and virgin glass are virtually indistinguishable in terms of performance. **Unlike mechanical recycling of plastics and paper, glass does not suffer inherent losses in performance characteristics during recycling,** meaning the quality of glass containers made with cullet is identical to that of glass bottles made of virgin materials. Technical deficiencies in recycled glass can arise when the cullet contains contaminants such as ceramics or metal. Contaminants can cause defects in glass containers that lead to failure when filled under pressure. However, glass container manufacturers tend to have sound quality control practices to detect and correct defects. The beneficiation step helps remove these contaminants.

## Aesthetics of recycled glass

Clarity and color of containers manufactured with cullet are not major concerns, although visible defects arising from contaminated cullet show up in finished products on rare occasions. To make glass containers a certain color, manufacturers source cullet of that color, or a color that can be adjusted to the desired color.

Most glass originating from a MRF is a mix of flint (clear), amber, and green, called a “three-mix”. The mix is then processed into furnace-ready cullet by a beneficiator. Beneficiation almost always includes color separation using optical sorters that sorts three-mix into flint, amber, and green cullet. Cullet that is not separated by color is termed “mixed recycled glass,” or “mixed cullet,” and is typically used in non-packaging markets such as roadbed, concrete, filtration, abrasive agents and fiberglass.

Amber and green cullet are the most widely available to glass manufacturers since colored bottles — mostly wine and beer bottles — represent a large portion of glass collected. Amber and green cullet are generally only suitable for use in the manufacture of new amber and green containers and it is not uncommon for colored containers to contain 70% or more cullet. Amber and green cullet are not suitable for use in the manufacture of new clear containers, since color can be removed with decolorizers but not to a substantial extent. However, flint cullet is also a substantial portion of the cullet supply.

Glass container manufacturers using cullet must manage some variability in the color of cullet to match the more predictable coloring of virgin material. Batch manager in glass container manufacturing plants typically combine virgin feedstocks and cullet to produce bottles to match the specifications of brands.

**Brand owners with commitments to use recycled glass can expect to achieve higher levels of recycled content usage in colored glass containers as opposed to clear glass containers.**

### Success Story



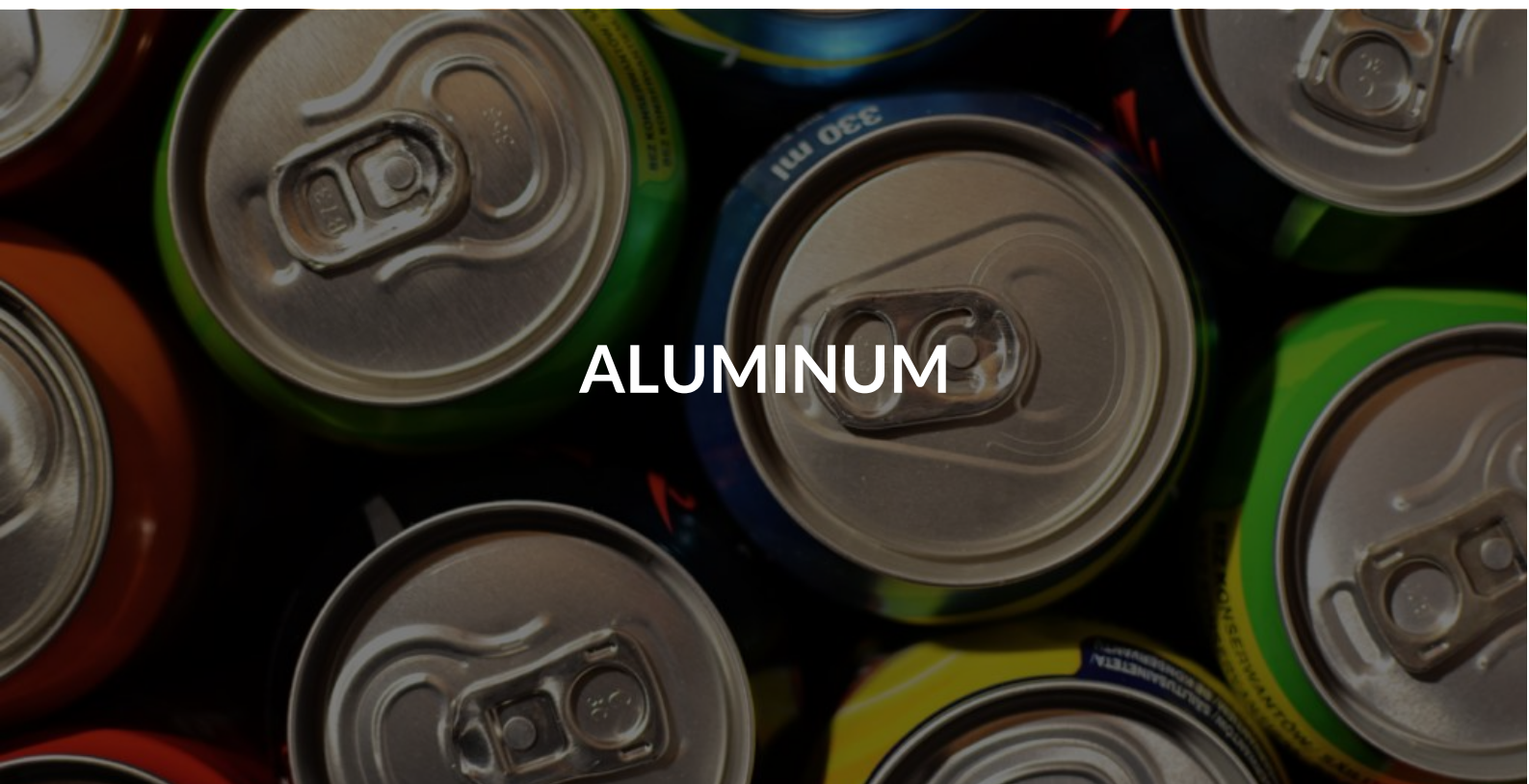
## Using recycled glass in clear applications



Absolut Vodka has a [comprehensive sustainability program](#) that includes the use of recycled content. The company produces about 600,000 bottles of vodka a day in Åhus, Sweden, and their bottles contain 40% recycled glass, in mostly clear bottles. This reduces Absolut's energy consumption by 10%. The bottles are produced in the nearest glassworks manufacturer to Åhus in order to reduce cost.



Habersham Beverage Warehouse



## Key takeaways:

- ▶ Aluminum cans typically have an average of 70% recycled content from a mixture of post-industrial and post-consumer sources.
- ▶ Use of recycled aluminum in new aluminum cans has few significant performance or aesthetic issues. It is challenging, however, to incorporate recycled content into aluminum foil. Aerosol containers typically do not contain post-consumer recycled content because their alloy is different than the predominant alloy in the recycling stream, but they may contain post-industrial recycled content.
- ▶ The specific amount of recycled aluminum in a given package is largely unknown, due to how aluminum supply chains are structured with many players and diverse scrap inputs.



## Environmental benefits

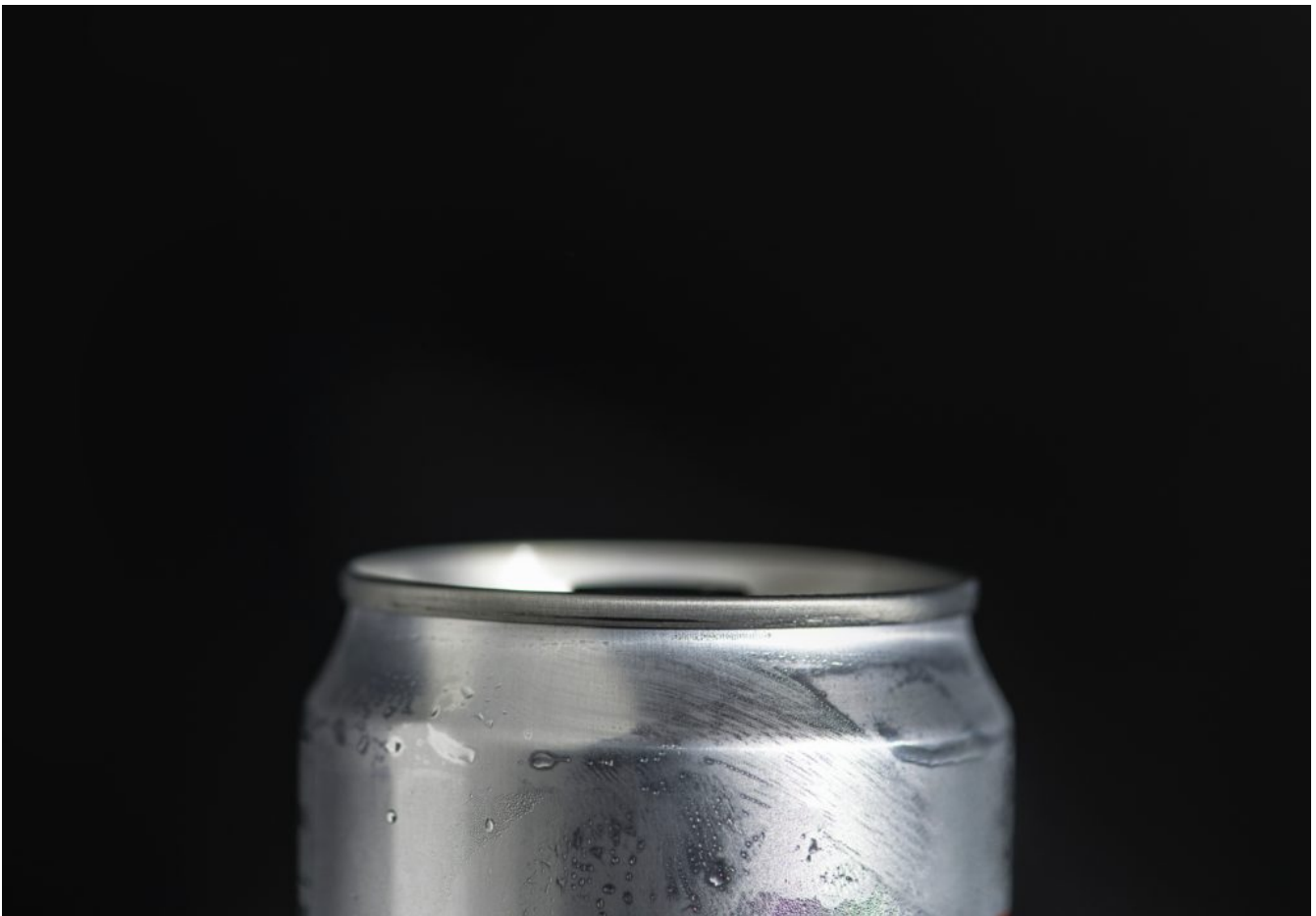
The production of virgin aluminum, which involves the mining of bauxite ore and smelting at high temperatures, can impact ecosystems and incur relatively large amounts of greenhouse gas emissions. In contrast, manufacturing recycled aluminum **requires 95% less energy and produces 95% fewer greenhouse gas emissions** than manufacturing primary aluminum.

## Supply and demand of recycled aluminum

Used beverage containers (UBCs) comprise the largest component of the post-consumer recycled aluminum supply. Most UBCs are manufactured back into aluminum cans. Additional supply of recycled aluminum comes from post-industrial manufacturing scrap, other forms of aluminum packaging from post-consumer streams, and non-packaging post-industrial sources like certain grades of automotive scrap or building and construction scrap.

**On average**, aluminum cans contain 70% recycled aluminum from a mixture of post-consumer and post-industrial sources. This is an overall industry average, and aluminum manufacturers fluctuate specific percentages of recycled aluminum usage based on the availability of UBCs. These specific percentages are rarely tracked and shared with downstream supply chain partners, so there tends to be little to no visibility into the exact amount of recycled aluminum in any given new aluminum can.





#### What you need to know about aluminum recycling

Aluminum cans are widely accepted by municipal recycling collection systems because they carry a high commodity value with robust market demand. According to the latest EPA estimates, 54.9% of aluminum drink cans are collected for recycling. **The domestic availability of UBCs has not always been sufficient to meet demand**, which has driven mills to import UBCs from abroad. Cans are commonly imported from Mexico, the Middle East, and in some cases Europe.

It is often difficult for brand owners to receive information regarding the exact amount of recycled aluminum in their aluminum cans because can manufacturers often do not receive this information from their suppliers. It is challenging to trace the amount of recycled aluminum that flows through the industry due to its large number of suppliers and large-scale production. The batch process by which aluminum cans are made involves a mixture of virgin aluminum and recycled aluminum from post-industrial and post-consumer sources. Different feedstocks are available at different times, and **the ability to include recycled aluminum depends on the availability, alloy composition, and quality of recycled aluminum at the time the batch is made**. Sometimes there are not enough UBCs available to fill a batch, and other times there are.

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*“The canmaker doesn’t make the aluminum; they buy the aluminum from an aluminum maker. My sense is the reason that we have a hard time getting good numbers from our canmakers is because they have a hard time getting good numbers from the aluminum makers.”*

- Brand Owner

**Past efforts** to market cans with consistent, high levels of recycled aluminum (at least 90%) encountered barriers, including challenges around accounting for the percentage of recycled aluminum in specific batches of cans. An additional challenge was brand owners’ resistance to

committing to a single supplier of cans, even if it meant guaranteed and verified high levels of recycled aluminum.

Brand owners can encourage a system in which more recycled aluminum usage is tracked and verified by increasing their demand for recycled aluminum and increasing their willingness to work with suppliers to develop chain of custody systems that track and trace recycled aluminum usage. To this end, brand owners could consider signing long-term contracts with suppliers who are able to provide and verify the percentage of recycled aluminum used.

## Cost of recycled aluminum

Aluminum manufacturers are often challenged to find a steady supply of UBCs in close proximity, which is important since the cost to transport UBCs over long distances may erode the price advantage (and greenhouse gas emissions savings) of using recycled aluminum instead of virgin aluminum. It makes sense, both economically and environmentally, for a bale of UBCs to be shipped to the nearest aluminum mill, and therefore some buyers may have better access to UBCs at some times than others. Because of these cost dynamics, using higher percentages of recycled aluminum may sometimes increase costs.

Brand owners should be prepared to work closely with suppliers to encourage the use of recycled aluminum, while considering potential trade-offs in life cycle impacts that may arise when recycled aluminum needs to be transported over long distances in order to replace virgin aluminum. Life cycle assessments are a valuable tool that can be used to weigh these impacts.

## Processing of recycled aluminum

Recycled aluminum cans do not present any processing challenges. UBCs are remelted at 600 to 700 degrees Celsius, which eliminates most impurities that they may have come into contact with in the municipal recycling stream.

Within aluminum cans, the can body, lid and pull-tab are each made of unique alloys with have slight variations in their chemical compositions. Because these alloys are blended together when UBCs are used to make a new can body, recycled aluminum may need to be diluted with virgin aluminum in order to achieve the appropriate chemical composition of the can body alloy. Adjustments to the alloy always depend on the mix of alloys in the incoming feedstock stream and the desired end use application.

### Important initiative related to recycled aluminum

The **Aluminum Stewardship Initiative (ASI)** has developed a Chain of Custody certification so that aluminum consumers can be assured that the product they are buying is responsibly sourced and produced. The [standard](#) is applicable to all stages of aluminium production and transformation, including criteria for both virgin and recycled aluminum as well as guidance on recycled content and other sustainability claims.

### Success Story

## Success story of using recycled aluminum

Reynolds Wrap® offers a foil made from 100% recycled aluminum, which is made from a mix of post-industrial and post-consumer aluminum and is food-safe. Reynolds Consumer Products notes on their product page that the foil has the potential to be recycled again, but that consumers need to check locally to see if their local recycling facility accepts aluminum foil — an important step to improving future quality of recycled aluminum. Their process for making recycled aluminum foil uses 80% less energy than it does to make foil from virgin aluminum.



## Performance of recycled aluminum

There are no challenges surrounding the quality or performance of recycled aluminum in new aluminum beverage cans. In thin foils, recycled aluminum may introduce pinholes, so care must be taken to detect defects.

## Aesthetics of recycled aluminum

There are no known aesthetic issues with using recycled content aluminum in packaging.



- ▶ Virtually all steel packaging contains 20-30% recycled steel. Steelmakers typically do not manufacture with recycled steel percentages outside this range due to the nature of the steelmaking process.
- ▶ The steel recycling process does not cause any inherent degradation of material properties or introduce any important performance or aesthetic considerations.
- ▶ It is difficult to know the specific percentage of recycled steel in a given package because of a lack of tracking during processing.



### Environmental benefits

Every ton of steel recycled avoids the use of 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone.

# Supply and demand of recycled steel

Waste steel used in new manufacturing processes, termed “scrap”, originates from recycled steel packaging, construction and demolition waste, appliance and “white goods” recycling, automotive recycling, and a number of other streams. Steel recycling is extraordinarily “open loop” in nature, meaning steel scrap from different markets are interchangeably used as feedstocks in manufacturing processes for new steel products. For example, automotive scrap may be used in the manufacture of a new aerosol container, which may then be used as scrap in the manufacture of a new stop sign, which may then be used as scrap in the manufacture of a new refrigerator, which may then be used as scrap in the manufacture of a new soup can. Because of this, and because of the nature of steelmaking processes, the numerous markets for steel products do not “compete” for recycled steel in the way that markets do for most other types of packaging materials. Iron foundries provide some demand for scrap steel outside of the steelmaking industry, as new iron products are often made with recycled steel, but this competition does not restrict the amount of steel scrap used in the manufacture of new steel products such as packaging. The supply of scrap is robust and stable, as steel is a highly recycled material.

## What you need to know about steel recycling

Steel containers have a high overall [recycling rate](#) of around 73%, however the volume of steel containers is relatively small compared to other sources of recycled steel such as automotive recycling, appliance recycling, and construction and demolition waste recycling. For context, the U.S. Environmental Protection Agency estimates that 1.6 million tons of steel containers were recycled in the U.S. in 2014, which is a small fraction of the 60 to 80 million tons of steel scrap that the Steel Recycling Institute estimates to be recycled each year in North America.

Compared to other substrates, steel is very easy to identify and sort from other materials because it is inherently magnetic. The vast majority of steel products in waste streams are readily identifiable and removable for recycling.

All steel products contain recycled steel, so demand for recycled steel is inherent to demand for steel. There are two main steelmaking processes: electric arc furnace (EAF) steelmaking, which always uses around 90% scrap, and the basic oxygen process (BOP), which always uses around 20-30% scrap. Only BOP steelmaking is capable of manufacturing the grades of steel used in packaging, and while the percentage of scrap used in BOP steelmaking can be adjusted within the range of roughly 20 to 30 percent, the steel industry is unaccustomed to meeting demand for higher percentages of recycled content by raising the percentage of scrap towards the practical limit of 30 percent. It is theoretically possible that dynamics around demand for recycled content could influence the amount of scrap used in BOP steelmaking, but in practice, demand for steel products is uncoupled from demand for recycled content, and steelmakers adjust the percentage of scrap based on processing requirements, cost, and energy prices.

The lack of demand dynamics around recycled content in new steel products is responsible for a lack of information on the specific amount of recycled steel in new steel packaging. Steelmakers vary the percentage of scrap used in manufacturing but do not tend to track that information and share it with downstream supply chain partners, who usually source steel from a number of different steelmakers and do not tend to track the specific source of each unit of steel they procure. The relative percentages of post-industrial and post-consumer scrap are also not tracked and shared with supply chain partners. Despite the lack of traceability and tracking, the assumption that all steel packaging contains 25% recycled content is usually sufficient, since there is limited variance in the percentage of scrap used by BOP steelmakers.



## Cost of recycled steel

Using between 20 and 30% scrap in BOP steelmaking optimizes costs associated with the manufacturing process and is a major reason why the percentage of scrap is virtually fixed. The foundation of BOP steelmaking involves using oxygen to remove carbon from iron, which releases a large amount of heat. Managing waste heat is typically an operational cost, but by adjusting the relative percentages of virgin iron and recovered scrap in a basic oxygen furnace, the amount of waste heat generated during de-carbonation of the virgin iron can match the amount of heat required to melt the scrap. If the amount of scrap used falls below this “sweet spot,” then the steelmaker must manage waste heat, since there is not enough scrap to absorb it. On the other hand, if the amount of scrap used exceeds the “sweet spot,” then the steelmaker must add energy in order to melt the scrap. Both of these scenarios involve added costs. In practice, BOP steelmakers adjust the percentage of scrap based on the carbon content of the virgin iron – which dictates the “sweet spot” – and they may intentionally use a percentage of scrap that exceeds the “sweet spot” when energy prices and scrap prices are especially attractive. Theoretically, the percentage of scrap used in BOP steelmaking could drastically exceed the “sweet spot,” but if this is done on a regular basis, then the large amount of energy required to melt the additional scrap would drastically increase costs.

It is also important to note that EAF steelmaking serves as a relatively large sink for scrap. This hedges against volatility in scrap prices and prevents the market value of scrap from long-term lows that would help enable BOP steelmakers to use higher percentages at a cost savings.

Since the primary cost consideration around increasing scrap percentages is the amount of energy required to melt the amount of scrap that exceeds the “sweet spot,” the environmental impact intensity of BOP steelmaking generally follows suit.

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*“[Increasing recycled content in steel cans] would throw off the life cycle benefit of the can. Right now ... we’re at the cross-section of creating steel and offsetting raw materials and energy where we can, and if we were to inject more energy into this process, which energy is probably one of the biggest life cycle footprints, it would make the process much less environmentally friendly so that would not be the ideal scenario.”*

– Steel Recycler



# Processing of recycled steel

In contrast to the recycling systems of other materials, steel reprocessing operations are extremely tolerant of contaminants because the furnace temperature may reach 3,000° Fahrenheit. This high temperature causes all plastic, glass, paper and aluminum objects to vaporize, with some of their energy captured to impart a small amount of heat to the furnace.

Scrap used in BOP steelmaking comes from a variety of sources and usually does not match the grade required to make new steel packaging. BOP steelmakers must adjust the carbon content of the mixture of scrap, which is straightforward since de-carbonization is a central function of BOP steelmaking. They must also remove elements such as tin and chromium that may be present in coatings on the incoming scrap. Additionally, there are various metallurgical processes to adjust the amounts of alloying elements. BOP steelmakers who use scrap from waste steel packaging will incur less processing requirements, since the feedstock more closely matches the desired grade. However, this type of “closed loop” recycling is not common, since the commodity market for scrap steel is robust and steelmakers tend to use many grades of scrap that are available in close proximity at suitable prices.

## Performance of recycled steel

Recycled content in steel packaging does not cause performance defects or deficiencies. Scrap can be stockpiled for a long period of time without deteriorating and steel can be recycled endlessly without any deterioration of inherent physical properties.

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## Aesthetics of recycled steel

The use of recycled content in steel packaging does not introduce any aesthetic trade-offs, as the aesthetic qualities of steel are not modified during the recycling process. Furthermore, virtually all steel packaging is coated with either chromium or tin (hence why steel cans are more commonly referred to as “tin cans”), which is more influential in the appearance of steel packaging.

# QUESTIONS

This resource was launched in early 2019 and is a living document to track the latest information about recycled content. This is a living guide and will be updated regularly.

For questions about the content or to suggest updates, please email [spcinfo@greenblue.org](mailto:spcinfo@greenblue.org) and reference the “Design for Recycled Content Guide” in the subject line.

Media inquiries? Please email [anne.elsea@greenblue.org](mailto:anne.elsea@greenblue.org).