

Thinking Inside the Box: A Circular Approach to Extending the Lifecycle of Fiber-based Packaging



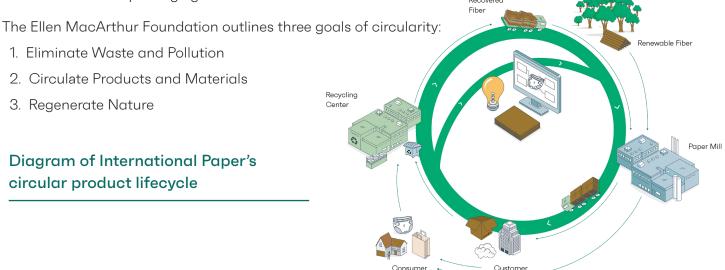
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Abstract

The story of International Paper (IP) began more than 125 years ago, with a focus on manufacturing a highly adaptable fiber-based product that changed the world through the proliferation of newspapers. Since the company's origin, the world has undergone dramatic change. IP's focus in the current century has turned towards corrugated products. With a global customer base that touches every conceivable industry, the responsibility towards a sustainable future lies not just with individuals, but also with companies whose products are in the hands of consumers around the world.

While reports and surveys indicate that consumers broadly care about protecting the environment, knowledge about the most sustainable forms of packaging is limited. This report will outline the challenges associated with transitioning from a single-use economic model to one that prioritizes sustainable, circular use of resources in packaging.



From an ordinary source comes an extraordinary product: containerboard mills convert trees to pulp and paper, and thus a renewable resource is transformed into useful products. Fiber-based products range from absorbent lining in hygiene products, essential to healthy living and childhood development; leak-resistant containers that transport liquids ranging from raw ingredients to vital medicines; endlessly customizable and configurable corrugated containers that facilitate the daily transport of goods across the world; and robust packaging solutions that protect what's inside.

Introduction: Packaging Waste and the Need for Sustainable Improvement

In the last century alone, material changes to the average standard of living have dramatically improved human health and well-being worldwide. These changes come at a cost, and the looming issue—troubling scientists and researchers as far back as the 1960s —is the collective reliance on intensive greenhouse gas (GHG) producing processes to maintain a modern lifestyle. While a large part of our GHG impact comes from the sources of energy we use, our consumption of materials – the way we make and use products and food – are responsible for the remainder of emissions.¹

Since 2018, the earth has consumed over half a trillion metric tons of materials, which is "nearly as much as the entire 20th century combined".² This challenge—what the <u>Circle Economy Foundation</u> refers to as the "circularity gap" — highlights the urgent need for the transition to a more circular economy to achieve broader societal and environmental goals.

The Circle Economy Foundation identifies four global systems that put the most pressure on key "planetary boundaries", or measures of impacts to the earth's environmental health for which the world currently exceeds its limits. The first global system is the food system, which is the largest driver of land-use change causing globally significant biodiversity loss and contributing to one-third of GHG emissions. The second system is built environment, which is responsible for 40% of global GHG emissions, one-quarter of land system change and contributes to water stress. The third is manufactured goods, which contribute primarily to pollution and climate change through heavy material- and energy-intensive industrial activities at the production level. The fourth global system, and no less important than the other three, is transportation and mobility, which account for 25% of GHG emissions globally, through high fossil fuel use, and drive land use change and biodiversity loss.³

Packaging is involved at every stage of these four global systems. Producers and recyclers of sustainable packaging such as International Paper can affect positive environmental change across each of these global systems. By using experience and expertise in the sustainable material space, as well as innovation in product design to increase recyclability and reusability, we are already working to replace single-use materials with sustainable, recyclable and adaptable packaging.

The Ellen MacArthur Foundation highlights how applying circular economy principles to the way we make and use products can not only create value, but also significantly reduce global emissions:⁴

- By eliminating waste and pollution, we reduce greenhouse gas emissions across the value chain
- By circulating products and materials, we retain their embodied energy
- By regenerating nature, we sequester carbon in soil and products

Through continuous innovation, sustainable infrastructure development and circular design, a future is possible in which high standards of living are maintained while minimizing environmental impact.

What Prevents the Reuse and Recycling of Packaging Materials?

Transitioning to a more circular economy for packaging means moving away from single use to recyclable or reusable alternatives. It is important to make a distinction between these two practices. Reuse involves processing and cleaning a container in its existing form. Recycling requires a further stage

of processing, where the container is converted back to its base material and reintroduced into the value chain as an entirely new product. Both reuse and recycling practices are essential parts of the circular economy but can be improved at all levels of the supply chain by transitioning away from single-use materials, eliminating waste and optimizing recovery processes. Single-use material forms of packaging, made of ostensibly recyclable material, are poorly designed for the recovery process, which leads them to be discarded as waste.⁵

The packaging marketplace uses a variety of materials: metal, glass, plastic and paper. Many of these materials are chosen for their perceived durability and ability to protect packaged contents. Our current resource challenge is that many materials are theoretically reusable or recyclable but fail to be recovered at various points in the supply chain or are forsaken due to inadequate economies of scale. According to a Bain & Company 2023 report, "companies often find themselves at the mercy of inadequate recycling and waste management systems..."⁶

In many ways, the development of an efficient global supply chain and innovative manufacturing sector has outpaced our ability to effectively manage waste. Single-use product manufacturing takes natural resource abundance for granted. It is only in recent years that global awareness of the pressures on natural resources has grown. Hand in hand with new approaches to sustainable resource use, the circular economy model identifies and addresses many of the most egregious causes of waste.

The logistics involved in collecting, sorting, treating, processing and recycling certain types of postconsumer waste have proven to be a significant challenge, in addition to ensuring a competitive rate can be paid to the labor force required to accomplish these tasks. Put simply: for certain types of packaging, the decades-long campaign to encourage recycling at the industry/company level has struggled due to lack of profit motive and collection infrastructure development. A recent report issued by the <u>Center For</u> <u>Climate Integrity</u> provided forty years' worth of internal documentation demonstrating that consumers are often left to shoulder the burden of recycling plastic (in 2021, 6% of the plastic waste generated in the U.S. was recycled⁷) while simultaneously acknowledging the impossibility of effectively recycling plastic due to the natural degradation of the material during use.⁸ The response from the plastics industry has been to point to market dynamics, suggesting that recycling plastic is only a viable solution when the price of oil is sufficiently high as to discourage new petroleum use in plastic.⁹

The Sustainable Advantage of Fiber-based Packaging in Comparison to Other Packaging Materials

Fiber-based packaging continues to address many of the challenges outlined above. Fiber-based packaging rates highest on the biodegradability of its material components.¹⁰ Corrugated boxes are the single most recycled form of packaging, with more than 3x as much paper being recovered by weight as aluminum, steel, glass and plastic combined¹¹.

Circularity can be achieved with the increased adoption of sustainable packaging derived from a renewable resource: trees. Wood fiber sourced from responsibly managed forests that are healthy and growing can also serve as carbon sinks to pull excess CO2 out of the atmosphere. While fiber-based packaging is already a demonstrably successful example of the circular economy at work, there are still knowledge gaps that need to be navigated.

According to a 2023 McKinsey survey, only 59% of consumers believed paper-based cartons to be "very sustainable", and "roughly two-thirds of consumers say sustainable packaging is at least somewhat important when making a purchase."¹² While fiber-based packaging is sustainable, additional education is needed to broaden the understanding of the sustainability of corrugated products. Simply put, consumers need to better understand the fully circular nature of fiber-based packaging. This knowledge will drive consumer and industry preference for packaging solutions that transition away from wasteful and carbon-intensive materials towards a more sustainable future.

Evidence from voluntary reporting and trends in demand suggests that consumers and governments support phasing out single-use packaging in favor of reusable and easily recyclable solutions derived from "bio-based" materials. In Europe, 71% of consumers claim they want to buy sustainable products, and in the U.S. 71% of consumers want to buy products with "as little packaging as possible."¹³ In the last decade, use of paper packaging has grown by 2%, to constitute 35% of the global packaging market, although it is still outpaced by the growth of flexible and rigid plastic.¹⁴

Paper products have the highest material recycling rate, in part because corrugated boxes frequently assist intermediate stages of the shipping process—from the production line to the retail store—and therefore can be easily collected, flattened and prepared for recycling at the retail location. Furthermore, the paper industry has invested significantly to build out recycling infrastructure and continually improve the recovery of paper-based materials. Corrugated is the most recycled material in use today, due in large part to the strong end market. Recycled fiber is a vital input to produce new corrugated boxes. The American Forest and Paper Association (AF&PA) calculated the recycling rate for corrugated to be 93.6% in 2022, an increase from the year prior.¹⁵

The use of sustainable raw materials aligns with a core principle of circularity: regenerating natural systems. Because fiber-based products are made from renewable resources, they replace less sustainable, carbonintensive, non-renewable products. Corrugated packaging remains an exemplary material in terms of properties conducive to a circular economic model. Corrugated packaging is the only packaging for which the raw material is itself an excellent renewable resource that contributes to carbon sequestration: wood fiber from forests.

What is the Lifecycle of a Box?

Rethinking economic production as a continuous cycle of use and renewal has become a subject of great interest for businesses committed to a sustainable future. Likewise, economic benefits are gained

from reduced fuel and raw material costs, and a closed-loop manufacturing process that minimizes energy waste.

For the containerboard box, circularity begins in the forest. From the forest, renewable fiber is transported to a paper mill, where it is converted to pulp in a process that yields cooking "liquors" as well as biomass that can be reintroduced into the process as fuel, considered carbon neutral biomass energy.

Paper mills are the catalyst in the circular lifecycle of a box: these facilities realize incredible energy savings through efficient biomass cycles and effective water treatment. Due in part to the high capital cost of updating mill and box plant equipment, the paper and packaging industry has a broad range of technology and energy efficiency in facilities. International Paper is committed to demonstrating strong leadership in manufacturing excellence, emissions reduction and process improvements. As part of IP's Vision 2030 goals, the company is focusing its efforts on projects that minimize fossil fuel use, improve energy efficiency and expand the use of renewable energy. As a result, 70% of the company's mill energy is derived from carbon-neutral biomass residuals, a by-product of the paper manufacturing process turned into energy.

International Paper implements circular principles and practices throughout its value chain to ensure that its products are responsibly sourced, recovered and recycled into new boxes. While wood fiber cannot be used indefinitely, it can be used many times before the fibers are too brittle and short and considered "lost". These "lost" fibers, and other manufacturing byproducts, are captured and used for biomass-based fuel to power the mill.

After pulp is transformed into containerboard, it enters the converting process, where rolls of containerboard are cut, shaped and printed to fit customer specifications at box plants. Nearly all trimmings and scrap paper at box plants are recovered and returned to the paper mill to be recycled into new containerboard. After customer use, a robust network of recycling collectors, including IP's own recycling business, transports recovered materials to a recycling facility, then to paper mills, where the fiber is broken down and reintroduced, beginning the circular process again.

Why Circularity Matters

Effective leadership in the circular economy requires companies to think carefully about the entire life cycle of their products. With much of modern commerce occurring online, this has led to the development of a complex global supply chain that is often erratic, wasteful and energy intensive. Businesses throughout the value chain, as well as individual consumers, are becoming more aware of how their habits contribute waste to the landfill after use. The packaging industry and packaging users must continue to prioritize renewable solutions that can be easily reused or recovered as a sustainable alternative to products made from non-renewable resources.

While the circularity story of a corrugated box starts in the forest, it ends with high collection and recovery of this valued natural resource. The fiber-based packaging cycle naturally aligns with the circular economic model. Still, there is always room for improvement in residual loss, resource efficiency, and striving for a closed-loop resource cycle to reduce GHG emissions and prevent pollution.

The Importance of New and Recycled Fiber to Maximize the Sustainability of Fiber Packaging

A point of contention within the fiber-based packaging industry is whether virgin fiber or 100% recycled fiber is more sustainable. At first glance, it might seem that using only recycled fiber would be more sustainable, but recycled fiber is only one part of a sustainable fiber system. The other part is virgin or 'new' fiber, which, when sourced from forests whose ecosystems are sustainably managed, plays a critical role in mitigating climate change and promoting biodiversity. While the use of recycled fiber avoids some GHG emissions from landfills, new fiber from sustainably managed forests can support the removal of carbon emissions from the atmosphere.¹⁶ Underscoring the need for new fiber inputs is that trees are a renewable natural resource and provide considerable benefits to humans and biodiversity while they are growing in the form of carbon sequestration. Using new fiber maintains the demand for sustainably managed forests.



On average, containerboard producers use 56% recycled fiber in their production process.¹⁷ International Paper believes that, in the long run, using a mix of new and recycled fiber is more sustainable. Recent studies on the recyclability of packaging materials show that fibers can be recycled up to 25 times

without significant losses in strength properties.¹⁸ This is significant, but at some point, the fibers will become brittle and lost. Using a mix of new and recycled fiber increases the useful lifespan of a single corrugated box, because recycled fibers cannot be used indefinitely.

Given the limited reusability of any recyclable material, including wood fiber, businesses labeling their products as 100% recycled fiber are procuring their recycled material from new kraft manufacturers and vertically integrated companies like International Paper. This collaboration within the packaging supply chain requires input in the form of new fiber.

Digital tools and data infrastructure have led to improvements in the recovery process. As a member of the American Forests & Paper Association, International Paper facilities contribute data to the <u>Fiber Box</u> <u>Association Life Cycle Assessment report</u>, which has documented considerable improvements in the overall circularity of the box lifecycle since 2008.

From 2006 to 2020, industry-wide recovery rates increased from 72% to 90%, which reduces both landfill emissions and the requirement for extraneous new fiber production. During the same time, containerboard that was made from 100%-recycled fiber increased from 22.3% to 31.8%.

The introduction of fresh fiber into the system drives the removal of CO2 from the atmosphere, while the use of recycled fiber contributes to the avoidance of CO2 and methane from the landfill.¹⁹

Looking at either stream of production in isolation has advantages and disadvantages, but the combination of new, fresh fibers and recycled fibers maximizes fiber reuse and enables circularity. By investing in sustainable forest management as well as its recycling infrastructure, true circularity can be brought to the wood fiber value chain.

Case Study: Leading the Way with Circularity

International Paper implements circular principles and practices throughout its value chain to ensure that its products are responsibly sourced, recovered and recycled into new boxes.

The company's Vision 2030 goals align with the principles of the circular economy—and its actions demonstrate a commitment to progress and growth in the sustainability space. By 2030, IP aims to source 100% of its fiber from responsible sources, meaning sources that conform to 3rd party certification standards. The company also aims to create products that are 100% reusable, recyclable and compostable.

Setting measurable sustainability goals helps packaging companies align to the principles of a circular economy: to eliminate waste and pollution, circulate products and materials and regenerate nature.

Eliminate Waste and Pollution

Much of the world economy operates in a way that converts raw materials to products and then eventually disposes these products as waste. Waste accumulates and becomes unusable. At the same time, landfills are one of the largest producers of GHG emissions. Circular economic thinking treats waste as a "design flaw"²⁰, which can be mitigated and eventually solved through adaptations to the use and reuse of products.

Responsible use of natural resources and transparency in sourcing are essential to meeting increased demand for wood fiber without destroying valuable forests. The recovery and recycling of fiber-based products is integral to "reducing consumption footprints, providing sustainable products and thereby contributing to creating more sustainable lifestyles."²¹

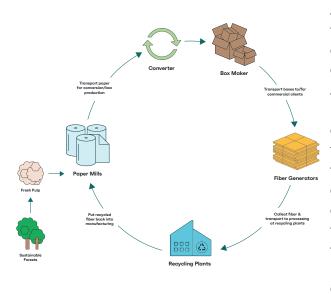
A core component of any circularity strategy are products that enjoy multiple lives through repeated cycles of reuse, recovery and recycling, and the assurance that any byproducts of the manufacturing process are put to good use. Every year, IP uses five million tons of recovered fiber to make new fiber-based packaging, making International Paper one of the world's largest users of recovered fiber. Additionally, nearly 50% of the company's manufacturing waste is diverted from landfills each year for beneficial use. For example, the ash created from burning tree bark and other residuals is used to stabilize pH levels in farmland. Dry ash can be used in road construction and in the manufacturing of concrete. Other wood byproducts are used to make everyday products such as paints, fabrics, lubricants and even cosmetics.

In International Paper's Europe, Middle East and Africa (EMEA) region, the company is promoting sustainable and renewable products by developing solutions for all types of packaging. As a result of these efforts in EMEA, IP's corrugated products have replaced 765 tons of plastics in 2022, and 1,410 tons replaced since the beginning of the decade.

Circulate Products and Materials

International Paper occupies a unique position in the market as both a producer of fiber-based products and a consumer of reclaimed cardboard. As such, the company has a marked impact on the overall industry for recycled cardboard.

There are few products in the world where a used product can generate revenue, but cardboard is one. .In the customer success story below, International Paper was able to solve the customer's challenges created by China's withdrawal from the import waste market, generate revenue from would-be waste product, and close the circularity loop in its sustainable packaging story. A national wholesaler was faced with the challenge of needing to diversify its recycling partners. A single distribution center uses tens of thousands of tons of cardboard each year. Without an outlet, its used cardboard would accumulate on its loading docks and in its parking lots, impeding business, creating a fire hazard and otherwise threatening human safety. As both an aggregator and manufacturer, International Paper offered end-to-end circularity. International Paper has a nationwide network of 18 recycling plants to handle the old corrugated containers (OCC) volume produced by a national wholesaler of this scale. IP also had the transportation infrastructure to step in from day one and guarantee movement of 100% of this wholesaler's OCC volume from its distribution centers nationwide—thousands of tons per year. And, as the largest producer of containerboard in the country, making as much as a third of all U.S. corrugated packaging, only International Paper could also guarantee that this wholesaler's OCC would be appropriately recycled and reused. With its scale, national network and recycling expertise, International Paper was able to offer an end-to-end solution.



Another example of a circular customer solution comes from Italy where IP collaborated with long-standing customer Colgate-Palmolive to design a circular supply chain solution to decrease waste and increase recycling. A local transport company collects paper and corrugated packaging scraps from the Colgate-Palmolive plant and delivers them to a local recycled paper manufacturing facility. IP's Pomezia, Italy box plant then transforms it into the Circular Box, which is used for transporting personal care products. The result is a closed and sustainable circular supply chain. The Circular Box was chosen as a finalist in the Best Packaging 2022 contest, organized by the Italian Packaging Institute (Istituto Italiano Imballagio) in collaboration with Conai (National Packaging Consortium).²²

Positively Impact Nature

1.6 billion people worldwide depend on healthy forests for their livelihoods.²³ Because the creation of paper-based products begins in the forest, packaging companies should be committed to using only fiber from sustainably managed forests, as well as recovered fiber.

It all starts with responsible and transparent sourcing. At IP, the fiber supply team has developed an internal fiber procurement mapping tool called ForSite[™], an industry-leading platform that exemplifies transparency, risk mitigation and targeted collaboration. ForSite[™] enables IP to know where its wood is coming from and ensures that the right resources and decisions are made before the fiber enters the mill system.

This system guides IP's responsible fiber procurement on non-certified forestland in the U.S. It ensures that conservation approaches, similar to those practiced on third-party certified lands, are incorporated in forest management and harvest practices on non-certified lands.

ForSite[™] uses Geographic information system (GIS) technology to display and organize spatial data within the complex network of family-owned and institutional "stands" that make up the forests where IP procures its fiber. ForSite[™] data includes an array of environmental and spatial attributes, including rare, threatened and endangered species, priority forest types and landscapes, soil types, topography

and hydrology, satellite imagery and optimized delivery location. This data is presented in an easyto-use mobile app, which allows fiber supply team members to make informed decisions prior to the fiber entering IP's supply chain. In addition, ForSite™ assists partners in the tree farming industry and conservation groups.



By knowing the exact location of the direct fiber purchased, IP can ensure not only that its fiber is derived from sustainably managed forests, but also that it is delivered to the most cost-effective facility.

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As one of the world's leading producers of renewable, fiber-based packaging, International Paper uses new pulp from sustainably managed forests, and millions of tons of used cardboard, which is processed into new boxes. It is this end-to-end circular model that sets IP's approach apart from almost every other cardboard recycler.

International Paper works at every level of the circular economy to improve recovery and recycling of fiber; it is critical to its entire business. IP makes about one of every three cardboard boxes used in the United States, and on average, a third of the fiber in any given box is recycled. As such, International Paper is one of the largest buyers of used cardboard globally. The company recovers, processes, buys or facilitates the sale of more than 7 million tons of fiber every year. That is 12% of the entire U.S. market for recycled cardboard. And IP has increased recovery of OCC by 60% since 2010. That recovery is good for communities nationwide as it reduces the volume of materials sent to landfill and extends the useful life of natural resources.

The current rate of recovered fiber is high: nearing 70% in the United States and Europe, and 80% in Japan, this number approaches what the World Business Council for Sustainable Development (WBCSD) estimates to be the "maximum that can be practically achieved".²⁴ An estimated 10 tons of recovered bulk cardboard yields approximately 8 tons of reusable pulp. While that is a high ratio, it will likely never be 100%. If the industry had to rely solely on recovered fiber, it could run out of raw material entirely within six months. Additionally, recovered fiber can only produce "new paper of an equal or lower grade," meaning new fiber is necessary to retain a high level of quality. This is why International Paper uses both responsibly grown and managed new fiber along with recycled fiber to make sustainable, fiberbased products.

Conclusion

The 21st century will come to be defined by efforts made by people, governments and corporations to design a safer world for all generations. The global population is expected to reach 10 billion by 2050, thus the demand for forest products is likely to increase. Products sourced from healthy, working forests can help meet people's needs for fiber-based products, and the entire world can benefit from the environmental assets that forests naturally provide, including animal habitat, recreation, air quality and carbon sequestration. Fiber-based packaging makes the biggest companies in the world more sustainable by supplying them with recyclable, responsibly made products made from renewable resources.

Appendix

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- ²⁴ World Business Council for Sustainable Development, Facts and Trends: Fresh and Recycled Fiber Complementarity (2015) [link]

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