PLASTIC
INGENUITY

2024

THERMOFORM CIRCULARITY REPORT

REPORT CONTENTS

Letter from Dan Kuehn — President / CEO

Three years ago, in January 2020, I found myself sitting around a table with the Plastic Ingenuity executive management team in a strategic planning session. The discussion had turned to the inevitable SWOT analysis—beloved by no one but consultants. We discussed 'Threats' and the team began lamenting how plastic was severely misunderstood amid the prevailing anti-plastic narrative, which largely ignores the significant, positive attributes of plastic.

As the discussion continued, this anti-plastic threat seemed insurmountable. The problem seemed far bigger than what we could reasonably try to address. The ardently anti-plastic voices seemed so loud (and sometimes very famous!), while the reasonable voices searching for practical solutions to our problems seemed so muted, that it appeared impractical, even impossible, to try to tell our side of the story.

The discussion turned back to the upper-left 'Strengths' of PI's SWOT: technical expertise, customer focus, and practical problem-solving capabilities. How could we bring this skill set to bear on the common misunderstandings related to the indispensable role plastic plays in our modern society? From prior discussions with customers, it was obvious there is a lot of confusion in this sustainability space—even among well-informed stakeholders sincerely and ardently searching for practical solutions. We thought our technical base and collaborative culture would allow us to become a well-informed resource for our customers and other stakeholders within the relatively small niche of plastic thermoforming.

From this SWOT discussion, we decided to form a dedicated, internal group focused exclusively on sustainability. It was critical that this group continue the PI tradition of having a strong technical background. We envisioned an organization that was both deeply knowledgeable in the technical details related to sustainability, but also equipped with a practical approach to implement appropriate solutions. It is embarrassing to admit, but I seriously wondered if this was going to be a full-time job. ("Do we really need an entire person dedicated to this?") I was severely wrong. Three years later, it is a job for four full-time team members and growing.

After establishing the charter for our sustainability group, we began the search for its leader. We were very fortunate to already have Zach Muscato on staff, a mechanical engineer with 17 years of experience in the industry helping support customer-driven technical projects. Zach jumped at the chance to move from his technical sales engineering role and lead the fledgling sustainability group. He has proven to be an effective, forward-looking leader with a powerful vision for the role this group can serve for PI and the industry.
I'm pleased with how much we've accomplished and grown in the last three years. This report is full of evidence of the progress we have made in that short time.

Here are just some of the accomplishments of this group in 2023:

- **Achieved ISO 14001 certification**
  - -Established certain environmental goals
  - -Created processes, including a sustainability assessment for every new part design

- **Achieved ISCC+ certification**
  - -Prepared PI for the use of PCR feedstocks from enhanced recycled feedstocks

- **Received EcoVadis Bronze Medal Certification**

- **Established Carbon Accounting frameworks**
  - -Developed a product carbon footprint calculator
  - -Refined and enhanced our Life Cycle Assessment capabilities

- **Continued Sustainability Voice of the Customer discussions**

- **Oversaw PCR PET customer qualifications**

- **Conducted internal and external Materiality Assessments**

But the work is not complete; in many respects, it is just beginning.
Here are some highlights of our future sustainability- and ESG-related initiatives:

- **Increasing energy efficiency**

- **Evaluating business case for expanded use of renewable energy**

- **Reducing waste sent to landfill**

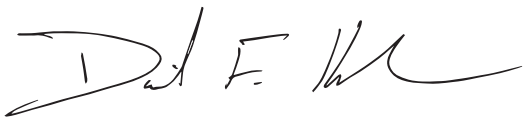
- **Conducting sustainability assessments for key PI customers**

- **Increasing the use of post-consumer recycled materials, including new PCR PP, PCR PET, and PCR from PET thermoform options**

- **Advising customers and key stakeholders to prepare for the impact of pending legislation, including California's SB 54**

This is just a sample of what we plan to pursue over the next 12 months. I hope you enjoy our 2024 Thermoform Circularity Report and find it useful. I'm proud of what this team has accomplished so far, and I already look forward to sharing our 2024 accomplishments with you in the 2025 edition.

Sincerely,



About Plastic Ingenuity

Plastic Ingenuity is the largest custom thermoformer in North America. From concept to final product, we do everything in house. That means you have the assets you need to support your solution end-to-end without the hassle and downtime that comes with outsourcing these capabilities. Our team of experts will work with you to understand your goals, prototype your vision, and create a best-in-class package that's market-ready in no time.

Vertically Integrated Services

- We build our own tools
- We extrude our own materials
- We build our own machines
- We provide rapid prototyping
- We offer automation consulting
- We provide a suite of circularity services

7 Strategic Locations

- HQ: Cross Plains, Wisconsin
- Mazomanie, Wisconsin
- Tooele, Utah
- Maumelle, Arkansas
- Oxford, North Carolina
- Monterrey, Mexico
- Guadalupe, Mexico

Cross-Industry Experience, Individualized Expertise

Food | **Healthcare** | **Consumer Goods**

PLASTIC INGENUITY

5 Core Values

1. Friendly & Genuine
2. Resourceful
3. Collaborative
4. Total Customer Focus
5. Dependable Doer

Where It All Began

From our start with just 5 employees in 1972, PI has grown into the largest custom thermoformer in the nation. In 2022, we celebrated our 50-year anniversary achieved through the resiliency, innovation and team expertise only earned by a lifetime of practice. In staying true to our mission statement, conservation has been a part of our work since day one. It wasn't always easy, but it was always better… together.

900+
Employees

13.4%
5Y Corporate CAGR

28 Years
average tenure of PI design engineers

18 Years
average tenure of PI quality assurance team

42% of Profits
bonused back to employees

84 NPS
Net Promoter Score, which is in the top 10% in the industry

Andy D.
Design Engineer
Madison, WI

I spend a lot of free time on various outdoor hobbies, and I was concerned that working for a plastics company would equate with negatively impacting the environment. On the contrary, there are controls put in place that encourage me to reduce and consider my environmental impact. As just one example, my role at PI allows me to reduce the amount of virgin material we process, while still designing parts that meet the demands of complex healthcare applications.

A Resounding Success

Reduced package weight by 9.2 grams

Reduced package cost by 40%

Incorporated 100% PCR PET

Case Study

Creating a Functional Screen Protection Installation Package for Otter Products

The Challenge

Otter Products asked Plastic Ingenuity to create an innovative, glass screen protection installation tool. Their goal was to enhance the unpacking experience for customers and simplify installation of screen protectors on smartphones. Otter Products and Plastic Ingenuity achieved remarkable advancements through their dedication and innovation.

Otter Products and Plastic Ingenuity applied creative thinking by introducing a thermoformed PCR installation tool. This new tool brought about a redesign of the product packaging, which aimed to provide clear instructions and improve the overall experience of screen protection installation. The thermoformed tool proved to be a technical breakthrough, as it could be used to install Otter Products on virtually all smartphone devices with unparalleled accuracy compared to previous instruments.

The Process

Plastic Ingenuity's significant shift to 100% PCR PET was supported by our sustainability experts. The installation tool, primarily for smartphone screens, used a locking mechanism and cardboard sleeve for optimal protection. Users achieved 100% accurate application after comprehensive testing. Otter Products reduced costs by 40% by shifting from injection-molded to thermoformed tools, streamlining inventory with a universal design for multiple phone sizes.

The redesigned tool had a rubber band and secure assembly, enhancing user experience, distribution, and transportation efficiency. Structural and graphic improvements provided an organized, seamless unpacking experience, elevating consumer acceptance and making installation a positive part of the product experience.

The Solution

Environmental considerations were at the forefront of the re-design efforts. The previous injection-molded installation tool used non-recyclable virgin materials, posing a significant environmental challenge. Plastic Ingenuity achieved a more sustainable solution by switching to a thermoformed package made from 100% PCR PET material. The new material was recyclable in certain municipalities and regions, promoting responsible waste management practices. Furthermore, reducing package weight from 29.2 grams to 20.1 grams improved transportation efficiencies and contributed to lower carbon emissions during distribution.

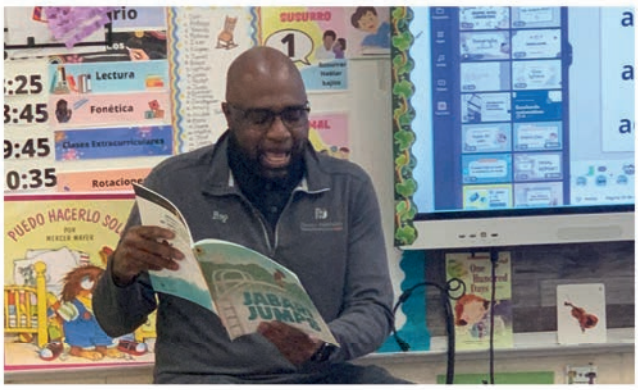
The Impact

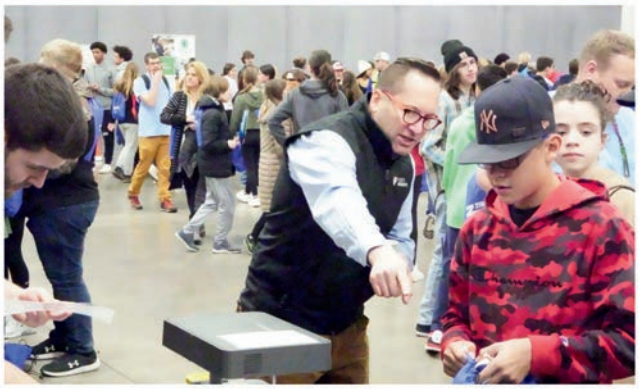
9.2
Reduced package weight by 9.2 grams

100%
Incorporated 100% PCR PET

40%
Reduced package cost by 40%

COMMUNITY IMPACT





We are dedicated to giving back to the communities we serve through community events, mentorship moments, and peer-driven experiences. We believe what matters to them, matters to us.


8:53 AM


SCHOOL BUS


PLASTIC INGENUITY

From the Archives

A focus on sustainability, engrained in the PI culture from the beginning.

Our commitment to environmental sustainability traces back to 1972 when our founder, Joe Kuehn, established Plastic Ingenuity. The philosophy of "we will be ever mindful of our natural environment" is engrained in our mission, driving our unwavering dedication to sustainable practices and solutions. The images below trace our commitment to environmental stewardship throughout our history.

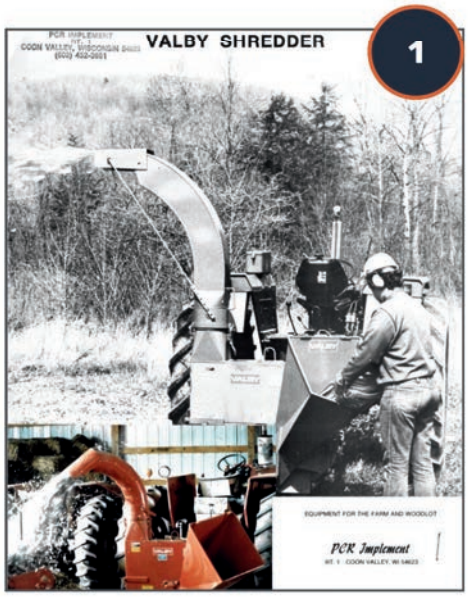
Image 1
Incorporating recycled industrial flake into our materials was so important that some of our first grinders were farm equipment better suited for agriculture than thermoforming.

Image 2
In 1999, we hired an outside contractor to investigate options to alleviate the effects of our facility on the Black Earth Creek that flows along the perimeter of the plant. Multiple enhancements were made to our facility and property, all of which remain intact to this day.

Image 3
Founder Joe Kuehn recaps our mission statement "to be ever mindful of our natural environment."

Image 4
Plastic Ingenuity installed solar panels that generate over 13,000 kWh of energy per year, removing nearly 19,000 lbs. of greenhouse gases annually.

Image 5
To mitigate water usage, we implemented a closed-loop cooling tower, eliminating the need for city water by capturing and recycling all water used to cool molds in-house.



1


LAMSHEET
8 Plastic Ingenuity, Inc. Aug. 2001
Enviro-news
Sheila Drake - WI Intern
The environment seems to be one of the hottest topics in which everyone is talking about. Whether it is someone complaining about how bad the smog is in certain cities, or how further recycling measures need to be taken in order to preserve what we have and to prevent further damage, it is a topic that is prevalent in today's society.
I can hear you now...environment-schmenvironment... who really cares? I also realize that many people are sick of hearing about it and refuse to listen anymore, and that is a major reason why the earth is in this predicament in the first place.
When environmental issues first came to the forefront, a reactive approach was taken. Meaning, problems that were already apparent were remedied or at least addressed. These days, a more PRO-active approach is needed. This means that we need to prevent these harmful things from occurring in our environment before they happen. After all, not every-
2


3


4


5

Innovations in Circularity

WorldStar & AmeriStar Winner

Award-Winning Innovation

At Plastic Ingenuity, devising groundbreaking circularity innovations and services for our customers is embedded in our core values. Over the years, this commitment has yielded significant results. This year, Plastic Ingenuity and Otter Products partnered to create an innovative, redesigned screen protection installation tool that won both an AmeriStar and WorldStar Award.

Environmental Considerations at the Forefront of Redesign Efforts

The previous injection-molded installation tool used non-recyclable virgin materials, posing a significant environmental challenge. Plastic Ingenuity achieved a more sustainable solution by switching to a thermoformed package made from 100% PCR PET material. The new material was recyclable in certain municipalities and regions, promoting responsible waste management practices. Furthermore, reducing package weight from 29.2 grams to 20.1 grams improved transportation efficiencies and contributed to lower carbon emissions during distribution.

Reduced package weight by 9.2 grams

Incorporated 100% PCR

Reduced package cost by 40%

WORLDSTAR GLOBAL PACKAGING AWARDS

2023 AmeriStar Winner

Visit **www.PlasticIngenuity.com** to learn more.

Alignment with the U.N. Sustainable Development Goals.

The United Nations Sustainable Development Goals (SDGs) provide a framework for organizations and governments to follow to ensure the development of new goods and services is as sustainable as possible. This is a holistic, people-centered approach with categories ranging from "no poverty" to "peace and justice." Plastic Ingenuity is committed to aligning with the SDG framework. The following information details our alignment and progress to date.

1 NO POVERTY

End poverty in all its forms everywhere

We are committed to providing fair compensation for all of our team members and partners. In addition to competitive wages, team members share 42% of Plastic Ingenuity's profits through our discretionary profit-sharing program.

2 ZERO HUNGER

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

The custom thermoformed packaging we create plays a critical role in preserving and protecting food products. Effective packaging is essential to combat the issue of food waste, ensuring food reaches people safely and efficiently.

3 GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

We are committed to providing a safe and secure work environment for our team members and visitors. Our goal is to have zero reportable injuries in the workplace. Additionally, we provide weekly on-site physical therapy and yearly hearing test opportunities. We will continue to focus our engineering and capital resources to eliminate accidents and ensure well-being. We are committed to supporting the emotional and mental well-being of our team members with an Employee Assistance Program amongst other support mechanisms. In addition to internal measures, the products we make for the healthcare industry protect the medical devices and medicines trusted to save lives.

4 QUALITY EDUCATION

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

All team members are eligible to participate in our Educational Assistance Plan. The purpose of the Educational Assistance Plan is to help any team member who so desires to enhance his or her capabilities to the greatest extent possible within their career at Plastic Ingenuity.

5 GENDER EQUALITY

Achieve gender equality and empower all women and girls

We remain committed toward equal opportunities for all genders. We will treat all people equally and nurture talent, regardless of gender. We support women's professional, academic, and general growth. We advocate for equality through community engagement.

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

We will be responsible stewards of the water we consume and discharge as part of our operations. We monitor our water consumption and strive for ways to reduce usage. As an example, we installed a closed-loop cooling system for our thermoforming machines to reduce water consumption by over 250,000 gallons per month.

7 AFFORDABLE AND CLEAN ENERGY

Ensure access to affordable, reliable, sustainable and modern energy for all

We are committed to increasing the energy efficiency of our operations. Our energy intensity has decreased by 22% over the last 6-year period from 2015 to 2021. In addition to efficiency, we will continue to generate renewable energy for our operations from on-site solar panels.

8 DECENT WORK AND ECONOMIC GROWTH

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

We provide team members with an environment to grow and feel pride in their work. We prioritize safe working conditions for all of our team members and partners. Our unique profit-sharing program creates a sense of ownership and fosters unparalleled teamwork. Unmatched employee tenure is a driver of our sustained growth. For example, the average tenure of PI design engineers is 28 years. We also provide a yearly cost of living adjustment to all team members, ensuring wages are modified to match the rising costs of living. Plastic Ingenuity participates in paid apprenticeship programs, featuring both youth apprentices and journeyworker apprentices.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

We leverage our design and innovation expertise to create sustainable thermoformed packaging solutions. These innovations result in optimized material usage, reduced waste, and increased circularity. We invest in infrastructure improvements through our partnerships and associations, to recover more plastic waste so it can recirculate in our economy as recycled material.

10 REDUCED INEQUALITIES

Reduce inequality within and among countries

We are committed to a diverse and inclusive workplace, as we know that each of our team members helps to make us better. We welcome people from all backgrounds and walks of life. We are diligent in our effort to eliminate discrimination and harassment, ensuring the entire team completes necessary yearly training.

11 SUSTAINABLE CITIES AND COMMUNITIES

Make cities and human settlements inclusive, safe, resilient and sustainable

We are aligned with the shift to a circular economy, which will improve the sustainability of our communities. We abide by the Association of Plastic Recyclers Design Guide to create custom thermoformed packaging that is compatible with residential recycling systems. We collaborate with associations, like The Recycling Partnership, focused on increasing equitable access to recycling in our communities. We provide educational resources for customers through newsletters, video series, eBooks, and a yearly Thermoform Circularity Report, promoting the transition to a circular economy.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Ensure sustainable consumption and production patterns

We support the sustainable management of natural resources with pride. We seek to use more recycled content in our thermoformers to lessen our dependence on fossil fuel-derived materials. We design our packaging to be recycled so its valuable material can be recovered for reuse at the end-of-life. We leverage our design expertise to use the minimal amount of plastic while offering utmost product protection. We deploy lean manufacturing principles and continuous improvements to efficiently use the resources required in operations.

13 CLIMATE ACTION

Take urgent action to combat climate change and its impacts

The phrase "we will be ever mindful of our natural environment" is embedded in Plastic Ingenuity's mission statement. We quantify our Scope 1 and Scope 2 emissions, along with a detailed Scope 3 screening. This enables identification of opportunities to reduce our greenhouse gas intensity. We are evaluating ways to further bolster the use of renewable energy in our operations.

14 LIFE BELOW WATER

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Our Corporate HQ in Cross Plains, WI borders the Black Earth Creek, a world-class trout stream. To protect this ecosystem, we developed five rain gardens that reduce storm water run-off. We are pledged supporters of Operation Clean Sweep, a stringent program designed to eliminate resin loss to the environment.

15 LIFE ON LAND

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

We are committed to natural environment preservation. We have reduced our landfill contributions by over 80% with our robust recycling program. We recycle aerosol cans, batteries, corrugate, skids, used oils, and scrap steel amongst other operational waste items.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

We hold ourselves to the highest legal and ethical standards. We serve our internal and external stakeholders with honesty and integrity. We are dedicated to eradicating all forms of corruption within our company.

17 PARTNERSHIPS FOR THE GOALS

Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

We support a variety of collaborations and initiatives whose objectives are in line with the Sustainable Development Goals. In order to lessen our impact on the environment, enhance the circular economy, and encourage climate action, we collaborate with trade groups, NGOs, and other key stakeholders. Organizations and associations include PLASTICS (Plastics Industry Association), The Recycling Partnership, PP Recycling Coalition, Association of Plastics Recyclers, Sustainable Packaging Coalition, NAPCOR (National Association for PET Container Resources), Foodservice Packaging Institute, Healthcare Plastics Recycling Council, and the Associated Recyclers of Wisconsin.

PLASTIC INGENUITY INITIATIVES

Materiality Assessment

Introduction

Plastic Ingenuity conducted its first materiality assessment in 2023. A materiality assessment is a tool to help organizations identify and prioritize aspects that are relevant to their stakeholders and business performance. The tool leads to a better understanding of important aspects to stakeholders as well as important issues that may be overlooked by leadership, identifying emerging trends that can affect the business, and detecting potential risks.

Aspects

The relevant aspects were identified by reviewing the results of previous stakeholder studies, examining materiality assessments of industry peers, analyzing company reports, and screening internal stakeholders. Aspects influencing PI's economic performance, environmental impact, and social contribution were included. The following table (on opposite page) is a list of 22 aspects identified for stakeholder feedback with their designated area of impact.

Process

A diverse group of stakeholders was identified to ensure opinions included a broad perspective. This group included PI team members, customers, suppliers, community members, and leadership. Stakeholders were asked to prioritize each of the aspects listed above relative to the importance of that aspect to the stakeholder's relationship with PI.

The results were graphed in two ways to create materiality matrixes for further analysis:

A **Impact on Business vs. Stakeholder Importance**

The average score for each aspect rated by leadership for impact on business was graphed relative to how all stakeholders rated that aspect.

B **Internal Stakeholder Importance vs. External Stakeholder Importance**

The average score for each aspect rated by internal stakeholders was graphed relative to how external stakeholders rated that aspect.

The materiality matrixes are shown on the following pages. Points further to the right or further to the top of the chart represent higher-rated aspects. The diagonal line denotes an equal rating of an aspect by the stakeholder groups compared in the chart. Distance away from the diagonal line represents a disparity in the rating of an aspect by the stakeholder groups compared in the chart.

Conclusion

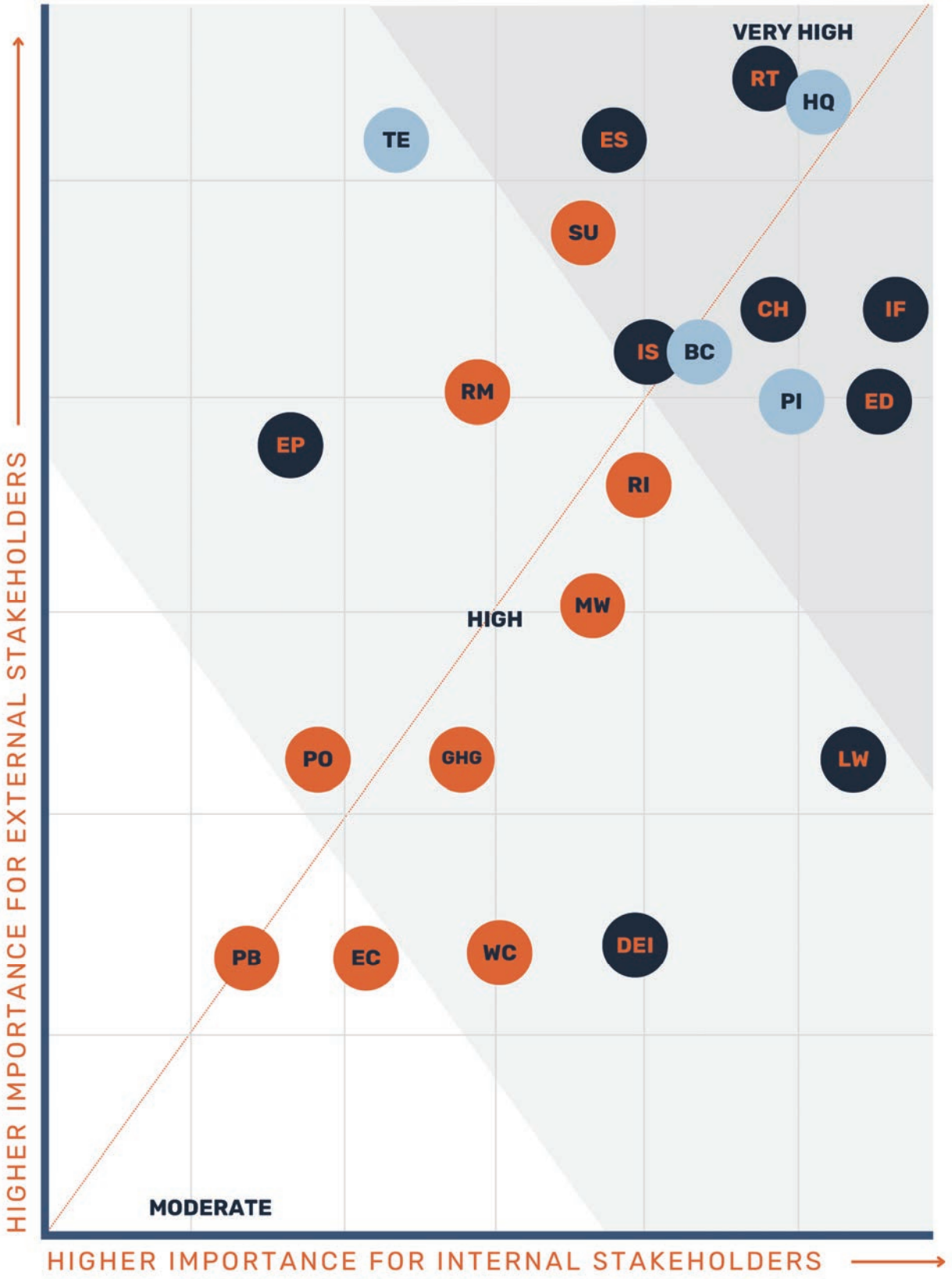
The results of the materiality assessment were reviewed with PI's organizational leadership. Initiatives stemming from the results of this assessment will be included in our strategic planning process for further action. These initiatives include furthering our uptake of sustainable materials, minimizing waste from operations, and contributing to collaboratives that advance the circular economy.

ASPECTS


ECONOMIC
HQ
Manufacturing high-quality products that are safe for their intended use
PI
Ensuring the sustainable, profitable growth of PI
BC
Ensuring business continuity in the event of a crisis
TE
Ensuring external communication is clear, accurate, and timely
ENVIRONMENTAL
SU
Designing packaging to be more sustainable
RM
Using raw materials that minimize environmental impact
RI
Reducing waste to landfill by investing in plastic recycling infrastructure
MW
Minimizing waste generated from PI's operations
GHG
Reducing greenhouse gas emissions from operations
EC
Reducing energy consumption from non-renewable sources
PO
Reducing the environmental impact of PI's procurement operations
WC
Practicing responsible water conservation and wastewater management
PB
Protecting the biodiversity of all environments PI operates in
SOCIAL
ED
Eliminating discrimination and harassment
RT
Recruiting and developing high-quality team members
CH
Keeping PI's operations and supply chain free of child or forced labor
IF
Creating an injury-free workplace for all employees and visitors
LW
Providing a living wage to employees
ES
Complying to stringent ethical standards, such as anti-bribery and corruption
DEI
Creating a diverse, equitable, and inclusive workplace
IS
Building resilient information systems to defend against cyberattacks
EP
Promoting public policy that helps create a more circular economy

A

MATERIALITY MATRIX B: INTERNAL STAKEHOLDER IMPORTANCE VS. EXTERNAL STAKEHOLDER IMPORTANCE



A

EQUAL		INTERNAL		EXTERNAL	
HQ	Manufacturing high-quality and safe products	LW	Providing a living wage	TE	Transparent external communication
RT	Recruiting and developing talent	ED	Eliminating discrimination	EP	Promoting circular economy public policy
CH	Eliminating child or forced labor	IF	Injury free workplace		
SU	Designing sustainable packaging	DEI	Creating a diverse, equitable, and inclusive workplace		
ES	Complying to stringent ethical standards	PI	Ensuring sustainable growth of PI		
RM	Using sustainable raw materials				
RI	Investing in plastic recycling infrastructure				
MW	Minimizing waste generated in operations				
BC	Ensuring business continuity				
IS	Building resilient information systems				
GHG	Reducing greenhouse gas emissions from ops				
EC	Reducing energy consumption				
PO	Sustainable procurement operations				
WC	Responsible water conservation				
PB	Protecting biodiversity				

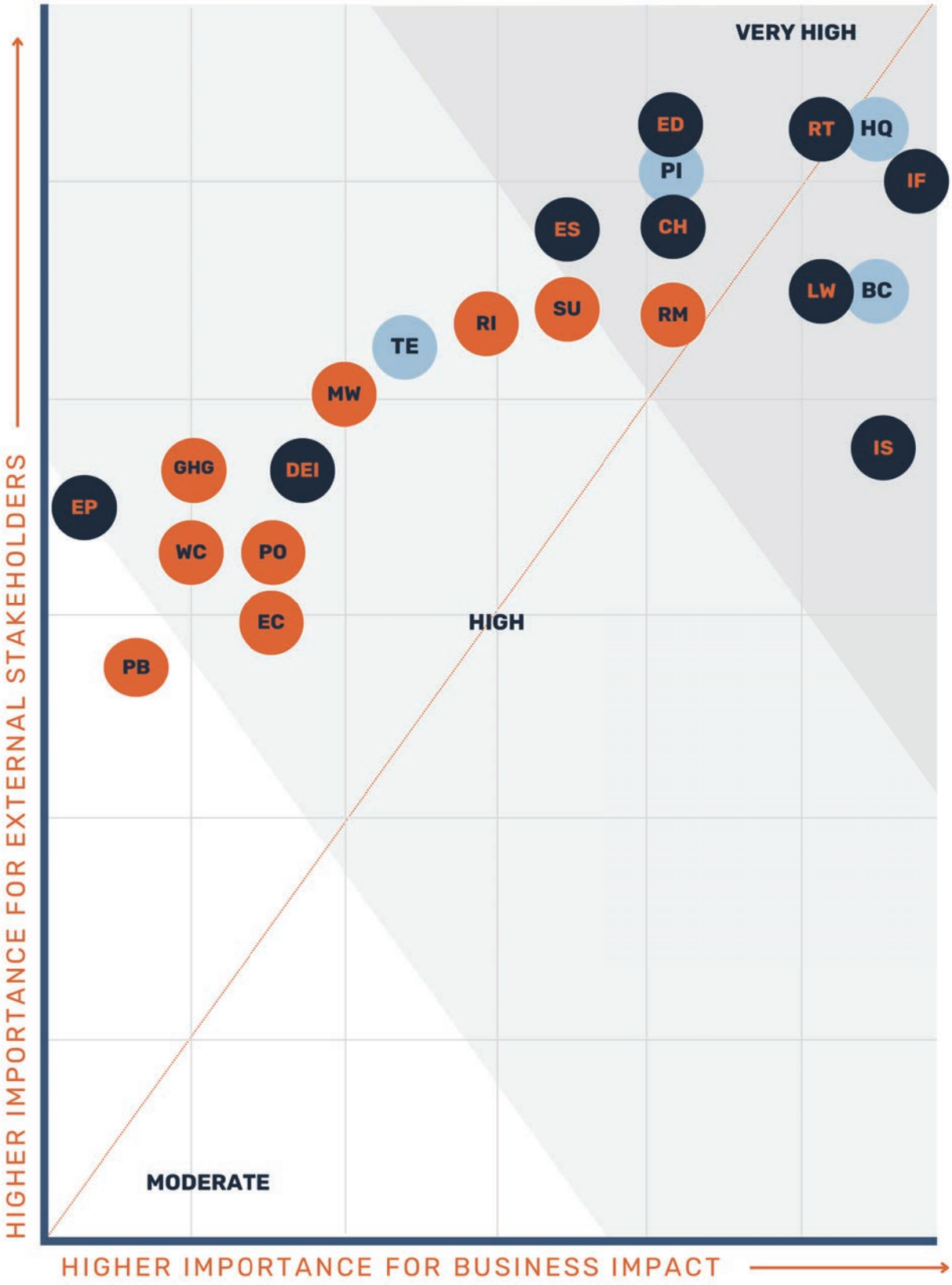
ENVIRONMENTAL

SOCIAL

ECONOMIC

B

MATERIALITY MATRIX A: IMPACT ON BUSINESS VS. STAKEHOLDER IMPORTANCE



B


IMPACT ON BUSINESS
EQUAL
STAKEHOLDER IMPORTANCE
IS
Building resilient information systems
ED
Eliminating discrimination
HQ
Manufacturing high-quality & safe products
RT
Recruiting and developing talent
CH
Eliminate child or forced labor
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Protecting biodiversity
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Minimizing waste generated in operations
DEI
Creating a diverse, equitable, and inclusive workplace
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Transparent external communication
EC
Reducing energy consumption
ENVIRONMENTAL
SOCIAL
ECONOMIC

Sustainability in Focus: Plastic Ingenuity's Journey to ISO 14001 Certification

ISO 14001 Certification

Plastic Ingenuity was awarded ISO 14001 certification for our Cross Plains, WI and Mazomanie, WI facilities in September 2023. This certification enables us to embed sustainability into our operational frameworks in addition to the products and solutions we provide to our stakeholders. ISO 14001 builds upon PI's existing ISO certifications, including ISO 9001—Quality Management Systems and ISO 13485—Medical Devices.

What is ISO 14001?

The ISO 14001 standard is an internationally recognized framework that assists organizations in navigating environmental management challenges. Established by the International Organization for Standardization (ISO), this standard provides a pragmatic approach for organizations to enhance their environmental performance through systematizing policies, processes, and practices. It ensures environmental management is not static but a dynamic, evolving process. Organizations are empowered to identify, monitor, manage, and control their environmental aspects and impacts through a structured Environmental Management System (EMS). Additionally, it enables compliance with applicable legal requirements and provides a mechanism to demonstrate such compliance to stakeholders.

Sustainability in Focus

Benefits of ISO 14001 Certification

PI decided to pursue ISO 14001 certification to realize the following benefits for our customers, suppliers, employees, and community members:

Enhanced Environmental Performance:
The systematic approach to environmental management enables PI to identify significant environmental aspects of our operations and implement controls to mitigate those impacts, thereby elevating our overall environmental performance.

Stakeholder Confidence:
Certification signals to stakeholders—including our customers, suppliers, team members, and community—that we are committed to managing our environmental responsibilities diligently, which fosters enhanced trust and credibility.

Operational Efficiencies:
Continuous improvement is a core value of ours and a principle of ISO 14001. The standard will help PI identify opportunities to enhance efficiency, leading to reduced waste generation and optimal utilization of resources.

Risk Management:
The standard will help us fortify operational resiliency and safeguard against potential regulatory changes by proactively identifying and mitigating environmental risks.

Team Member Engagement:
"Being ever mindful of our natural environment" is in our mission statement. ISO 14001 will enable our team members to realize our founder's vision for the company.

Supply Chain Sustainability:
The ISO 14001 standard permeates the supply chain, enabling PI to ensure our suppliers adhere to environmentally responsible practices, thereby mitigating supply chain risks.

Implementation

We formed a cross-functional team to modernize our legacy environmental system for alignment with the ISO 14001 standard and updated our quality policy to reflect our environmental commitments.

Key commitments include:

- Designing products for our customers that minimize environmental impact through the full lifecycle.
- Reducing operational waste through reuse and recycling.
- Using resources, energy, and water efficiently within our operations.
- Monitoring our environmental performance regularly.

Two environmental goals were formalized as a result of implementing the framework in our organization: Reduction of our greenhouse gas intensity and incorporation of more post-consumer recycled materials into our products. Multiple projects to address these goals have already been identified and resourced. Additional environmental programs have also been established to reduce operational waste sent to landfills and minimize water consumption.

The standard also provided a roadmap for integrating lifecycle considerations into our design and development process. As a result of this integration, a sustainability assessment is executed on every new design created by our design engineers, which covers all stages of the lifecycle, including design for recycling, incorporation of circular materials, and minimized material usage. We are confident these process improvements will benefit our customers and other stakeholders.

To download the certifications, please visit our website.
https://www.plasticingenuity.com/certifications/

Carbon Accounting

The "WHY"

Our 2022 Stakeholder Study identified minimizing greenhouse gas emissions as the top sustainability goal among organizations. In 2022, 64% of organizations interviewed had a goal to reduce their greenhouse gas emissions, with 43% of participating companies denoting it as a top pick. Not only was minimizing greenhouse gas emissions a top goal, but it was also the invisible string that tied many sustainability initiatives together. For example, maximizing post-consumer recycled (PCR) content, minimizing material usage, and optimizing designs all assist the broader goal of minimizing greenhouse gas emissions.

Organizations leading the charge on climate action are commonly aligned with the Science Based Targets initiative (SBTi). This is a collaborative effort aimed at assisting companies in establishing greenhouse gas emission reduction targets that are scientifically grounded and are aligned with the objectives of the Paris Agreement. As we see many organizations aligning with initiatives such as SBTi to enhance climate resilience, we saw an opportunity to align with our key stakeholders by developing a strategic plan to address our emissions.

We acknowledge the call to action from our stakeholders and understand the urgency of addressing climate change. We turned this acknowledgment into action in 2023. The first step in this journey was to establish a baseline. Therefore, we embarked on a journey to quantify our carbon emissions for the 2022 calendar year.

Carbon Accounting

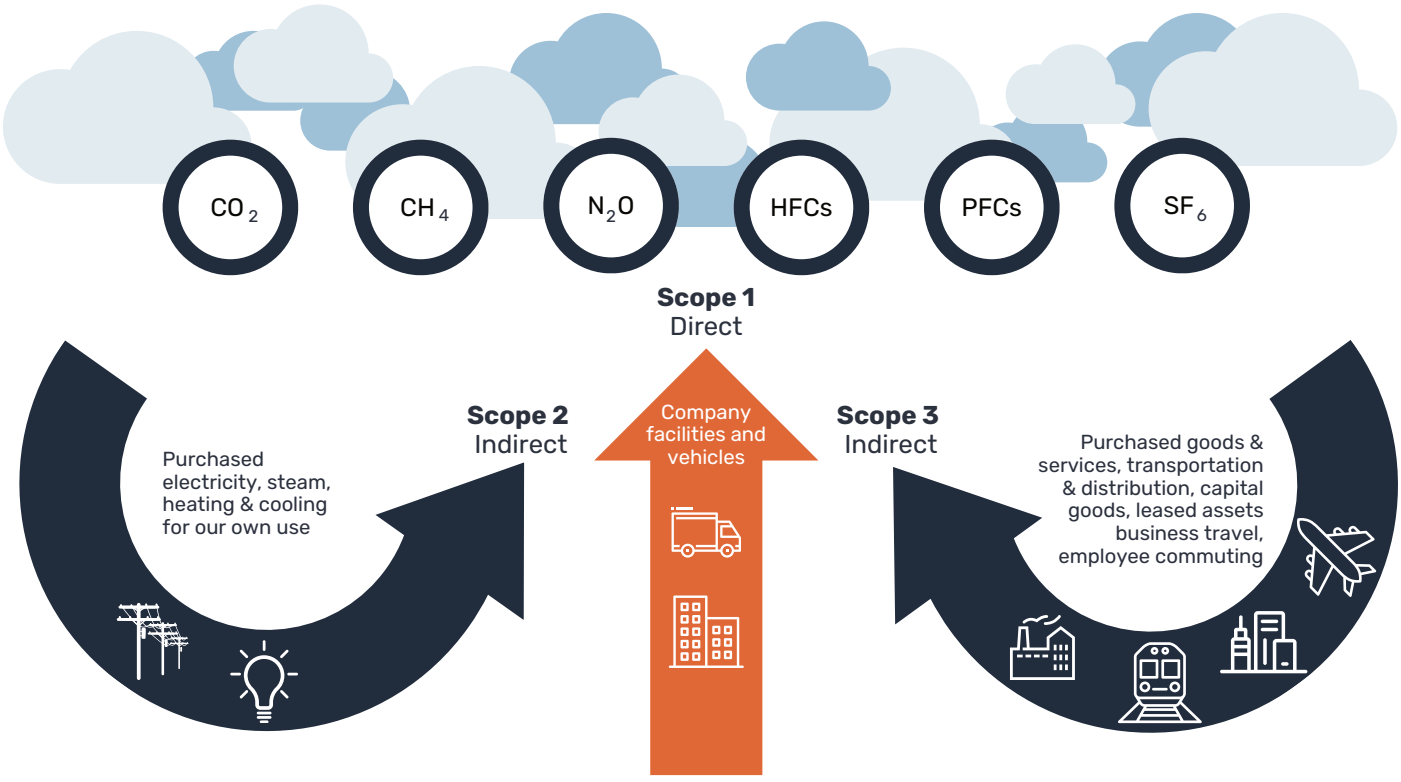
The “HOW”

Greenhouse gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases. These gases contribute to the greenhouse effect, a process where heat is trapped near the Earth’s atmosphere, thus causing an increase in Earth’s temperature. This effect is essential for maintaining the habitable temperature of our planet. However, an excess of certain greenhouse gases from activities such as burning fossil fuels and deforestation has led to disrupted weather patterns, higher global temperature averages, changes in rainfall, and rising sea levels. These effects of climate change will likely present challenges to our society and environment in the future.

According to the U.S. Environmental Protection Agency (EPA), carbon dioxide is recognized as the predominant anthropogenic greenhouse gas as it presently contributes to the majority of warming associated with human activities. Therefore, carbon emissions are prioritized when accounting for and reducing greenhouse gas emissions within organizations.

Like financial accounting that tracks income and expenses, carbon accounting operates similarly, where a carbon inventory represents an organization’s emissions. Carbon accounting categorizes CO2 emissions into three groups: Scope 1, Scope 2, and Scope 3. In concordance with the Greenhouse Gas Protocol, the EPA defines Scope 1 emissions as direct emissions that result from sources owned or controlled by the organization, such as fuel combustion from generators, furnaces, or vehicles. Scope 2 emissions are indirect emissions from purchased electricity, heating, or cooling. Scope 3 emissions, commonly defined as value chain emissions, encompass a broader range of indirect emissions, such as purchased goods and services, upstream and downstream transportation and distribution, employee commuting, business travel, and end-of-life treatment of sold products.

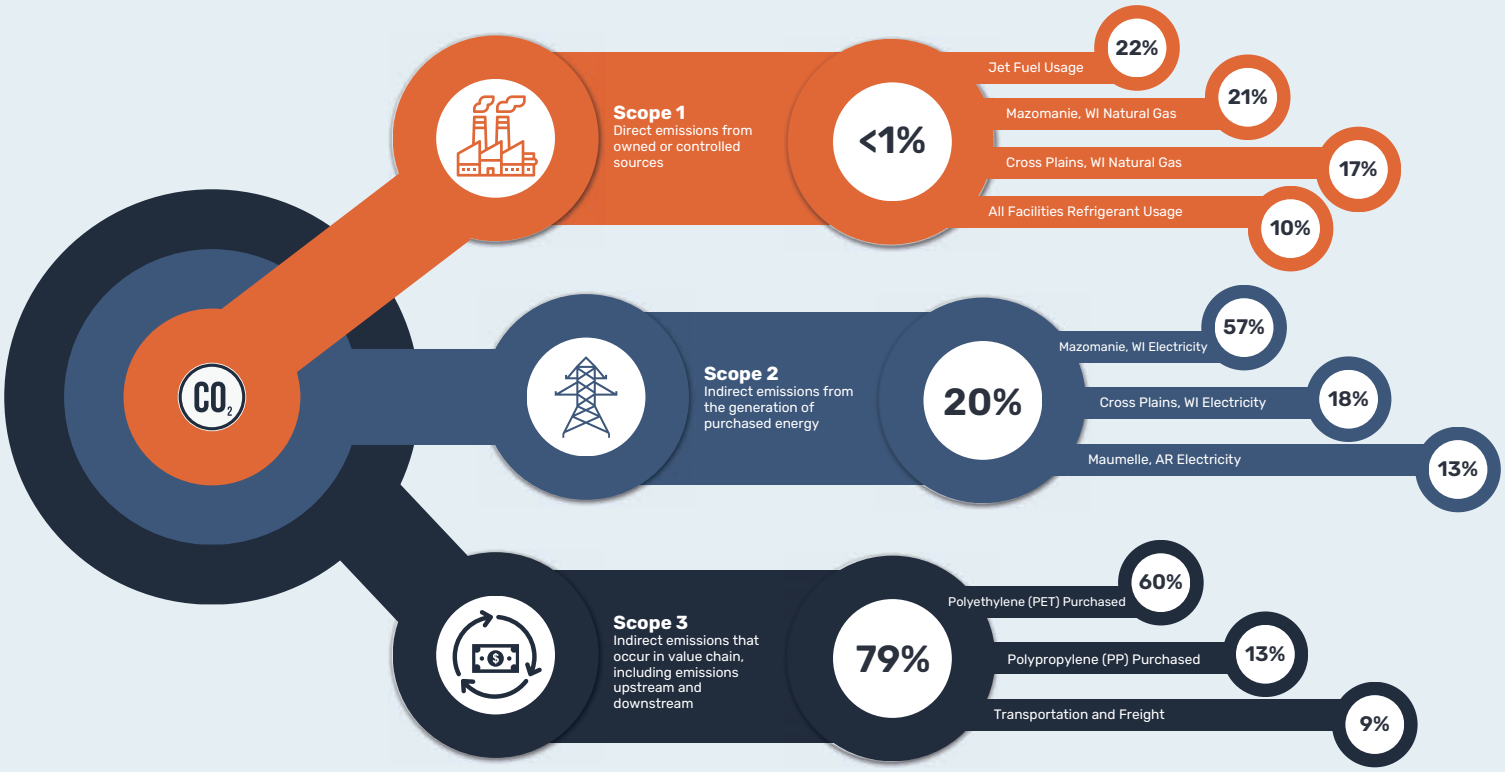
The carbon accounting process systematically tracks, calculates, and reports our emissions within a given year. Starting with data collection, we gathered data related to our emissions, including energy consumption, manufacturing processes, and supply chain activities from all sites within the 2022 calendar year. Once data was collected, the emissions were calculated using emission factors, which relate to the quantity of pollutants associated with an activity. The outputs of these calculations were carbon dioxide equivalents (CO2e), the standard unit for measuring carbon emissions.



Carbon Accounting

The “RESULTS”

In 2022, Plastic Ingenuity’s Scope 3 emissions comprised nearly 80% of our total carbon emissions. This is mainly due to our raw material purchases, which accounted for 73% of Scope 3 emissions. Scope 2 emissions accounted for 20% of overall emissions from electrical usage of our facilities. Lastly, our Scope 1 emissions are attributed to less than 1% of overall emissions, mainly due to natural gas and refrigerant usage within our facilities.



Although our Scope 1 and 2 emissions account for just over 20% of our overall emissions, we realized plenty of improvements can be made within our operations. Because of the extensive data collection of our in-house emissions, we created strategic plans to strive for efficiency and energy reduction within our operations. Strategies to maximize our post-consumer recycled (PCR) inputs and analyze transportation and distribution patterns will be crucial as we address our Scope 3 impacts. As a result of our baseline carbon emission data, Plastic Ingenuity has developed goals to maximize the use of PCR content and decrease our carbon emission factor year over year.

Carbon Accounting

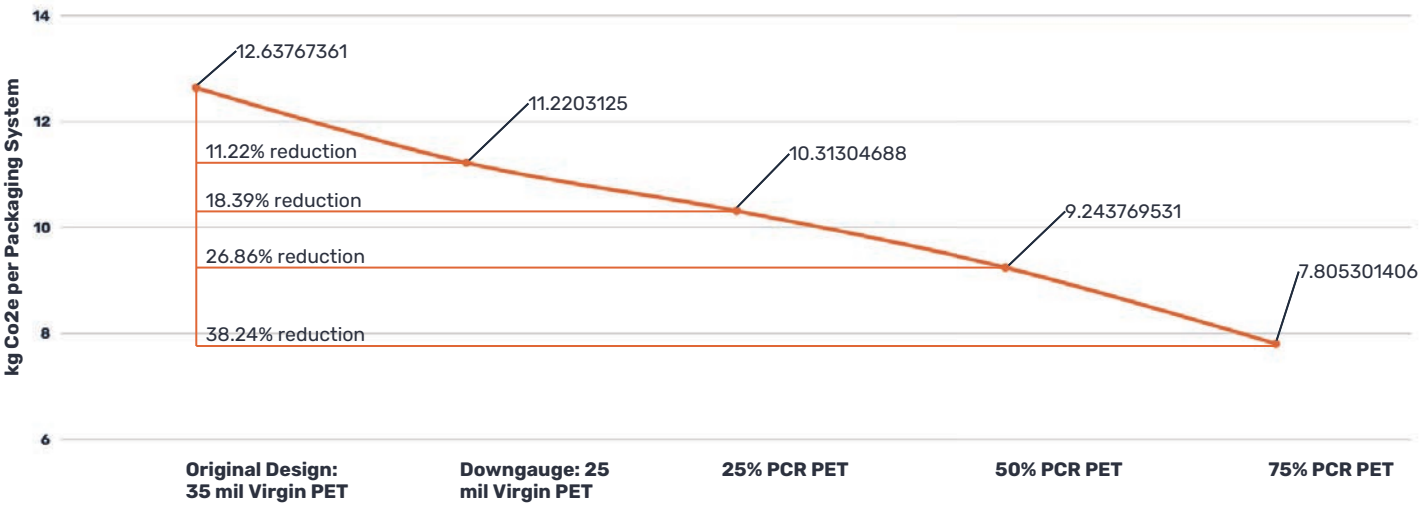
The “ACTION”

Although calculating and analyzing our carbon emissions is a large task, what we do with this data is more important. Upon receiving our carbon emission data, we drastically improved our lifecycle assessment capabilities, especially by implementing a Plastic Ingenuity custom product carbon footprint (PCF) calculator.

Our custom product carbon footprint calculator is a powerful tool for our team to communicate the embodied carbon of our products to our customers. Not only can we provide customers with the embodied carbon associated with the products we currently produce for them, but we can also forecast carbon reductions if a customer were to increase their recycled content, downgauge, change material, or optimize design attributes.

The figure below shows a joint action plan our team uses to reduce a product's carbon emissions for the products we create. By proposing downgauging opportunities and incorporating various levels of PCR PET, we can articulate the embodied carbon savings our customers can achieve.

PRODUCT CARBON FOOTPRINT REDUCTION PLAN



ISCC PLUS

Incorporating the use of circular plastics from advanced recycling technologies is an important service that Plastic Ingenuity focused on in 2023. We knew we needed to build the foundation to incorporate advanced recycled materials into our thermoformed packaging. In pursuit of this goal, we received our International Sustainability and Carbon Certification (ISCC) PLUS certification in the first quarter of 2023.

Background

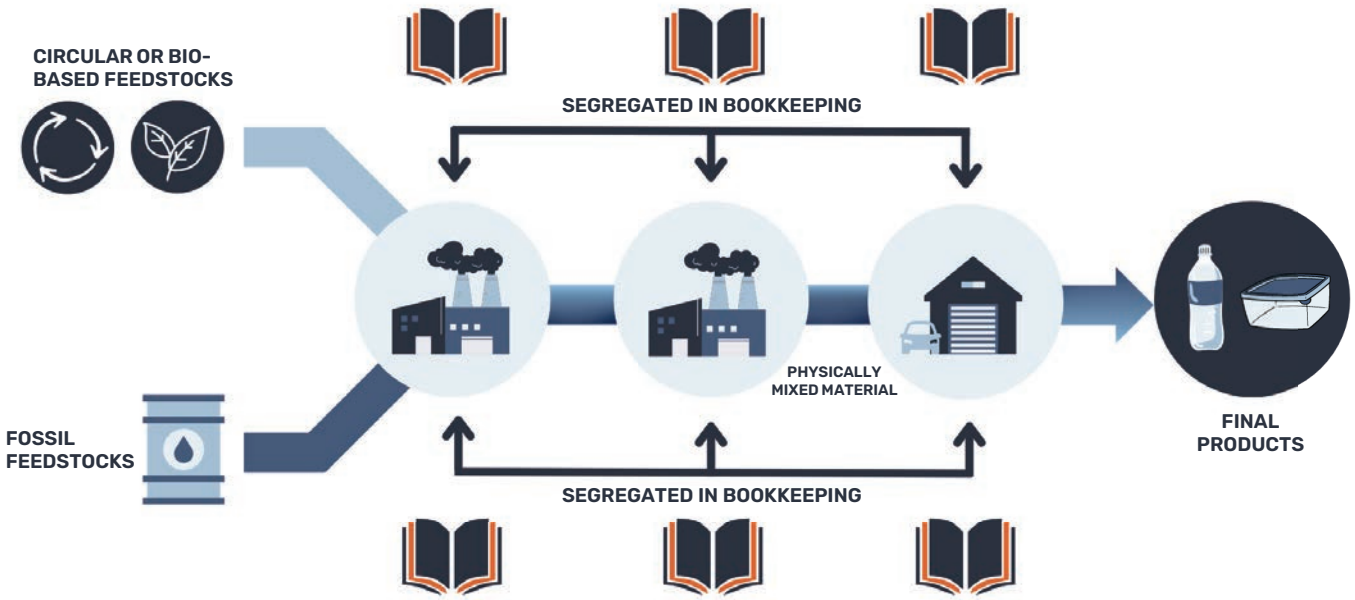
As the global demand for sustainable packaging increases, there has been a growing interest in utilizing advanced recycling technologies for plastics. Advanced recycling involves the breakdown of plastic waste into its basic monomer components, which can be used to create virgin-quality plastics. Ensuring this process is conducted sustainably and with a focus on mass balance is essential.

Since the recycled plastics created by advanced recycling technologies are indistinguishable from virgin plastics derived from fossil fuels, a mass balance chain of custody model is required to track recycled materials through the value chain. Therefore, a comprehensive chain of custody process is fundamental to scaling advanced recycling technologies.

What is ISCC PLUS?

The ISCC PLUS is an internationally recognized certification of compliance with robust environmental, social, and traceability requirements. ISCC PLUS establishes traceability in global supply chains for circular and bio-based materials. The ISCC PLUS system is based on the mass balance approach, which ensures the conservation of the certified content throughout the value chain. The mass balance approach is used to track raw materials from their origin through to the final product via segregated bookkeeping, ensuring that the amount of sustainable content used is accurately recorded by a full and unbroken chain of custody. It aims to seamlessly integrate advanced recycled technologies into existing production assets.

Under the mass balance approach, the entire supply chain is considered—from the raw materials, through the production processes, to the finished products. By establishing transparency and ensuring compliance, the chain of custody enhances the credibility of advanced recycling practices.



ISCC PLUS

How does the mass balance approach work?

Mass balance is a chain of custody model, which refers to the documented and chronological record of materials through a value chain. Mass balance involves accounting for the input and output of materials to ensure that the total mass of materials going into a system equals the total mass of products and by-products leaving the system.

Mass balance is a crucial component to ensuring accuracy when incorporating advanced recycled materials into a manufacturing process. Advanced recycled materials are typically blended with virgin material feedstocks during the manufacturing process. Since advanced recycled materials are nearly identical to virgin feedstock, physical segregation of recycled content is not possible.

The mass balance approach provides a credible and verifiable solution for tracing sustainably sourced materials throughout a complex value chain.

How does mass balance promote circularity?

Use of Existing Infrastructure

Incorporating a mass balance approach enables companies to integrate sustainable raw materials seamlessly into existing processes and assets. Without this approach, companies would need to duplicate infrastructure, increasing timelines, cost, and emissions. Mass balance is the key to rapidly scaling sustainable material integration and credibly driving circularity.

Decreased Carbon Footprint

Mass balance allows for advanced recycled materials to integrate into packaging systems that cannot incorporate mechanically recycled materials. When compared to fossil-fuel-derived virgin plastic, advanced recycling ranges from a 7-20% reduction in carbon emissions.[1] However, advanced recycling should complement, not compete, with mechanical recycling as traditional mechanical recycling has a lower carbon footprint than advanced recycling.

Compliance

Chain of custody practices play a pivotal role in helping healthcare organizations and recycling facilities meet compliance requirements and adhere to regulations. By maintaining meticulous records of the plastic waste collected, recycled, and utilized in the production of new products via advanced recycling, healthcare manufacturers can have proper documentation for verification and auditing purposes.

Incorporation of Recycled Content for Complicated Packaging Systems and Highly Regulated Industries

All industries can benefit from incorporating advanced recycled materials within their packaging. Many packaging systems require virgin quality feedstocks to ensure the safety of products, maintain barrier properties, and guarantee manufacturability. The healthcare packaging industry is uniquely suited for incorporating advanced recycled materials into their packaging. Healthcare packaging requires virgin materials for all sterile barrier system packaging to ensure safe and sterile medical devices, so using traditional mechanically recycled materials is not an option. Incorporating advanced recycled materials via mass balance allows for organizations to meet recycled content goals with virgin-quality plastics.

A comprehensive chain of custody process is fundamental to implementing circular plastics from advanced recycling technologies. By establishing transparency and ensuring compliance, the chain of custody enhances the credibility of advanced recycling practices. The ISCC PLUS certification allows for truthfulness in recycled content claims when utilizing advanced recycled materials. The use of a mass balance system will build trust with consumers, regulators, and the wider public, thus driving the transformation of the sustainable plastics landscape.

Sources:
1–Closed Loop Partners, Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada, 2021


BRONZE
2023
ecovadis
Sustainability
Rating
PLASTIC iNGENUITY

Bronze 2023

EcoVadis Sustainability Rating

Our commitment to sustainability

In 2023, Plastic Ingenuity chose to participate in the EcoVadis sustainability assessment and was awarded a Bronze medal in recognition of our sustainability and corporate responsibility efforts. EcoVadis is a globally recognized leader in sustainability assessments, providing a comprehensive and standardized platform for evaluating the environmental and social performance of companies across various industries. EcoVadis medals are reserved for companies that demonstrate a strong management system focused on policies, actions, and results. We are proud of this accomplishment, and we remain committed to further improvements.

Benchmarking sustainability in business

The EcoVadis sustainability assessment is a rigorous evaluation covering a range of criteria, including environmental, social, and ethical considerations. Companies that undergo this assessment receive a scorecard detailing their performance in these areas, which allows them to identify strengths, weaknesses, and areas for improvement. The assessment considers a broad spectrum of factors, from carbon emissions and energy consumption to labor practices, human rights, and ethical business conduct.

One of the key strengths of the EcoVadis assessment is its ability to provide a standardized and objective benchmark for companies. The assessment methodology is built on international sustainability standards, ensuring businesses are evaluated against a common set of criteria. This enables companies to compare their performance with industry peers, fostering healthy competition and encouraging continuous improvement in sustainability practices.

The assessment results provide a roadmap for companies to navigate the complex landscape of environmental and social responsibility, where sustainable business practices are the norm rather than the exception. With its standardized approach, comprehensive criteria, and adaptability, the EcoVadis sustainability assessment plays a pivotal role in promoting, measuring, and enhancing the sustainability performance of businesses worldwide, enabling them to make positive contributions to a more sustainable and responsible global economy.

PACKAGING SUSTAINABILITY STAKEHOLDER STUDY

OVERALL

Packaging Sustainability Stakeholder Study

The shift towards a circular packaging economy necessitates extensive cooperation across all tiers of the value chain. Upstream innovations in packaging design and downstream interventions in the recycling systems are vital for realizing circular solutions in plastic packaging. While it may pose challenges, making strides in this direction is attainable when stakeholders embrace change and collaborate with common goals.

In 2021, Plastic Ingenuity embarked on a mission to gain a deeper understanding of the requirements and motivations of stakeholders at the forefront of advancing circular packaging. The knowledge acquired from these discussions shaped our strategic initiatives, allowing us to tailor our sustainability services and capabilities to meet the specific needs of these stakeholders. Our adoption of ISCC PLUS, ISO 14001, and carbon emission accounting are tangible outcomes of how we integrated these insights into our business.

Throughout 2023, the comprehensive study of packaging sustainability stakeholders continued. We engaged in interactive dialogues by conducting live listening sessions involving sustainability and packaging experts from consumer-packaged goods (CPGs), retail sectors, and healthcare organizations. These participants encompassed various roles, including packaging engineers, sourcing and procurement specialists, operations managers, marketing professionals, and sustainability champions.

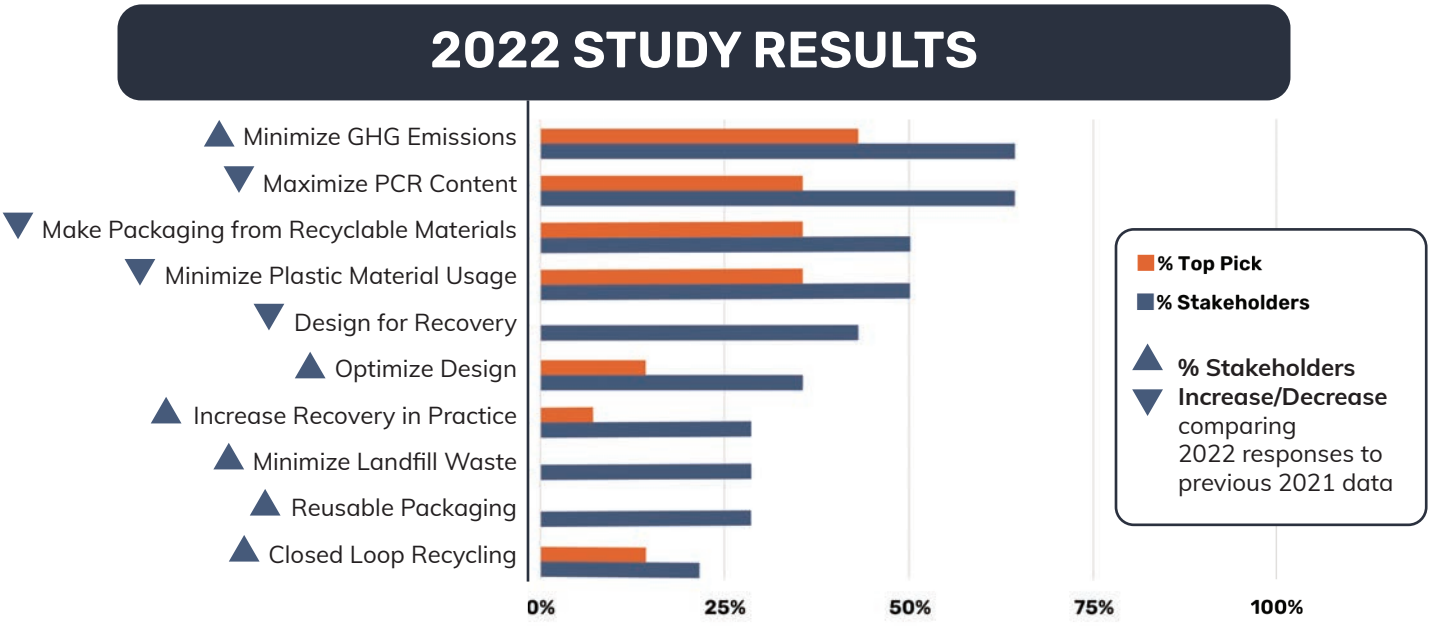
We asked stakeholders to define their objectives, describe the drivers of those objectives, and provide guidance on packaging strategies to achieve those objectives. The insights gathered from these discussions will continue to strengthen the foundation of our sustainability initiatives.

Packaging Sustainability Stakeholder Study

2022 Recap: Key Findings

Before we dive into the 2023 study results, the following section briefly summarizes key findings from the 2022 study. Stakeholders were asked to describe their organization's packaging sustainability goals. The answers were dissected into individual goal statements, and high-priority goals were identified as "Top Picks."
The following table and graph summarize the findings:

GOAL	% Stakeholders	% Top Pick
Minimize GHG Emissions	64	43
Maximize PCR Content	64	36
Make Packaging from Recyclable Materials	50	36
Minimize Plastic Material Usage	50	36
Design for Recovery	43	0
Optimize Design	36	14
Increase Recovery in Practice	29	7
Minimize Landfill Waste	29	0
Reusable Packaging	29	0
Closed Loop Recycling	21	14



The top sustainability goal identified by stakeholders in 2022 was to "Minimize GHG Emissions," as 64% of organizations interviewed had a goal to reduce their greenhouse gas emissions, including 43% that denoted it as a top pick. The results also reveal a continued commitment to circularity. Circularity goals related to utilizing recycled content, selecting packaging materials with robust recycling markets, minimizing packaging material usage, and designing for recycling remain prevalent. Organizations were focused on increasing the actual recovery of their packaging in practice, including closed-loop recycling programs.

Packaging Sustainability Stakeholder Study
2023 Study Results

What is Sustainability?

Each interview was initiated with a request for the stakeholder's definition of sustainability. Sustainability is a concept that can be quite nebulous, as its meanings can differ from person to person. Our definitions of sustainability often mirror our values and life experiences. When engaging in sustainability conversations with internal and external stakeholders, it becomes vital to align definitions. A stakeholder shared, "Having a common understanding of sustainability is critical. We must ask ourselves, 'What problem are we trying to solve?'"

The United Nations Sustainable Development Goals[1] (SDGs) were commonly cited by stakeholders when sharing their definition of sustainability. This holistic framework emphasizes that businesses and institutions should consider their impact not only in terms of profits (economic) but also in terms of their effects on people (social) and the planet (environmental):

Environmental:
Applies to preserving and protecting the natural environment for current and future generations. It involves practices that minimize ecosystem harm, conserve resources, and reduce pollution. Environmental sustainability aims to balance the planet's ecosystems and biodiversity.

Social:
Relates to the well-being and quality of life of individuals and communities. It emphasizes equity, social justice, and inclusivity, ensuring all members of society have access to basic needs, such as healthcare, education, and employment opportunities. Social sustainability also promotes strong community connections and cultural diversity.

Economic:
Refers to the capacity of an economic system to maintain or improve the well-being of current and future generations. It involves managing resources, businesses, and investments to ensure long-term economic growth, stability, and prosperity without depleting resources or causing economic crises.

These aspects demonstrate the multifaceted nature of sustainability—encompassing ecological, economic, social, and ethical considerations to ensure the long-term well-being of our planet and its inhabitants.

Drivers of Change

The drivers of change identified in 2023 mirror the results of our previous studies. These drivers include consumer preference for sustainable products, NGO influence on corporate initiatives, investment community focus on ESG performance, large retailer purchasing power, and legislation. A driver that became more pronounced in 2023 is the looming implementation of Extended Producer Responsibility (EPR) legislation. EPR policies make producers of products responsible for the entire life cycle of their goods, including disposal and recycling. EPR encourages producers to design and manage products in an environmentally responsible manner and to bear the costs associated with their end-of-life management.

Four states have passed EPR legislation[2]: Maine, Oregon, Colorado, and California. The California EPR legislation (SB 54) is the bill often identified by stakeholders as the most influential. The bill will require all plastic packaging in the state to reach a recycling rate of 30% by 2028 and 65% by 2032. The bill also sets a plastic packaging source-reduction target of 25% by 2032. If packaging categories fail to meet these targets, producers who continue to use them could be subject to fines or outright bans.

The state is expected to release a recyclable and compostable list in 2024 for all items covered by the bill. The list shows how packaging categories are viewed through the lens of the EPR bill and sets the stage for potential eco-modulation schemes. Eco-modulation refers to adjusting fees based on the environmental impact of products, thus incentivizing more sustainable choices by making positive environmental options more cost-effective.

PET thermoforms are a category that will be closely watched when the state-wide recyclable list is published. PET thermoforms are accepted in most curbside recycling programs in the state, but they need to meet all the criteria set by the state to be considered widely recycled. Well-defined end markets for thermoforms, such as recycled tray-to-tray applications using thermoform-only bales, and additional recovery in practice are needed to solidify PET thermoform packaging's status on the recyclables list.

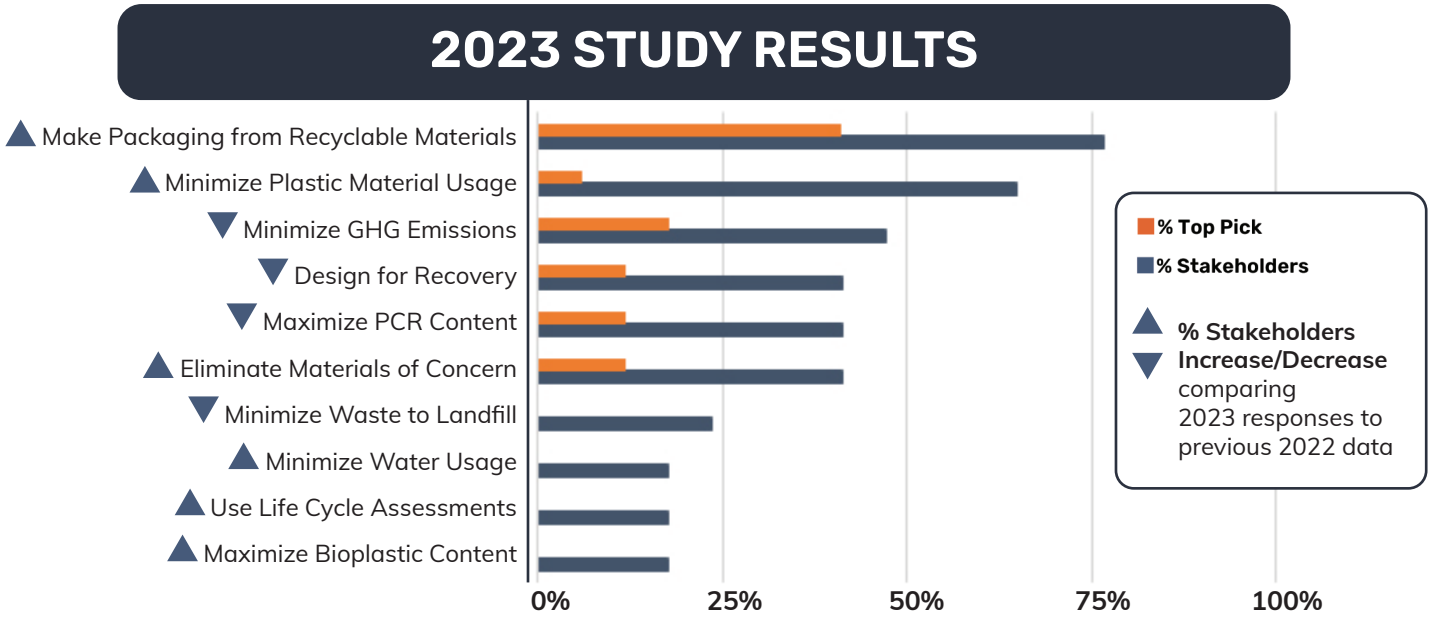
Packaging Sustainability Stakeholder Study

Sustainability Goal Analysis

Of the organizations we interviewed in 2023, 100% had well-defined sustainability goals at the time of the discussion. This number increased from 92% in our 2022 study and 67% in our 2021 study. The increasing adoption of formal corporate goals is evidence of the growing integration of sustainability into organizational strategy. Although all organizations had sustainability goals, packaging-specific goals were not always defined.

Stakeholders were asked to describe their organization's packaging sustainability goals. The answers were dissected into individual goal statements, and high-priority goals were identified as "Top Picks."
The following table and graph summarize the findings:

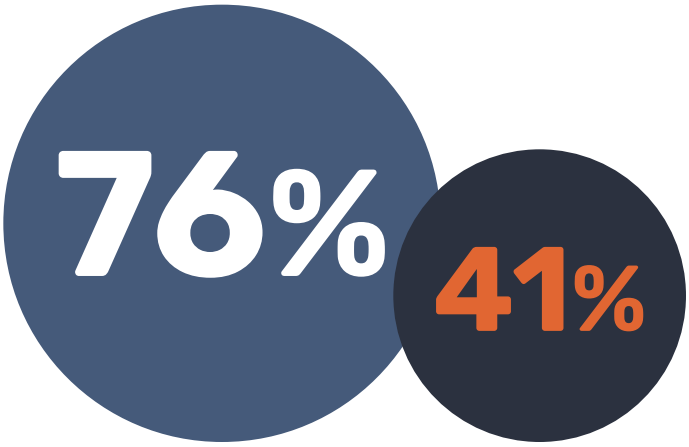
GOAL	% Stakeholders	% Top Pick
Make Packaging from Recyclable Materials	76	41
Minimize Plastic Material Usage	65	6
Minimize GHG Emissions	47	18
Design for Recovery	41	12
Maximize PCR Content	41	12
Eliminate Materials of Concern	41	12
Minimize Waste to Landfill	24	0
Minimize Water Usage	18	0
Use Life Cycle Assessments	18	0
Maximize Bioplastic Content	18	0



Stakeholder Study Goal Analysis

Make Packaging from Recyclable Materials

The top sustainability goal identified by stakeholders in 2023 was to "Make Packaging from Recyclable Materials," as 76% of organizations interviewed have a goal related to this aspect, including 41% that denote it as a top pick. This compares to 50% and 36%, respectively, from the 2022 study.

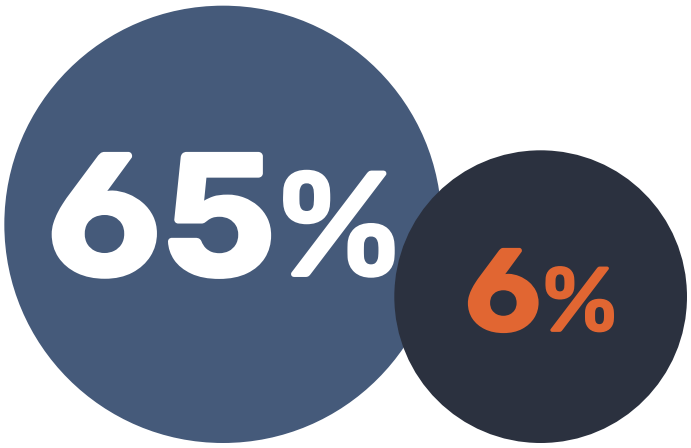


Material selection is a critical step in creating packaging that can be truly recycled in practice. Commonly recycled plastics, PET and HDPE, have the most robust recycling markets for rigid packaging formats. PP recycling has grown rapidly in recent years and is seen by stakeholders as a viable option. Stakeholders use these materials to leverage their established recycling systems and end markets.

Polystyrene (PS) and Polyvinyl Chloride (PVC) are two specific polymers identified by stakeholders as problematic to continue to use due to lack of recycling systems. These polymers are substituted for alternatives, like PET, when performance requirements can be met without compromise. Stakeholders identified several packaging categories that were most exposed to these polymers. Examples include single-use cookie trays made from Oriented Polystyrene (OPS) and blister packs made from PVC.

Using colorants is an aspect of material selection that can impact the ability to recycle a package in practice. Colorants can interfere with Near-Infrared (NIR) sortation equipment at Material Recovery Facilities (MRFs) and reclaimers. These automated sorters measure the amount of light an item reflects to detect the type of material used to make the item. Certain colorants, like carbon black, change how the items reflect light. This affects the accuracy and efficiency of the detection process. Colorants can be formulated to not interfere with NIR sortation, but testing is recommended to confirm performance. Colorants can also impact the value of recovered material and the availability of end markets. Recycled colored HDPE has robust end markets, but the same cannot be said for PET.

Stakeholder Study Goal Analysis



> **“We need plastic, especially in a lower carbon economy.**

Minimize Plastic Material Usage

The second most identified sustainability goal in 2023 was to “Minimize Plastic Material Usage,” as 65% of organizations interviewed have a goal related to this aspect. However, only 6% denote it as a top pick. This compares to 50% and 36%, respectively, from the 2022 study. In other words, this aspect is a core goal in most organizations we interviewed, but other goals rank higher in priority.

It is no surprise that the use of plastic in packaging is under scrutiny. Brands are facing mounting pressure from consumers, NGOs, and governments to curtail the use of plastic in their products and packaging. Substituting plastic for another material and/or reducing the weight of the plastic in the item are methods brands deploy to meet this goal. Several stakeholders noted that their organization’s plastic reduction goals are limited to the virgin (fossil fuel-derived) plastic in their packaging. These organizations leverage the use of recycled materials along with weight reduction and substitution to meet their plastic reduction goals.

Meeting plastic reduction goals can conflict with an organization’s climate goals. Plastic often has a lower carbon footprint than alternative packaging materials[3]. Additionally, stakeholders noted the need to be aware of potential unintended harmful consequences when substituting or reducing packaging material. The embodied carbon of a packaged good, like a food or pharmaceutical product, often vastly exceeds the embodied carbon of packaging. Any packaging change must be validated so as not to harm the preservation or protection attributes of the packaging system.

Stakeholders acknowledge that plastic use in packaging is essential but needs to be done responsibly to minimize environmental impacts like pollution and resource consumption. Additional goals outlined below detail how organizations are approaching this paradox. One stakeholder succinctly said, “We need plastic, especially in a lower carbon economy. We have to address waste generation.”

Stakeholder Study Goal Analysis

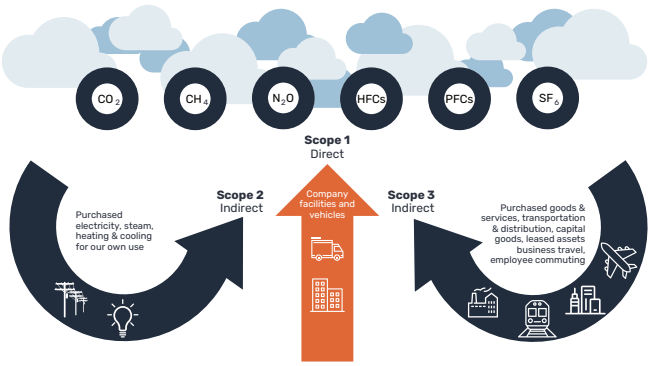
Minimize GHG Emissions

The third-highest sustainability goal identified by stakeholders in 2023 was to "Minimize GHG Emissions," as 47% of organizations interviewed have a goal related to this aspect, including 18% that denote it as a top pick. This compares to 64% and 43%, respectively, from the 2022 study, where it was ranked as the top sustainability goal.

According to Shelton Group research, 78% of people believe that climate change is occurring and is primarily caused by humans. People surveyed also believe companies bear the most responsibility for change, even higher than the actions of governments and individuals[4]. In this context, corporations are making public pledges on climate action.

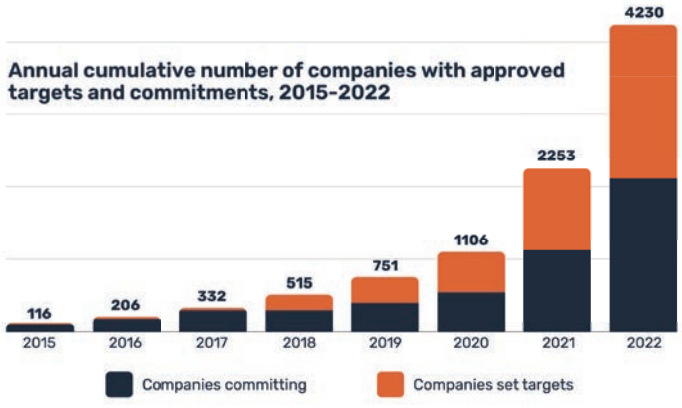
The Science Based Targets initiative[5] (SBTi) was commonly cited as an influential NGO helping to drive climate action. SBTi helps organizations in the private sector set science-based emission reduction targets. These targets are intended to align with the goals of the Paris Agreement to limit global warming to below 1.5 degrees Celsius above pre-industrial levels. SBTi provides organizations with the framework to assess Scope 1, 2, and 3 emissions and guidance to set ambitious reduction targets.

Of the organizations participating in our study, 71% have committed to the SBTi[6]. This compares to 62% in our 2022 study. SBTi's 2022 progress report outlined the exponential growth of pledges, reflecting the commitment of the private sector to take climate action. SBTi commitments were made by 4,230 companies by the end of 2022, an 87% year-over-year increase. These companies collectively represent 34% of the global economy. As of November 2023, the number of companies making commitments stood at over 6,400.



Organizations interviewed in 2023 were primarily focused on lowering their Scope 1 & 2 emissions in the near term. Methods to reduce these emissions include electrification of processes that currently combust fuel and investing in renewable energy. These organizations implement renewable energy through on-site generation or the purchase of Renewable Energy Certificates (RECs). Reducing these emissions to zero is a challenge for organizations and requires significant capital to achieve. "Our CEO made a (Scope 1 & 2) Net Zero commitment by 2025 and now I need to figure out how we are going to do it," shared a sustainability leader.

Packaging is considered a purchased good and is therefore classified as a Scope 3 emission for brands and OEMs. Scope 3 emissions are expected to come into more focus as these organizations make progress on their Scope 1 & 2 emissions and transition resources to reducing Scope 3 impacts. The primary method stakeholders are leveraging to reduce Scope 3 emissions from plastic packaging is incorporating recycled materials since using recycled materials significantly reduces the embodied carbon of a product.

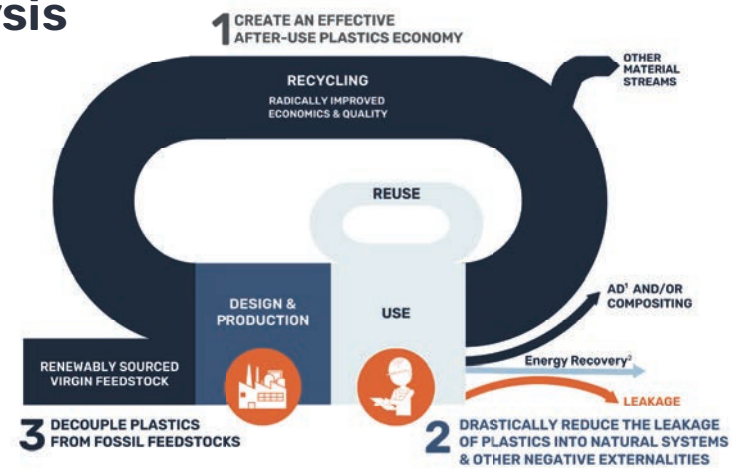


Stakeholder Study Goal Analysis

Design for Recovery

"Design for Recovery" was listed by 41% of stakeholders as a goal their company is working toward, and 12% listed this as a top pick. Choosing a highly recycled polymer is insufficient to ensure a package design is optimized for recovery. Stakeholders recognize the importance of following design for recycling guidelines, such as the Association of Plastic Recyclers Design Guides[7]. Global stakeholders also identified RecyClass[8] and CEFLEX[9] as additional guides their designers use when creating new packaging.

Label and adhesive selection on thermoformed packaging is a common pain point identified by stakeholders in this aspect. Pressure-sensitive labels have traditionally been made from a paper-based structure with a strong adhesive for bonding to the package. The paper fibers in the label and the adhesive create issues for recyclers. Improper label selection can render a package non-recyclable. Labels designed for recycling compatibility tend to have a higher cost. "We are hesitant to switch to these labels and bear additional costs until recovery rates improve to a high enough level to justify the cost," shared a packaging development leader. Paradoxically, recyclers are hesitant to process thermoforms due to the issues with traditional paper-based labels.



Maximize PCR Content

"Maximize PCR Content" was listed by 41% of stakeholders as a goal their company is working toward, and 12% listed it as a top pick. PCR is an essential component of a circular economy for plastics[10]. Using PCR significantly lowers the embodied carbon of a package and reduces the use of virgin materials, thus unlocking corporate goals to reduce emissions and virgin plastic usage. Brands for product-sensitive applications are cognizant of potential trade-offs when transiting to PCR. "We want to move to PCR slowly to ensure performance and safety is not compromised," shared a food packaging expert.

The Ellen McArthur Foundation (EMF) is an NGO commonly cited by stakeholders as influential in adopting PCR into plastic packaging. According to the EMF Global Commitment 2023 progress report, brand and retailer signatories increased their use of PCR content for a fifth consecutive year (from 10.0% in 2021 to 11.7% in 2022). This is more than double the 4.7% baseline in 2018, with the top quartile of signatories nearly tripling their share of PCR over the past five years[11].

In addition to performance validation, cost impact is a concern cited by stakeholders as a bottleneck in the adoption of higher levels of PCR. In reference to PET, PCR was cost-neutral or slightly below virgin pricing for the majority of 2022. This helped alleviate this concern, but brands are cognizant of the impact of potential swings due to the inherent volatility in the PCR market. "We really need price certainty to mitigate risk when transitioning to PCR," shared a stakeholder.

Stakeholder Study Goal Analysis

Eliminate Materials of Concern

Of surveyed stakeholders, 41% listed "Eliminate Materials of Concern" as a goal their company is working toward. It was listed as a top pick by 12%. PFAS, also known as "forever chemicals," are under the microscope given their potential impact on human health. PFAS are used in countless consumer and industrial products. The coatings added to fiber-based packaging to protect the fibers from moisture and grease are examples of PFAs in packaging. They are also commonly used as processing aids in producing plastic films. Twenty states have either passed or proposed legislation regulating the use of PFAS in specific types of packaging in response to perceived health risks. The definition of "packaging," as detailed in the legislation, is critical to understanding potential impacts. Some states, like California, have limited the definition to plant or fiber-based food packaging[12]. As a packaging development leader stated, "PFAS are difficult for us to address in our supply chain because they are pervasive."

Minimize Waste to Landfill

"Minimize Waste to Landfill" was listed by 24% of stakeholders as a goal their company is working toward. None listed this as a top pick. The stakeholders clarified that this objective pertains to the waste produced during operational activities. Operational sustainability, including Zero Waste to Landfill initiatives, is increasingly becoming a fundamental element of organizational sustainability strategies. Among the pharmaceutical companies interviewed, there was a strong alignment with operational sustainability metrics. Additionally, take-back programs were highlighted as noteworthy initiatives to reduce operational waste from manufacturing processes. "Take-backs are a great way for us to 'walk the walk' when it comes to sustainability," shared a sustainability expert.

Maximize Bioplastic Content

Next, 18% of stakeholders listed "Maximize Bioplastic Content" as a goal their company is working toward. None listed this as a top pick. Stakeholders view bioplastics as an option to reduce the use of virgin plastics derived from fossil fuels. Traditionally, bioplastics for packaging have been considered biodegradable or industrially compostable, like PLA. However, awareness of traditional polymers, like PET and PP, from bio-based sources is increasing. Stakeholders recognize the ongoing need for virgin polymers to meet global demand, even if recycling and reuse increase dramatically. One stakeholder shared, "We view bio-based feedstocks, like sugar cane, as potential renewable feedstocks to replace fossil fuels as our economy transitions to circularity and regeneration."

"Take-backs are a great way for us to walk-the-walk when it comes to sustainability.

Stakeholder Study Goal Analysis

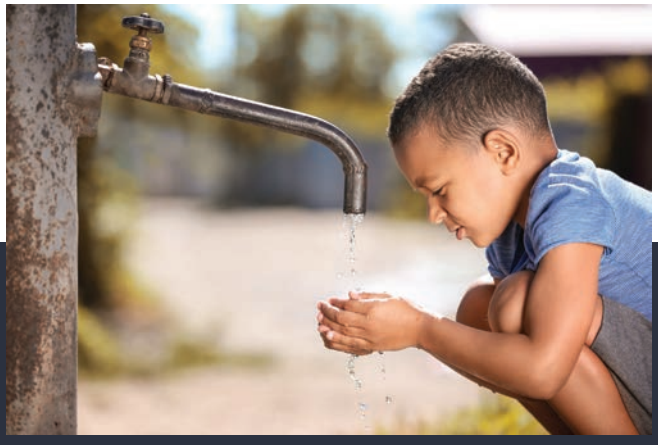
Use Life Cycle Assessments

Though none listed it as a top pick, 18% of stakeholders listed "Use Life Cycle Assessments" as a goal their company is working toward. LCA tools provide a comprehensive evaluation of a product's environmental impact throughout its life cycle—from raw material extraction and manufacturing to use and disposal. This holistic perspective helps companies identify areas to reduce resource consumption, emissions, and waste, ultimately leading to more sustainable designs. LCAs foster transparency and accountability, which is increasingly important to environmentally conscious consumers, investors, and regulators. LCAs can drive efficiency improvements and optimize production processes, translating into a competitive advantage in the market. "Integrating LCA tools into our development process not only benefits the environment but also enhances our competitiveness and reputation," shared a sustainability leader.

> **"Integrating LCA tools into our development process not only benefits the environment but also enhances our competitiveness and reputation.**

Minimize Water Usage

Lastly, 18% of stakeholders listed "Minimize Water Usage" as a goal their company is working toward. None listed this as a top pick. Organizations operating in regions of water scarcity are increasingly prioritizing efforts to minimize their water usage during operations. This is especially true for high water consumption industries, like pharmaceuticals and biotech, which account for up to 23% of global water usage[13]. Stakeholders are focused on new production methods to decrease water usage, but these can have tradeoffs on other environmental impacts, like waste. Another headwind highlighted by stakeholders is the relatively low cost of water. "Water is too cheap. It makes reduction projects difficult to justify based on capital ROI alone," stated a sustainability engineer.



PACKAGING SUSTAINABILITY STAKEHOLDER STUDY

HEALTHCARE

Packaging Sustainability Stakeholder Study - Healthcare

A significant share of the stakeholders interviewed in 2023 represent the healthcare industry. Organizations interviewed include manufacturers of medical devices, pharmaceutical products, biotech, and life science applications.
The healthcare industry is under considerable pressure to increase the sustainability of its products.

Drivers of Change

The healthcare industry's drivers of change are comparable to those of other industries, but there are some unique aspects to highlight. Pharmaceutical and biotech companies are acutely aware of their environmental impact, given the negative perceptions the industry may have in this regard in the eyes of the general public[14]. NGOs are impacting change, especially Practice Greenhealth. Group Purchasing Organizations (GPOs) are driving change by implementing Environmentally Preferred Procurement (EPP) policies into procurement processes.

Legislation is a significant driver of change. Several stakeholders cited the European Packaging and Packaging Waste Regulation (PPWR) as influencing their sustainability activities. The PPWR will be legally mandated by the end of 2024[15]. It aims to reduce packaging waste and promote a circular economy. Aspects include:

1. All packaging must be designed for recycling at scale.
2. Plastic packaging must use a minimum PCR percentage.
3. Labeling requirements surrounding material composition and recyclability.
4. EPR will be eco-modulated to incentivize environmentally positive design.

Notable for healthcare organizations, product-sensitive products like medical devices and pharmaceuticals are exempted from recycling and PCR requirements, but secondary packaging items likely are not exempt. "Many of our products will be exempt, but we want to embrace this as a way to get better and stay ahead of regulation," shared a packaging leader in pharma.

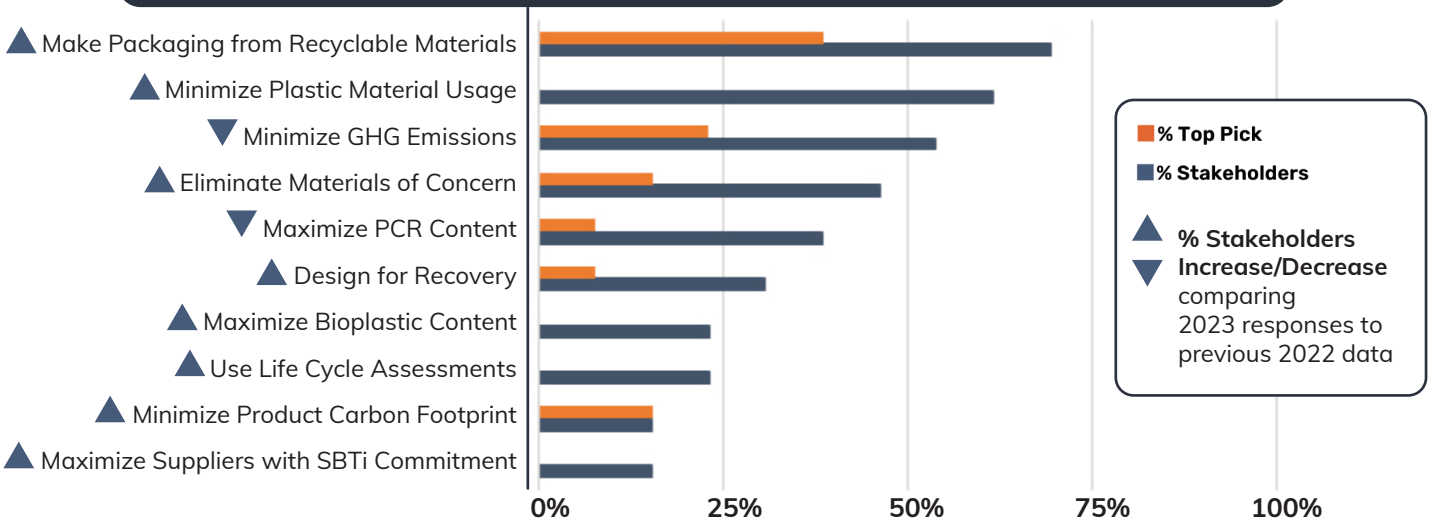
Packaging Sustainability Stakeholder Study - Healthcare

Sustainability Goal Analysis

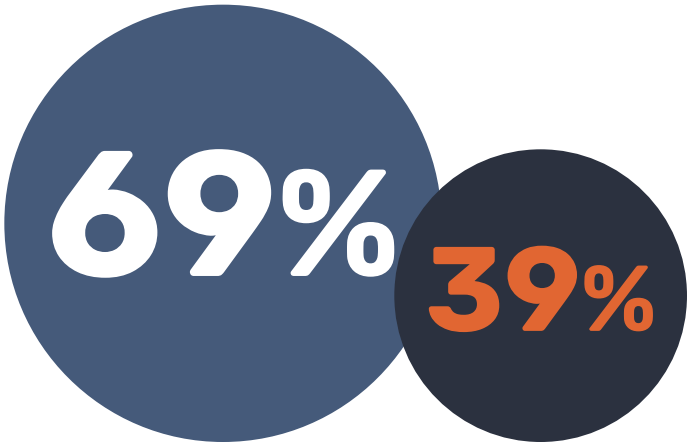
Isolating the sustainability goals shared by healthcare organizations provides some interesting insights to analyze:

GOAL	% Stakeholders	% Top Pick
Make Packaging from Recyclable Materials	69	38
Minimize Plastic Material Usage	62	0
Minimize GHG Emissions	54	23
Eliminate Materials of Concern	46	15
Maximize PCR Content	38	8
Design for Recovery	31	8
Maximize Bioplastic Content	23	0
Use Life Cycle Assessments	23	0
Minimize Product Carbon Footprint	15	15
Maximize Suppliers with SBTi Commitment	15	0

2023 STUDY RESULTS – Healthcare



Stakeholder Study Goal Analysis



Make Packaging from Recyclable Materials

The top sustainability goal identified by healthcare stakeholders in 2023 was to "Make Packaging from Recyclable Materials," as 69% of organizations interviewed have a goal related to this aspect, including 39% that denote it as a top pick. Given the substantial barriers to recycling plastics used in healthcare settings[16], this may be a surprise. "We want to understand if the materials with better recyclability will work for our applications if collection in the hospital improves," shared a packaging engineer.

Common materials used for rigid healthcare packaging include PETG, HIPS, PET, PP, HDPE, and PVC. Many of these materials, such as PETG, do not have existing robust recycling markets. However, their function, especially in sterilization processes, is nearly impossible with other materials. Stakeholders are considering materials with more robust recycling markets, but performance requirements, validation needs, and regulatory constraints limit the ability to transition to these materials.

In the case of PETG, PET resin can be modified to perform like PETG. However, the more it is modified, the less compatible it is with the PET recycling stream. One stakeholder shared how they are approaching this, "Our supplier says this is PET but it's modified to perform like PETG. So, is it PET? We are asking our suppliers, 'What data do you have that confirms this resin adheres to the PET definition in ASTM D7611[17]? Do you have APR Critical Guidance[18] for recycling with PET?'"

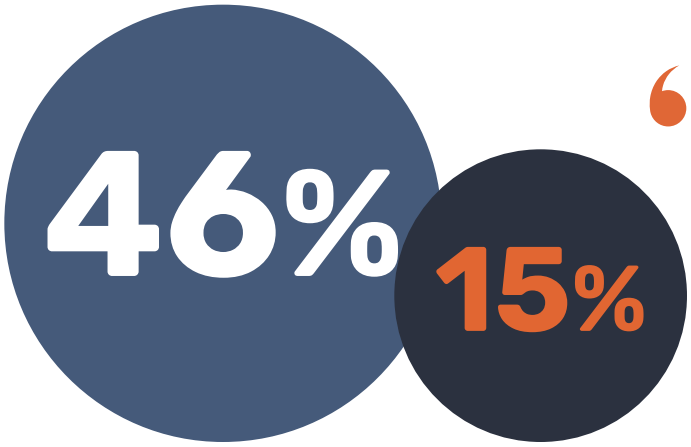
Minimize Plastic Material Usage

"Minimize Plastic Material Usage" was cited by 62% of healthcare organizations as a goal they are working toward. However, none listed it as a top pick. Packaging engineers frequently grapple with minimizing material usage while assuring the durability of packaging systems during distribution. While it's critical to avoid waste resulting from packaging-related defects, the practice of over-engineering to eliminate risk is no longer accepted. "We must use design expertise and material innovation to solve this challenge," shared a packaging development leader.

Minimize GHG Emissions

"Minimize GHG Emissions" was cited by 54% of healthcare organizations as a goal they are working toward, and 23% listed it as a top pick. Of the healthcare organizations participating in the study, 77% have committed to the Science Based Targets initiative (SBTi)[6]. Healthcare organizations are achieving their decarbonization goals by electrifying processes that currently combust fuel, investing in on-site solar or wind renewable energy, or procuring Renewable Energy Credits (RECs). RECs represent the environmental benefits of generating electricity from renewable sources, allowing businesses to support using renewable energy without physically connecting to a renewable energy source.

Stakeholder Study Goal Analysis



“We must use design expertise and material innovation...

Eliminate Materials of Concern

A top pick for 15% of stakeholders, 46% of stakeholders listed “Eliminate Materials of Concern” as a goal their company is working toward. PFAS were commonly cited as the highest priority material of concern (MOC) their organizations are focused on addressing. Healthcare organizations are particularly focused on MOCs, given the interaction of their products with people. The potential migration of MOCs from a package to a healthcare product represents a significant risk for the organization. Although regulatory authorities manage MOCs, these initiatives tend to involve sustainability resources in the organizations, given the potential impact on people.

Design for Recovery

Working toward “Design for Recovery” was listed by 31% of stakeholders as a company goal, and 8% listed this as a top pick. Healthcare organizations are becoming more astute in designing packaging for recovery. This is especially true for healthcare products not used in hospitals or clinical settings, like over-the-counter medication and laboratory consumables. These applications can potentially enter municipal recycling systems depending on the end-use specifics. Stakeholders cited the HPRC Design Guidance for Healthcare Plastics Recycling[19] as a resource they use when designing new packaging for recycling systems.

Maximize PCR Content

“Maximize PCR Content” was listed by 38% of stakeholders as a goal their company is working toward, with 8% listing it as a top pick. This goal may also be surprising given the regulatory limitations on using recycled material in healthcare packaging, especially for Sterile Barrier Systems (SBS). Healthcare organizations view secondary packaging as a potential avenue for recycled materials. Stakeholders approach these opportunities cautiously, given the need for robust product protection. Organizations are optimistic about the potential of advanced recycling to provide access to recycled materials for all packaging types by leveraging mass balance allocation.

Stakeholder Study Goal Analysis

Maximize Bioplastic Content

Even though none listed it as a top pick, 23% of stakeholders listed “Maximize Bioplastic Content” as a goal their company is working toward. Conventional plastics, like PET and PP, made from bio-sources are more of a focus in this regard than degradable bioplastics, like PLA and PHA. Stakeholders are intrigued by the potential of bioplastics to contribute to their Scope 3 emission reduction initiatives. These bio-based materials tend to have higher embodied water usage than fossil fuel-derived polymers since they are derived from a grown agricultural crop. Stakeholders are grappling with this trade-off when considering conversion. “We can’t accept that large of an increase in water consumption,” shared a sustainable packaging development leader.

Minimize Product Carbon Footprint

Of stakeholders, 15% listed “Minimize Product Carbon Footprint” as a goal their company is working toward, and 15% considered this a top pick. Product carbon footprint calculations use a company’s actual emissions data, instead of industry averages, to estimate the embodied carbon in a product. Healthcare organizations view product carbon footprint calculations as a way to measure and monitor their Scope 3 emissions from purchased goods. This methodology drives decision-making processes when evaluating potential improvements to a product. The organizations that listed this as a priority have made large strides toward their Scope 1 & 2 emissions and are focusing on reducing Scope 3 impacts.

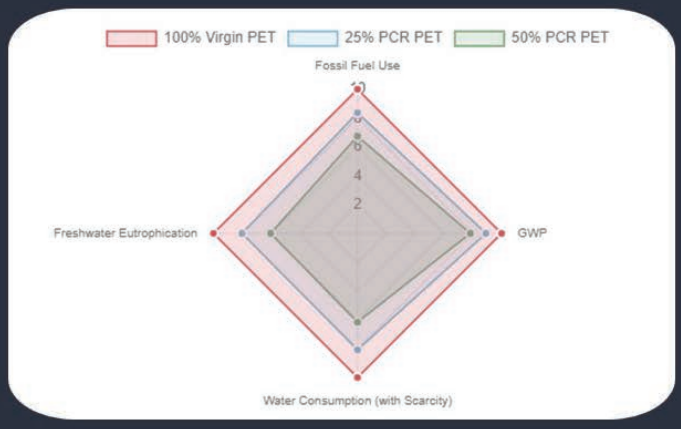
Use Life Cycle Assessments

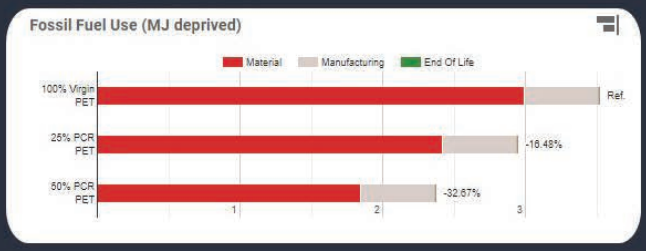
Another 23% of stakeholders listed “Use Life Cycle Assessments” as a goal their company is working toward. None listed this as a top pick. LCAs leverage industry average life cycle inventories to estimate the environmental impact of design choices. Healthcare organizations leverage LCAs in various ways, most notably when evaluating the impact of different packaging substrates. Stakeholders referenced the ISO 14040 standard as a framework their organizations leverage to ensure the efficacy of these assessments.

Maximize Suppliers with SBTi Commitment

Finally, 15% of stakeholders listed “Maximize Suppliers with SBTi Commitment” as a goal their company is working toward. No one listed this as a top pick. Organizations with aggressive decarbonization initiatives are influencing suppliers to take similar climate action. A stakeholder shared, “SBTi commitment will be a requirement by 2025 to be a preferred supplier to our company.”
A sustainability leader shared, “You will not be considered a preferred supplier to us if you do not have a decarbonization plan in place.”

LCA RESULTS OF PCR





Comparison Analysis of 100% Conventional PET, 25% PCR PET, 50% PCR PET
Source: Trayak Eco-Impact COMPASS

Packaging Sustainability Stakeholder Study
CONCLUSION

The shift to a circular economy for packaging continues to be prioritized by brands, retailers, and healthcare organizations. This shift is evident in the proliferation of sustainability goals related to packaging circularity and the establishment of dedicated resources within these organizations responsible for executing these goals. In addition to circularity, stakeholders focus on quantifying and reducing the embodied carbon in their products and packaging to minimize climate impact. Legislation, like Extended Producer Responsibility, is viewed by stakeholders as both a driver and enabler of transformation. Legislation will play a vital role in the coming years as organizations have struggled to meet their voluntary circularity goals.

Sources:

1–United Nations, Sustainable Development Goals
2–Sustainable Packaging Coalition, Guide to EPR Proposals
3–McKinsey & Company, Climate Impact of Plastics, 2022
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5–Science Based Targets, About Us
6–Science Based Targets, SBTi Monitoring Report 2022
7–The Association of Plastics Recyclers, APR Design® Guide for Plastics Recyclability
8–RecyClass
9–CEFLEX, A Circular Economy for Flexible Packaging
10–Ellen MacArthur Foundation, The New Plastics Economy: Rethinking the Future of Plastics
11–Ellen MacArthur Foundation, Global Commitment 2023
12–Bryan Cave Leighton Paisner (BCLP) Law, PFAS Update: State Regulation of PFAS in Food Packaging, 2023
13–PharmTech, Water, Water Everywhere?, 2008
14–Pharmaceutical Technology, Pharma and the Environment: Pollution Continues Despite Public Pressure, 2018
15–Smithers, White Paper: A Framework for Understanding the Packaging & Packaging Waste Regulation (PPWR)
16–Healthcare Plastics Recycling Council (HPRC), Barriers to Recycling Healthcare Plastics at Hospitals
17–ASTM D7611/D7611M-10, Standard Practice for Coding Plastic Manufactured Articles for Resin Identification, 2013
18–The Association of Plastic Recyclers, APR Design® for Recyclability Recognition Program
19–Healthcare Plastics Recycling Council (HPRC), Design Guidance

INDUSTRY COLLABORATION

Industry Collaboration

The transition to a circular economy for packaging requires extensive collaboration. A single company working independently cannot address the challenges inherent to system-wide transformation alone. Therefore, Plastic Ingenuity actively participates and pursues leadership roles in every association we support. This collective approach combined with our deep expertise in sustainable thermoforming creates significant value for our stakeholders.

2023 highlights include:

Celebrating the third anniversary of the Polypropylene (PP) Recycling Coalition. The impact of the coalition's investment in PP recycling is estimated at 42 million pounds of additional PP annually.

Achieving a leadership position on the Healthcare Plastics Recycling Council's executive committee, enabling continued progress toward increasing recycling for healthcare plastics.

Presenting at premier sustainability conferences including Sustainability in Packaging U.S., Sustainable Packaging Coalition Advance, and the PLASTICS ReFocus Summit.

Industry Collaboration

PI is proud to contribute to the following organizations in the pursuit of circularity for plastic packaging:

Associated Recyclers of Wisconsin (AROW)
AROW brings together a dynamic cross section of industry professionals from both private and public sectors, all dedicated to waste reduction, recycling, and product stewardship.

Association of Plastics Recyclers (APR)
APR promotes the development of the plastics recycling industry by providing leadership for long-term industry growth and vitality.

Healthcare Plastics Recycling Council (HPRC)
HPRC is an industry consortium comprised of medical device manufacturers, material manufacturers, converters, waste collectors, recyclers, and hospitals. They focus on identifying barriers to plastics recycling and developing solutions along the entire value chain.

–Executive Committee and Co-Lead of the Advanced Recycling Project Team

Institute of Packaging Professionals (IoPP)
IoPP is dedicated to creating networking and educational opportunities to help packaging professionals succeed. They formed the Sustainable Packaging Technical Committee in 2023.

–President of the Chicago Chapter

National Association for PET Container Resources (NAPCOR)
NAPCOR provides a forum for its members to collaborate with peers on key projects and address significant issues affecting PET packaging throughout its life cycle.

–Board Member and Chair of the Thermoforming Committee

Plastics Industry Association (PLASTICS)
PLASTICS brings equipment makers, brand owners, processors, and material suppliers together to align their efforts to put recycling at the forefront of their businesses.

–Recycling Committee members

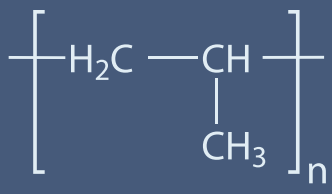
Sustainable Packaging Coalition (SPC)
SPC brings packaging sustainability stakeholders together to catalyze actionable improvements to packaging systems and lend an authoritative voice on issues related to packaging sustainability.

The Recycling Partnership
The Recycling Partnership is a nonprofit organization that leverages corporate partner funding to transform recycling for good in states, cities, and communities nationwide.

–Funding member of the PP Recycling Coalition, which is focused on increasing access for people to recycle polypropylene through curbside recycling programs, ensuring more recycling processing facilities can sort the material successfully, and stimulating a robust end-market of high-quality recycled polypropylene for reuse in packaging.

–Funding member of the PET Recycling Coalition, a robust group of stakeholders driving improvements that transform the PET plastic recycling landscape.

SPOTLIGHT: PP RECYCLING COALITION



POLYPROPYLENE RECYCLING COALITION
AN INITIATIVE OF THE RECYCLING PARTNERSHIP

The Recycling Partnership (TRP) launched the Polypropylene Recycling Coalition in 2020 to increase access for people to recycle polypropylene (PP) through curbside recycling programs, ensure more recycling processing facilities can sort the material successfully, and stimulate a robust end-market of high-quality recycled polypropylene for reuse in packaging.[1]

The coalition model combines grants, community-level education, and big data analysis to accelerate progress towards these goals. The coalition provides grants to recycling facilities for capital equipment to improve the capture of PP packaging items.

Rapid progress has been made since the coalition was formed. This progress resulted in the achievement of a major milestone in 2022 when most rigid PP containers were upgraded to "Widely Recycled" by the How2Recycle program.

Noteworthy impacts include:

$10.3 million in grants for 41 Material Recovery Facilities' capital investments

Improving curbside access to PP affecting approximately 11% of households, 34.2 million people

Increasing PP recovery by an estimated 42 million pounds annually

Plastic Ingenuity joined the Polypropylene Recycling Coalition in August 2021. We are energized by the progress the coalition has made in three years and will continue to focus the resources needed to grow the recycling ecosystem for this very important packaging polymer.

Please visit Polypropylene Recycling Coalition–The Recycling Partnership for more information.

PLASTIC INGENUITY

Spotlight: PP

PP in Packaging

The primary purpose of a package is to maintain product integrity, and intentional material selection is a critical component of a package's success. PP is a popular packaging material for many applications due to its lightweight nature, extreme durability, and processing versatility. The customizable nature of PP allows this polymer to be produced in various colors and formats, such as thermoformed cups or trays, injection-molded containers, blow-molded bottles, and form-fill-seal packages. Due to these adaptable properties, PP is used across the food, beverage, cosmetic, household cleaning, and healthcare industries.

PP Recycling Landscape

The widespread use of PP has led to challenges in recovery. Due to its diversity in size, format, and color, properly collecting and sorting PP has proven incredibly challenging compared to other commonly recycled materials. Unlike the PET water bottle or HDPE milk jug, PP does not have a distinguishable standard format to help with sortation. For decades, PP was sorted into mixed plastic bales, typically containing plastics 3 through 7 (PVC, LDPE, PP, PS, and others). These mixed plastic bales were commonly exported overseas until China's National Sword policy in 2018 redirected the attention back to domestic markets for PP.

The Sustainable Packaging Coalition reported in their 2020–2021 Centralized Study on Availability of Recycling that PP tubs and containers had fallen to a 59% acceptance rate for recycling nationwide. According to the Association of Plastic Recyclers' definition of recyclable, at least 60% of consumers must have access to a collection system that accepts the item per the FTC Green Guides. Therefore, PP tubs and containers were downgraded to a "check-locally" status by SPC's How2Recycle program. This distinction catalyzed The Recycling Partnership's Polypropylene Recycling Coalition in July 2020. Plastic Ingenuity joined TRP's Polypropylene Recycling Coalition in August 2021.

Since the Coalition's birth, industry leaders reinforced PP's value as a recycled material and its essential role in the circular economy. Significant investments by TRP's Polypropylene Recycling Coalition to improve PP recovery in the U.S. included grants impacting 600 communities and 41 material recovery facilities (MRFs).

In early 2022, the Sustainable Packaging Coalition and The Recycling Partnership worked together to evaluate access rates and end-market criteria for PP. By leveraging TRP's National Recycling Database and Circular Packaging Assessment tool, the evaluation proved that polypropylene's access rate increased to 65% and demonstrated growth in domestic end markets. This collaborative evaluation by SPC and TRP returned most PP applications to a "widely recyclable" designation by How2Recycle.

Spotlight: PP

Polypropylene Recovery in Practice

The Recycling Partnership estimates that single-family households in the U.S. generate more than 2 billion pounds of polypropylene annually. If MRFs recovered 30% of this material, it would provide over 600 million pounds of recycled material and reduce greenhouse gas emissions by 311,000 metric tons of CO2.

The investments in curbside access and MRF investments by TRP's Polypropylene Recycling Coalition truly make a difference. A compelling example of the Coalition's success can be found in the state of Ohio. At the close of 2020, a mere 34% of Ohio households had access to recycle polypropylene. Thanks to the Coalition's grant initiatives, this figure has impressively surged to 69%, demonstrating the tangible impact of their concerted efforts. Rumpke Waste & Recycling, with MRFs in Colombus and Cincinnati, received an MRF grant from TRP. As a result of these investments, more than 1 million new pounds of PP is recovered per year in this area[2].

Sortation Advancements

Although PP is the third-highest material by volume in a residential recycling bin, behind PET and HDPE, sortation capabilities for PP are underdeveloped compared to PET and HDPE. However, significant improvements in sortation technologies have increased efficiency and stream acceptance for PP[3].

Optical Sorters

Optical identification through near-infrared (NIR) scanning technology is increasingly prevalent in MRFs. This technology uses sensors and cameras to identify and sort recyclables based on their material properties. Optical sorters are being strategically applied to identify and sort PP into its own bale.

Robotics

Robotic arms built over conveyor belts aim to enhance the automatic sorting process at a MRF. Robots are capable of 40–100 picks per minute, drastically increasing efficiency and reducing manual labor.

Artificial Intelligence

AI technology is designed to be used with optical and robotic sorters to increase the number of easily identified and sorted materials. Cameras capture images of the waste stream across a conveyor belt while AI algorithms simultaneously analyze the pictures for visual characteristics such as the shape and color of materials.

Spotlight: PP

Food Grade PP Reclamation

The demand for recycled polypropylene (rPP) continues to grow as 2025 brand commitments for recycled content are just over the horizon. An increased supply of rPP will require growing collection through policy changes such as extended producer responsibility (EPR), improvements in sorting capabilities for PP-only bales, and a growing capacity for food-grade rPP.

Food grade rPP production presents challenges due to its various grades, colors, and formats. Not all PP grades are food-grade, so creating a clean stream of food-grade rPP has proven difficult. Because of PP's ability to absorb chemicals when used for non-food purposes, rPP feedstocks must undergo extensive source control and decontamination to be considered food-grade. However, a small number of reclaimers, including KW Plastics, Plastic Recycling Inc., Envision Plastics, Merlin Plastics, and PureCycle, have received a letter of no objection (LNO) for food contact rPP from the FDA. The FDA LNO approval is based on the process developed by the reclaimers to produce food-grade material, including a complete description of the recycling process, passing results of surrogate contaminant challenge testing, and the intended conditions of use for the material.

An FDA LNO is becoming ever more prevalent as demand for rPP increases. Plastic Ingenuity is uniquely positioned within the value chain to evaluate food-grade rPP options from reclaimers. We also provide brands with support and guidance as they incorporate rPP into their packaging systems to meet recycled content goals.

Conclusion

PP's widespread use in packaging has led to an increase in PP generated by U.S. households and a surge in demand for post-consumer recycled PP. Although there is still work to be done to increase recycling rates, improve sortation capabilities, and increase the supply of food-grade material, the signs of change for PP recovery are encouraging.

While polypropylene recycling has made significant strides with the support of The Recycling Partnership's PP Recycling Coalition, plenty of work remains to unlock the full spectrum of environmental and economic benefits associated with PP recycling. PP recycling holds a promising future and, with continued support and investment, it is well on its way to contributing to a more sustainable and circular economy.

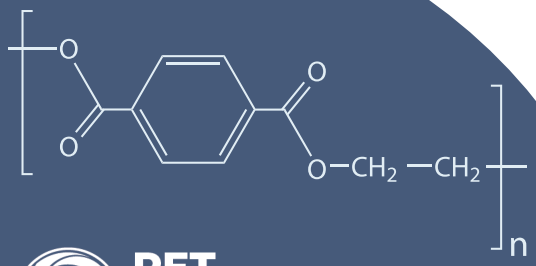
Sources:

1–The Recycling Partnership, Polypropylene Recycling Coalition

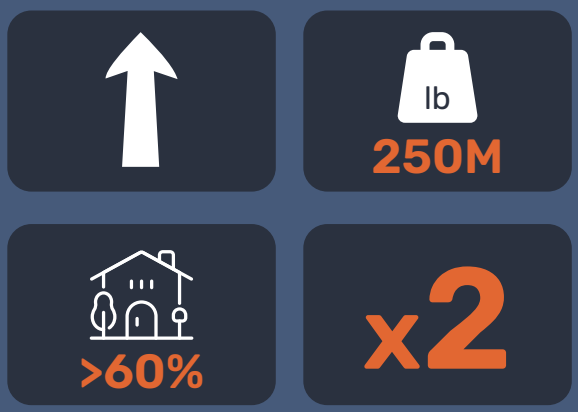
2–The Recycling Partnership, Impact Report 2022

3–Plastics Industry Association, Resource Recycling Systems Report 2022

SPOTLIGHT: PET RECYCLING COALITION



PET Recycling Coalition
THE RECYCLING PARTNERSHIP



The Recycling Partnership launched the PET Recycling Coalition in 2022 to further enhance the recycling of PET packaging.

The coalition is focused on achieving the following objectives[1]:

Increase Capture by 250 million pounds per year by 2027

- Boost the PET bottle recycling rate over 30%
- Significantly reduce yield loss at reclaimers and unlock new supply of rPET

Achieve >60% access for PET thermoforms by 2025

- Advance thermoform-to-thermoform recycling and other opportunities for separated recycling
- Double the PET thermoform recycling rate by 2027 (from 2022 baseline)

Create resilient recycling in practice and at scale for pigmented/opaque PET by 2025

- Strengthen robust end markets with pronounced environmental and economic benefits
- Earn an improved designation from industry-accepted recyclability assessment programs

The coalition provides grants to PET reclaimers and material recovery facilities for capital equipment to improve the recovery of PET items. As of October 2023, 11 grants have been provided to recyclers nationwide. This will ultimately lead to increased consumer access to PET recycling systems and an additional volume of post-consumer recycled (PCR) PET for use in the market.

Plastic Ingenuity became the first thermoformer to fund the PET Recycling Coalition in October 2022. Our unique perspective and experience in thermoform circularity will aid the coalition's efforts and derive value for both PI and our customers. Key milestones are well within reach, including returning PET thermoforms to "widely recycled" status in the How2Recycle platform.

Please visit PET Recycling Coalition–The Recycling Partnership for more information.

PLASTIC INGENUITY

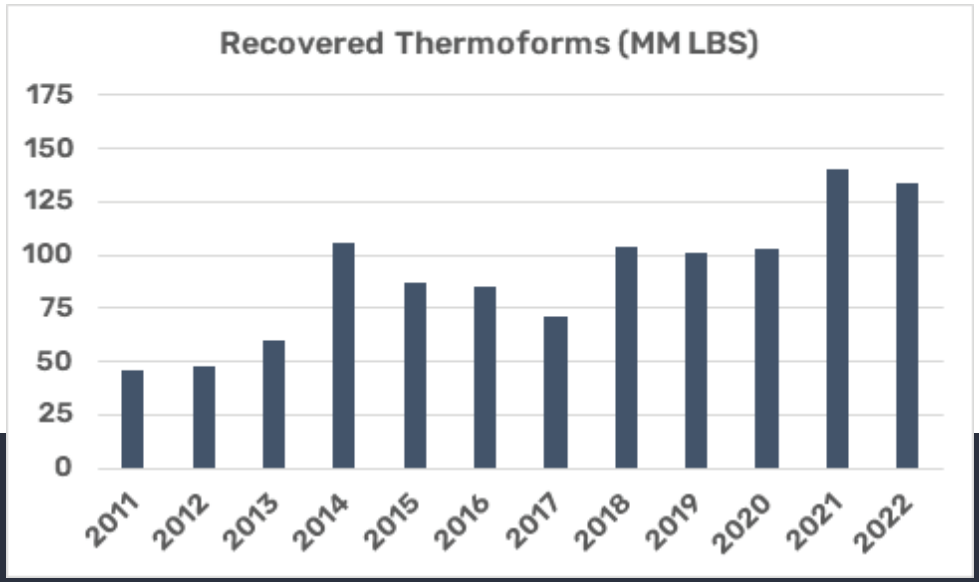
Spotlight: PET

PET Recycling Landscape

As a brief review of the plastic recycling value chain, material recovery facilities (MRFs) bring in single-stream recycling materials from municipalities. The MRFs sort and separate the comingled material types into bales of a common material, like PET. The bales are then sold to end buyers, known as reclaimers, for further processing. The reclaimers grind the waste into flake, remove residue and contaminants, and then filter out impurities. The final product, a plastic pellet or flake, is sold to a converter for incorporation into a new plastic product, such as a thermoformed package.

PET recycling rates remained mostly stagnant in 2022, the year with the latest data available. PET bottle recycling rates ticked down slightly in 2022. According to NAPCOR, the PET bottle recycling rate in 2022 was 29.0%[2], compared to 30.3%[2] the previous year. The rate decrease is attributed to an unusual spike in bottles collected in U.S. redemption systems in 2021 post-pandemic. In effect, this spike inflated 2021 rates.

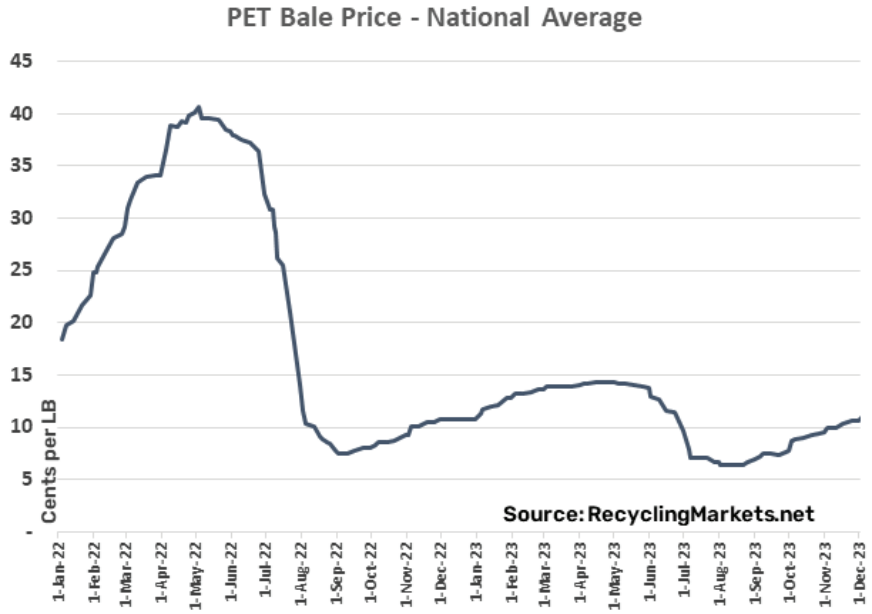
This trend extended to the recovery of thermoforms. In 2022, 134 million pounds of thermoforms were recovered[2]. This represents a decrease of 4% and 6 million pounds compared to the previous year. The trend of thermoform recovery in recent years is shown in this chart:



Spotlight: PET

In general, 2023 was a difficult year for many stakeholders operating in the PET recycling industry. Macroeconomic factors impacted the demand for recycled PET in fiber applications, like carpeting and textiles, which are a significant end market for recycled PET. Demand in these end markets declined significantly due to destocking and recessionary pressures. Recycled PET markets are heavily influenced by demand from fiber applications.

The impact of destocking and softening fiber demand on PET bale pricing is reflected in this chart from recyclingmarkets.net[3]:



PET bale pricing peaked in the spring of 2022 above 40 cents per pound. Pricing bottomed in the fall of 2022 and remained depressed in 2023. This decline in pricing has placed economic burdens on MRFs selling PET bales at these depressed levels. Reclaimers were also under pressure, given the softening demand for recycled PET flake. This comes when many reclaimers are planning or implementing capacity expansions to meet anticipated long-term increases in demand. A rebound in recycled PET pricing is needed to support the capital necessary to fuel capacity expansion. Many market participants are calling for the adoption of long-term pricing agreements to reduce volatility and provide stability to the market.

On a positive note, evidence supporting the uptake of PCR in packaging applications continued to emerge. According to the Ellen MacArthur Foundation's Global Commitment 2022 Progress Report[4], "Signatories' share of PCR content has doubled from 4.8% in 2018 to 10.0% in 2021. In other words, PCR content increased as much during the past three years as it did in all preceding years since plastic packaging was first introduced."

Spotlight: PET

Thermoform Recycling Insight

A majority of the PET thermoforms recycled in practice today are captured by inclusion with bottles in PET bales collected from curbside recycling programs. MRFs typically cap the level of thermoforms included in bottle bales at 10–20%, depending on agreements they have in place with their customers, the PET reclaimers. Unfortunately, many of these agreements do not allow thermoforms at any level. Some MRFs are sorting thermoform-only PET bales to serve emerging thermoform-to-thermoform recycling demand.

As thermoform recovery comes into focus, a healthy debate is emerging regarding which thermoform recovery method is the most effective for the holistic recycled PET ecosystem. There are two recovery mechanisms under debate:

1. Increase the amount of thermoforms in PET bottle bales
2. Capture thermoforms in dedicated bales

Each mechanism has advantages and trade-offs. Increasing the amount of thermoforms in bottle bales is perceived as the path of least resistance to make near-term gains in thermoform recovery. It may involve leveraging automation at the MRF level to divert additional thermoforms into the PET bales. However, it does not require additional bunker space, which is a constraint for many MRFs.

PET reclaimers purchase PET bales from the MRFs and then convert them to recycled material suitable for use in bottle, thermoform, or fiber applications. Reclaimers with end markets concentrated on bottles hesitate to support PET bales with high thermoform contents.

The reclaimers highlight several challenges thermoforms can have in their process:

- Their equipment was not designed to denest or separate thermoforms.
- Residue from labels and food causes issues.
- The shape of the flake (flat, instead of curly) presents conveying challenges.
- Thermoform cracking during the hot wash process causes fines that result in yield loss.
- Barrier layers impact efficiency and produce fines.
- Variation in intrinsic viscosity causes issues with the final product.
- Lack of availability of thermoform-only bales hinders the ability to experiment.

Spotlight: PET

It is feasible to convert recovered thermoforms to bottle-grade suitable material by utilizing a hot caustic wash to remove food residue and labels, solid state polymerization (SSP) to boost key properties and melt filtration to meet purity requirements. These capabilities are common among PET reclaimers in North America.

Reclaimer yields can be impacted when processing bales with high thermoform contents, given inherent differences in thermoform shapes, material intrinsic viscosity properties, and contamination from food residue and labels compared to bottles. This is especially true for reclaimers with processes highly tuned to bottle feedstocks and end markets. MRFs and reclaimers operating in regions with bottle deposit return schemes (DRS) report less concern with higher thermoform concentrations in bales. They commonly encounter a higher percentage of thermoforms in PET bales derived from residential recycling programs. Therefore, sortation and reclamation processes are tuned to these higher thermoform content bales.

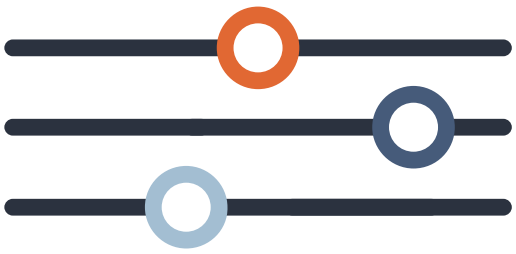
There is a mindset among many stakeholders that to optimize circularity initiatives, recycled bottles should be used to make new bottles, and recycled thermoforms should be used to make new thermoforms. Thermoforms are a significant end market for recycled materials derived from bottle feedstocks. As beverage brand owners increase the amount of PCR in their bottles to meet their corporate goals, they may seek more ownership of recycled materials derived from their bottles. This is especially true if extended producer responsibility (EPR) and DRS place additional economic incentives on the beverage industry to achieve circularity.

Sorting thermoforms into dedicated bales is a potential solution advocated by stakeholders. Reclaimers can convert thermoform bale feedstock to thermoform clean wash flake (TCWF) for use in thermoform-to-thermoform applications, including food containers. Advocates for this method argue developing an independent thermoform stream is critical to sustaining thermoform recovery in the long term.

Creating thermoform-only bales requires additional sorting, either at the MRF or reclaimer. This sortation is best achieved through automated sorting. MRFs also need bunker space and baling capabilities when adding a new bale type. Reclaimers processing thermoform-only bales must adjust their equipment for thermoform geometry and inherent material performance differences. Yields are expected to be lower for thermoform bales than bottle bales, even if processes are tuned accordingly.

Converters using TCWF as a feedstock for rollstock extrusion and thermoforming can expect an increased need for melt filtration capabilities to achieve purity expectations for end use in food-grade applications.

Regardless of which method emerges as a favorite by stakeholders, both will likely be used in tandem, given regional differences in recycling capabilities and end markets. Thermoform recovery must continue to increase so we may continue to reap the many benefits they provide.



Sources:

1–The Recycling Partnership, PET Recycling Coalition

2–National Association for PET Container Resources (NAPCOR), 2022 PET Recycling Report

3–RecyclingMarkets.net, Secondary Materials Pricing

4–Ellen MacArthur Foundation, The Global Commitment 2022 Progress Report

SPOTLIGHT: HEALTHCARE PLASTICS RECYCLING COUNCIL

HPRC
HEALTHCARE PLASTICS RECYCLING COUNCIL

Inspiring and Enabling Plastic Recycling Solutions in Healthcare

The Healthcare Plastics Recycling Council (HPRC) is a technical consortium with members from healthcare, recycling, and waste management industries. Their common goal is to improve the recyclability of plastic products and packaging used in healthcare settings. The council's efforts are project-based collaboratives designed to increase plastic recycling efforts in clinical settings. HPRC is active in the United States and Europe.

The council's flagship accomplishments include the Hospicycle toolkit for hospitals seeking to integrate recycling practices into their operations and their Design Guidance for Healthcare Plastics Recycling for designers looking to optimize packaging for recycling. HPRC's efforts in advanced recycling research are helping stakeholders understand the potential of the technology to enable a more circular future for healthcare plastics.

Plastic Ingenuity became a HPRC member in October 2021, then joined the HPRC Steering Committee in October 2022 and Executive Committee in January 2023 to accelerate progress toward the council's mission.

Spotlight: HC Plastics Recycling

Healthcare Plastics Recycling

According to the HPRC, 32 billion pounds of plastic was produced for healthcare products in 2020. This number is expected to grow to 48 billion pounds by 2025. Today, most healthcare plastics are incinerated or disposed of in landfills. However, there are many promising signs of progress in the healthcare plastics recycling landscape.

Barriers

Many healthcare products and packaging are comprised of multiple material types and multi-layer structures. These material structures are necessary to provide barrier properties for healthcare products, such as maintaining sterility or creating light, oxygen, and moisture barriers. However, these complicated material structures make it difficult for hospital staff to properly sort waste for recycling. Plastic types are difficult for healthcare professionals to identify when determining waste streams for plastics, resulting in inconsistent collection. Within a healthcare facility, there is often a lack of space for proper recycling collection infrastructure, and most hospitals were not designed to include collection bins and recycling infrastructure.

Progress

Although the work is far from over for healthcare plastics recycling, there has been extensive progress made by healthcare packaging and medical device manufacturers, group purchasing organizations (GPOs), non-governmental organizations (NGOs), healthcare facilities, and recyclers to improve recovery for healthcare plastics.

Suppliers & Manufacturers

For healthcare plastics to be collected, sorted, and recycled, they must first be designed to be recycled. Balancing the need for excellent performance with recyclability attributes can be difficult for medical device manufacturers and healthcare packaging suppliers. HPRC's Design Guide helps reduce this barrier by recommending preferred packaging attributes for optimum recyclability.[1]

The Plastic Ingenuity design team has integrated the HPRC Design Guidance into our design and development process to homogenize design attributes for healthcare packaging recyclability. Each healthcare thermoformed part designed by Plastic Ingenuity is screened for optimal plastic recycling attributes in a hospital setting while maintaining package integrity and performance.

Spotlight: HC Plastics Recycling

GPOs & NGOs

In recent years, GPOs have implemented environmentally preferred purchasing (EPP) programs to encourage healthcare providers to prioritize environmentally favorable products. For example, EPP models promote healthcare products with reduced environmental impact or enhanced recyclability. Vizient's EPP dashboard exemplifies a stellar environmentally preferred purchasing model. This free centralized platform tracks and analyzes environmentally preferable purchasing measures, helping healthcare organizations make informed decisions about products that match their facility's sustainability goals.[2] The dashboard covers a landscape of attributes ranging from hospital furniture's sustainability to a medical device's environmental impact or packaging recyclability.[2] Vizient's EPP dashboard is a comprehensive tool for healthcare organizations to monitor, analyze, benchmark, and enhance their environmentally preferable purchasing practices. As a result, the healthcare plastics industry is being propelled in a positive direction by GPOs to design recyclable packaging with a reduced environmental impact.

Influential NGOs, such as Practice Greenhealth, are accelerating progress for sustainability initiatives within the healthcare sector. Practice Greenhealth is an organization that fosters sustainable practices within the healthcare industry through guidance, certification programs, and resources. In their 2022 Sustainability Benchmark Data report, participating facilities captured data such as the types and percentages of plastics recycled in an operating room.[3] Although operating rooms account for up to 60% of hospital revenue, they also produce more than 30% of a facility's general waste and over 65% of its medically regulated waste.[4] Practice Greenhealth's focus on operating room waste diversion drives the healthcare industry towards true circularity. In addition to benchmarking data, Practice Greenhealth aims to educate and establish recycling practices for participating facilities through step-by-step resources and recycling program guidance.

Spotlight: HC Plastics Recycling

Healthcare Facilities

Successful healthcare recycling programs show that healthcare plastics recycling is not only possible, but also economical. A case study by HPRC on the Ohio State Wexner Medical Center's zero-waste program highlights the facility's ability to overcome training resource constraints, lack of accurate data collection, and space restrictions. The Ohio State Wexner Medical Center overcame these barriers by executing industry best practices, including conducting pilot programs to determine the best training and education methods, developing standard operating procedures for high-volume waste areas to accurately measure waste, and implementing designated spaces for recycling bins and waste condensing equipment to address space limitations.[5] Although there is still plenty of work to be done, the institution has made great strides. For example, in 2022 they:

Diverted 37.4% of non-hazardous waste from landfills

Collected 23,558 pounds of healthcare plastics for recycling with Freepoint Eco-Systems

Decreased costs through waste management disposal efficiencies

Recyclers

Creating infrastructure and programming around healthcare plastics recycling is a monstrous task, but the process of recycling these materials is another challenge. Most healthcare plastics cannot be recycled by traditional mechanical recycling techniques due to their low tolerance for contamination. With the recent progress of advanced recycling technologies, the healthcare plastics waste stream is likely to have a more sustainable end-of-life scenario. HPRC's Advanced Recycling Research found over 90% of healthcare plastics evaluated in their study can be processed using advanced recycling technologies. A typical mixed stream of healthcare plastics is an acceptable feedstock for advanced recycling based on the seven participating recyclers.[4] The ability of advanced recycling to manage hard-to-recycle materials provides a viable solution for the challenges associated with healthcare plastics.

Alignment across the industry to promote healthcare plastics recycling will drive a genuine opportunity for circularity. Designing packages for recovery aids healthcare facilities with collection and sortation. Pressure from GPOs and NGOs drives the industry towards sustainable progress. Advanced recycling innovations tackle hard-to-recycle plastics and create a viable feedstock for recycled content for highly regulated healthcare packaging.

Sources:
1–Healthcare Plastics Recycling Council (HPRC), Advanced Recycling Pilot Project White Paper, 2022
2–Vizient, Environmentally Preferred Purchasing Dashboard is, Naturally, a Perfect Solution for Sustainability Insights, 2022
3–Practice Greenhealth, 2022 Sustainability Benchmark Data
4–Healthcare Plastics Recycling Council (HPRC), Advanced Recycling Research
5–Healthcare Plastics Recycling Council (HPRC), Barrier Mapping Case Study: The Ohio State University Wexner Medical Center, 2023

A Resounding Success

58% less plastic used

255,735 lbs. of material saved per million parts

370.82 MT of CO_2e reduced per million parts

Case Study

Beckman Coulter's Path to Sustainability Success

The Challenge

Beckman Coulter Diagnostics supports healthcare professionals in offering improved patient care by delivering accurate diagnostic information. In 2017, they approached Plastic Ingenuity to assist with packaging that would seamlessly integrate with the launch of a highly automated diagnostic machine while minimizing material usage and capitalizing on increased recycling opportunities.

Beckman Coulter began designing a custom thermoformed package to protect their newly developed consumables, including an extremely sensitive pipette tip requiring critical protection. They enlisted Plastic Ingenuity to help convert their initial design concept into a manufacturable solution. This took five years of extensive design engineering to achieve.

The Process

We discovered through substantial testing that the pipette tips were highly susceptible to damage, and any damage caused failures with the automated equipment. Even a slightly bent tip could shut down the machines for extended durations.

This meant the lid and base tray needed to be as robust as possible yet remain a viable thermoformed PET part. The initial design featured straight sidewalls, which failed drop testing when the boxes were filled with product. Instead of simply adding material, Plastic Ingenuity focused on incorporating design features that would increase overall package strength.

The Solution

Design ideations were deployed by the Plastic Ingenuity team, including ribbing, flutes, and structure to both the base and lid to increase strength and withstand the rigorous drop tests. These improvements resulted in successful test results, and the project moved forward.

Plastic Ingenuity incorporated a cut-out feature to the package's base by adding a unique contour trim, allowing the lab techs to reach inside the package easily when loading the individual pipette trays. The final packaging achieved their primary goals of product protection, material minimization, and recycling improvements with improved tray handling—a win for both Plastic Ingenuity and Beckman Coulter.

The Impact

58%
less plastic used

255,735
pounds of material saved per million parts

370.82
MT of CO_2e reduced per million parts

GOOD INFORMATION

Good Information Presents

Courses

What you'll learn

Welcome to Good Information Courses by Plastic Ingenuity. These courses are designed to give a deeper understanding of thermoformed packaging.

Who is this course for?

Throughout this course, you will become familiar with the principles of thermoformed packaging. If you're a packaging engineer, procurement officer, buyer, sustainability manager or packaging development research, this detailed course will help you become familiar with thermoforming and how you can impact your sustainability efforts.

Course 1: Thermoform Circularity

The course will include an overview of the thermoforming process, types of polymers used in thermoformed products, mechanical recycling, advanced recycling, and finally, progress being made toward thermoform circularity.

Course Instructors

Zach Muscato
Corporate Sustainability Manager
Plastic Ingenuity

Sarah Webber
Sustainable Packaging Engineer
Plastic Ingenuity

Visit
www.PlasticIngenuity.com
to learn more.

2025 Brand Owner Goal Analysis

As 2025 nears, the consumer-packaged goods (CPG) industry is at a crucial moment in its commitment to sustainable packaging. This important shift results from strategic planning efforts undertaken by large CPGs, setting the stage for the ambitious goals outlined by the Ellen MacArthur Foundation's Global Commitment[1] launch in 2018. By 2025, these signatories to the commitment are expected to transform their packaging, making it recyclable, reusable, or compostable while integrating higher amounts of recycled content. Here are the goals outlined by the foundation[2], highlighting the current status and future outlook, along with Plastic Ingenuity's perspective as a custom thermoformer helping brands meet these commitments.

GOAL 1
Eliminate Problematic or Unnecessary Plastic Packaging

Current Progress

Examples of problematic and unnecessary packaging include PVC, Polystyrene, and carbon black pigments. Progress has been made in reducing the use of these packaging types, especially with the elimination of expanded PS and PVC. However, 80% of signatories still utilize one of the eight identified primary problematic packaging types. While material substitution and lightweighting remain the predominant solutions for this goal, there is a notable shift towards direct elimination.

2025 Outlook

The reduction of problematic packaging types is evident, with a significant 36% drop in expanded PS packaging. Top-performing signatories have eliminated 92% and 100% of PVC and EPS packaging, respectively, in contrast to the global increase of over 3%.

Our Perspective

The shift from thermoformed PVC to alternatives has been a primary focus for brands over the last decade. Many of these applications have shifted to alternative materials, like PET. There is a renewed focus on eliminating Polystyrene, especially oriented Polystyrene (OPS) used for insert trays. Brands are exploring and implementing alternatives like PET for these trays with recycled content. There has been traction in eliminating carbon black and other colors not detectable by near-infrared (NIR) sorting equipment. Although challenging, colorant and additive suppliers are developing solutions to create the desired color without compromising NIR sortation performance. Costs are a common trade-off for all these transitions.

SWITCHING FROM OPS TO PET?

We can help.

The deadline for 2025 packaging sustainability targets is quickly approaching, and many large retailers aim to implement 100% recyclable packaging for all brands. Oriented Polystyrene (OPS) has been recognized as a problematic and unnecessary material by the U.S. Plastics Pact, and major retailers such as Walmart and Target are urging brands to transition away from OPS-based packaging.

OPS is categorized as a resin ID code #6, which is not commonly accepted by municipal recycling programs. OPS can be detrimental to recycling streams of common plastics, such as PET, and therefore result in losses due to contamination.

Plastic Ingenuity has tremendous experience developing OPS to PET transitions for customers. Our production and design engineers utilize a strategic framework to analyze the modifications needed for this type of material change, providing a seamless process to transition to an optimized and fully recyclable product.

PLASTIC INGENUITY

2025 Brand Owner Goal Analysis

GOAL 2
Move from Single-Use Towards Reuse Models

Current Progress

Despite increased investments in reuse pilots, the average share of reusable plastic packaging has remained at 1.2%. Approximately 53% of participants report having no reusable plastic packaging.

2025 Outlook

While efforts and attention towards reuse have surged since 2018, achieving progress at scale remains a challenge. Insights from pilot studies offer a clearer understanding of barriers and potential solutions, laying the groundwork for future advancements.

Our Perspective

Organizations are intrigued by the potential of reusable packaging models to reduce waste but recognize the challenges ahead, especially with consumer adoption. Stakeholders are exploring multiple packaging substrates for reusable models. The durability of plastic is sufficient given the return rates expected for these models. It is important to understand the expected return rate and not over-engineer the package—which could counterproductively increase material usage. For example, if a return rate of 80% is expected, the package will only get used an average of four times before escaping the system and should be designed as such.

GOAL 3
Decrease the Use of Virgin Plastics

Current Progress

Participants have maintained a relatively flat use of virgin plastic since 2018, contrasting with the market's 11% increase. This amounts to 65% of brands and retailers reducing virgin plastic use, with a few larger organizations hindering some progress.

2025 Outlook

Despite 27% of members being on track to meet or exceed their 2025 reduction targets, the collective trajectory falls short of the stated 21% aggregated virgin plastic reduction target. The challenge remains in ensuring a substantial reduction in virgin plastic use.

Our Perspective

There are multiple levers brands can pull to accomplish this goal with their thermoformed packaging. The most common methods include lightweighting, incorporating recycled content, and substituting alternative substrates. Lightweighting is typically the preferred method given the cost advantages associated with reducing weight. However, many brands have been lightweighting their packaging portfolio for decades, making further reductions difficult without compromising performance. Brands are exploring bio-based plastics to reduce their plastic usage derived from fossil fuels.

IS BLACK PACKAGING HINDERING YOUR RECYCLING EFFORTS?

We can help.

Black-colored packaging is very common among brands, especially within the food industry. A prevalent ingredient in black colorants is carbon black, a pigment that creates a black appearance by reflecting very little light into the visual spectrum.

Carbon black absorbs most light sources, including near-infrared (NIR) lights used in the sorting process of recycling. This prevents NIR technology from categorizing components made with carbon black into the proper material stream, so they are rejected from the recycling system and likely landfilled.

Non-detectable pigments, such as carbon black, are categorized as problematic and unnecessary materials by the U.S. Plastics Pact as they pose a problem for recycling. Our team conducted research on NIR-sortable black colorants that are compatible with polypropylene packaging, including conducting an Association of Plastic Recycler's NIR sortation screening test to prove compatibility with recycling infrastructure.

PLASTIC INGENUITY

2025 Brand Owner Goal Analysis

GOAL 4
Increase the Share of Post-Consumer Recycled Content (PCR)

Current Progress

Continuing a steady increase, participants have doubled their use of PCR content to 11.7% in 2022, more than tripling since 2018.

2025 Outlook

On this course, contributors are set to achieve approximately 17% recycled content by 2025, not reaching the collective target of 26%. The top quartile's tripling of PCR share showcases significant progress.

Our Perspective

Thermoforms are often a desirable outlet for brands to increase the amount of PCR used in their portfolio. Significant progress has been made in the uptake of PCR in food packaging, like clamshells and trays. Outside of PET and HDPE packaging, innovation is needed to create a supply of recycled materials for food applications, such as recycled PP. We expect the uptake of PCR in packaging to continue in full force. Limiting factors include PCR market volatility, stagnant consumer waste collection, and the absence of strong PCR supply options for materials like PP.

GOAL 5
Ensure 100% of Plastic Packaging is Reusable, Recyclable, or Compostable

Current Progress

Members marginally decreased the share of reusable, recyclable, and compostable plastic packaging from 65.4% in 2021 to 64.5% in 2022, primarily driven by a minority of organizations.

2025 Outlook

Meeting the 2025 target of 100% reusable, recyclable, or compostable packaging is not feasible. Flexible packaging and infrastructure gaps remain the primary barriers. Scaling recycling infrastructure for high-potential categories could contribute to a 7% increase.

Our Perspective

Brands are making progress on this goal by leveraging resources such as the Association of Plastic Recyclers (APR) Design Guide to design their packaging for recycling. These principles need to be integrated into the packaging design and development process to truly be effective. Compostable solutions are of interest for formats with inherent challenges to recycle, such as heavily soiled articles. Reusable packaging is intriguing to brands but this transition represents the largest amount of effort and consumer adoption.

Sources:
1–Ellen MacArthur Foundation, The Global Commitment Five Years In: Learnings to Accelerate Towards a Future Without Plastic Waste or Pollution, 2023,

2–Ellen MacArthur Foundation, The Global Commitment 2023

LOOKING FOR A SUSTAINABLE RTU TUB?

We can help.

In response to growing market demand from drug manufacturers, our team validated thermoformed Ready-to-use (RTU) pharma tubs with all the benefits of a traditional injection-molded tub. Not only does a thermoformed RTU tub have a lower cost of entry than an injection-molded solution, but it also uses 40% less plastic, saving 78,000 kilograms of material per 1 million tubs, equating to 245 metric tons of carbon dioxide equivalent.

PLASTIC INGENUITY

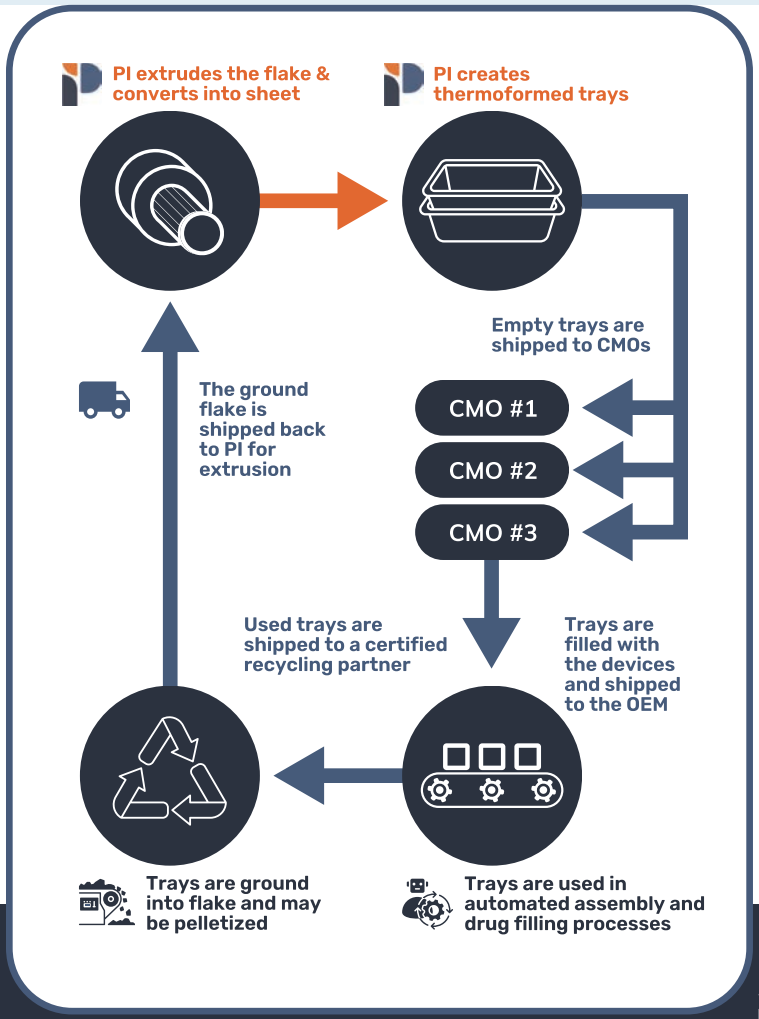
Take-Back Programs

In recent years, the growth in packaging take-back programs in business-to-business settings has increased significantly. Take-back programs provide one potential lever for organizations to pull to make progress toward their circularity goals. However, implementing a take-back program in practice involves navigating potential obstacles and trade-offs.

What is a Take-Back Program?

Take-back programs are an example of closed-loop recycling. Products are captured at the end of their useful life for recycling. The material derived from the recovered products is then used in the manufacturing of that same product in subsequent production batches. The material continues to circulate through multiple production cycles, reducing the need for virgin plastic. Alternatively, open-loop recycling involves utilizing the recovered material for applications other than the article recovered.

The key steps of a take-back program are shown in the schematic below, using a hypothetical pharmaceutical drug-filling application as an example:



In this example, thermoformed trays are used to protect and convey drug delivery devices through several stages of assembly and filling. These trays are known as automation or work-in-process (WIP) trays. First, the trays are produced in a thermoforming process at PI. They are then shipped to a contract manufacturing organization (CMO). The CMO uses the trays in their automated assembly process for the drug delivery device. There are often several CMOs involved in the value chain, as shown in the diagram. The trays are packed with assembled devices at the CMO and then shipped to the pharmaceutical manufacturer.

The pharmaceutical manufacturer removes the drug delivery devices from the trays. The devices are then filled with the drug product. The empty trays are collected at the pharmaceutical manufacturer and kept segregated from other waste. A certified recycler picks up the trays for recycling. Next, the trays are ground up into plastic flake and sent back to PI for extrusion into rollstock. The loop is closed when the rollstock is used to make new trays from the recycled material.

Take-Back Programs

Take-Back Program Benefits

Take-back programs offer several potential advantages:

Virgin Plastic Reduction:
The use of recycled materials reduces the need for virgin plastic.

Carbon Footprint Reduction:
Embodied carbon from the raw material is typically the largest contributor to a package's carbon footprint. Recycled materials have significantly lower embodied carbon than virgin materials derived from fossil fuels.

Circularity:
Recovering material at the end-of-life and reusing it to make a new article is true circularity in practice.

Cost Reduction:
These programs can reduce costs given the reduction of virgin material purchases.

Reduce Waste to Landfill:
Programs can enable the recycling of materials and formats that are not currently recycled in mass on the open market.

Take-Back Program Key Considerations

Key Considerations

There are several key aspects to consider when determining if a take-back program is advantageous for an application:

Centralized End Use

Centralized end use is a critical factor for efficient collection and transport. Articles are ideally utilized in a minimal number of facilities or are concentrated in regional hubs. This enables the efficient aggregation, collection, and transport of materials from stage to stage. Since transport is intensely dependent on fossil fuel consumption, any carbon footprint benefits of using recycled materials can be negated if transport in collection becomes excessive. A life cycle assessment is a critical tool in the take-back program planning phase to ensure positive environmental outcomes are achieved.

Contamination Control

Exposure to contaminates during the manufacturing process or product use can render a take-back program unfeasible. Articles are often used alongside substrates that may be incongruent with recycling for that article. Recyclers may have the ability to sort out contaminates, like other types of plastics, or to remove chemical or organic contaminates using a hot-caustic wash. However, the additional steps add costs and consumer resources. Understanding the expected contamination up front is critical to determining the level of processing required at the recycler.

Collection System Infrastructure

Collection systems at the point of end use must be considered to maximize collection efficiency. End users often lack the space and infrastructure needed to efficiently collect, aggregate, and store used articles. In an ideal scenario, end users can compress the used articles to decrease the amount of storage space required. This also enables transportation efficiency which has carbon footprint and cost implications.

Incentives

Given the amount of effort required to implement a take-back program, incentives must be sufficient for stakeholders to secure their commitment. Incentives could come in the form of cost reductions, carbon footprint reductions, increased circularity, and waste reduction. Key stakeholders often involve an end user's facility-level environmental team, procurement, package engineering, sustainability, and quality assurance teams.

Collection Process Control

End users typically have multiple waste streams from operations. It is challenging to efficiently collect a targeted article from comingled waste. Efficiently collecting articles and mitigating the risk of contamination requires thorough evaluation and implementation of process controls. Standard operating procedures and work instructions need to be developed and integrated into the end user's operation. Training and communication are critical components of implementing any new processes.

Waste Contractual Obligations

End users typically have a waste management partner to collect, haul, and manage their waste streams. Implementing a take-back program can cause disruptions to existing agreements. Take-back programs can remove materials of value from the waste management partner's stream. This can be a significant barrier to transitioning an article from mixed waste to a take-back program.

Take-Back Programs

Determining Feasibility

The ideal take-back program has the following characteristics:

End use is centralized or occurs in regional hubs to minimize transportation

There are sufficient incentives in place to motivate stakeholders to implement the program

End users can efficiently collect, aggregate, and store the articles

Recyclers with the capability to support the program are local to the end user

The articles are not exposed to potential contaminants, such as mixed plastic types, chemicals, or organic residue from product use

Existing contractual obligations regarding waste management do not hinder the ability to remove valuable materials from the waste stream

Take-Back Program Implementation Steps

Steps to Implementing a Take-Back Program

The following steps should be followed to design and implement a successful take-back program:

PLAN

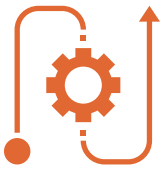
Collaborate with all stakeholders in the value chain to create a detailed map of each key process step. Perform a failure mode element analysis (FMEA) to identify potential risks. Include key considerations such as collection and storage systems, contamination exposure, existing contractual obligations, recycler selection, transportation, and capital equipment needs.

MEASURE

Quantify the impact of the planned take-program. Conduct a life cycle assessment to determine environmental impact benefits, such as greenhouse gas and virgin plastic reductions. Determine the impact on cost from a holistic perspective. Include any additional costs associated with collecting, transporting, recycling, and depreciation of new capital equipment.

COMMIT

Get buy-in from all key stakeholders needed to successfully implement the program. Identify and communicate incentives aligned with the stakeholder's objectives to gain their commitment. If competing incentives are identified, pull together the relevant stakeholders to determine a path forward.



PILOT

Conduct a pilot to confirm assumptions and understand potential obstacles for scale-up. Ensure key performance and quality metric expectations can be met sustainably. Collaborate with key stakeholders in every stage of the process to determine improvement opportunities.

IMPLEMENT

Invest in capital equipment, if necessary. Update standard operating procedures for the end user, product specifications, and material formulations. Communicate process changes with the affected associations and conduct training to ensure proficiency in the new process.

MONITOR

Diligently monitor key performance indicators and seek areas for continuous improvement. Ensure the anticipated benefits are being realized in practice.

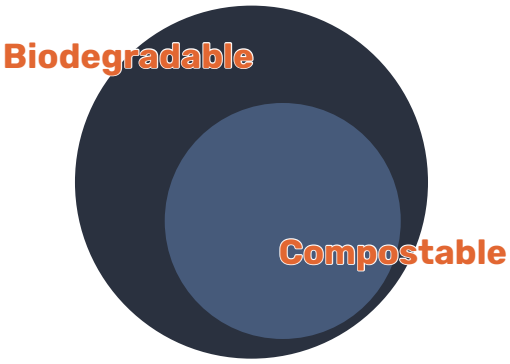
Implementing a take-back program can be challenging. Choosing partners with the expertise necessary to execute the program is crucial to achieving sustainable success.

Q&A: Bio-Based Plastics

Q **Are bio-based plastics biodegradable?**

A Some are, but not necessarily! Conventional polymers, like PET, PP, and HDPE, can be made from bio-based sources. These polymers are identical to their fossil-fuel-derived counterparts. They will not biodegrade easily but can be recycled if the article is designed for recycling and the recycling infrastructure for the article is accessible in the region of use.

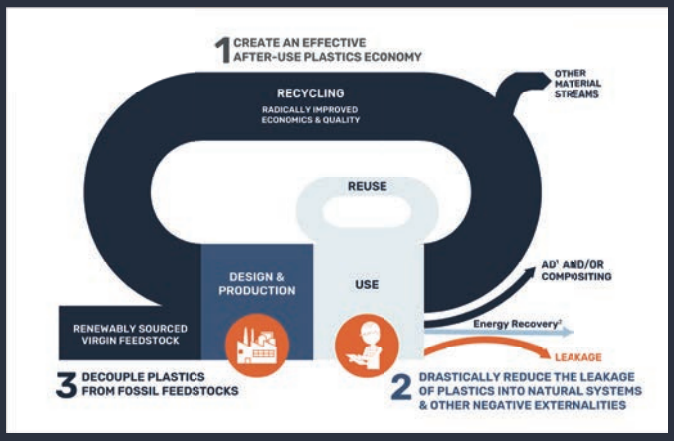
Biodegradation is a general term used to describe how an article is broken down by microorganisms within a given timeframe. Compostable plastics are a subset of biodegradable plastics. All compostable items are biodegradable, but not all biodegradable products are compostable, as illustrated in the diagram below. Composting requires specific conditions to break down materials, while biodegradable materials will break down naturally, but tend to take longer than composting[1].



Polylactic Acid (PLA) is the most well-known and commonly used bio-based plastic in the market today. PLA is compostable in specific industrial composting conditions and is commonly used in plastic foodservice packaging like drink cups and lids, and cutlery. Additional bio-based polymers entering the market for enhanced compostability and performance include Polyhydroxyalkanoates (PHA) and Polyethylene Furanoate (PEF).

Q **Are bio-based plastics circular?**

A Creating plastic from renewable sources is a critical facet of attaining circularity, as illustrated in Step 3 of the chart below, courtesy of the Ellen MacArthur Foundation[2]. Creating plastic from renewable sources reduces society's dependence on fossil feedstocks, which can lead to long-term benefits. It should be noted that bio-based materials tend to have higher water usage across their lifecycle given the water required to grow the crops. The overall impact on greenhouse gas generation compared to fossil fuel sources is under debate since growing and harvesting bio-based feedstocks requires agriculture equipment currently dependent on fossil fuel sources. However, these crops do absorb carbon dioxide from the atmosphere as they grow. Another consideration is land use, both in terms of its potential impact on the food supply chain and biodiversity. Sustainable agriculture practices will be critical to minimize these negative impacts as bio-based plastic production scales.



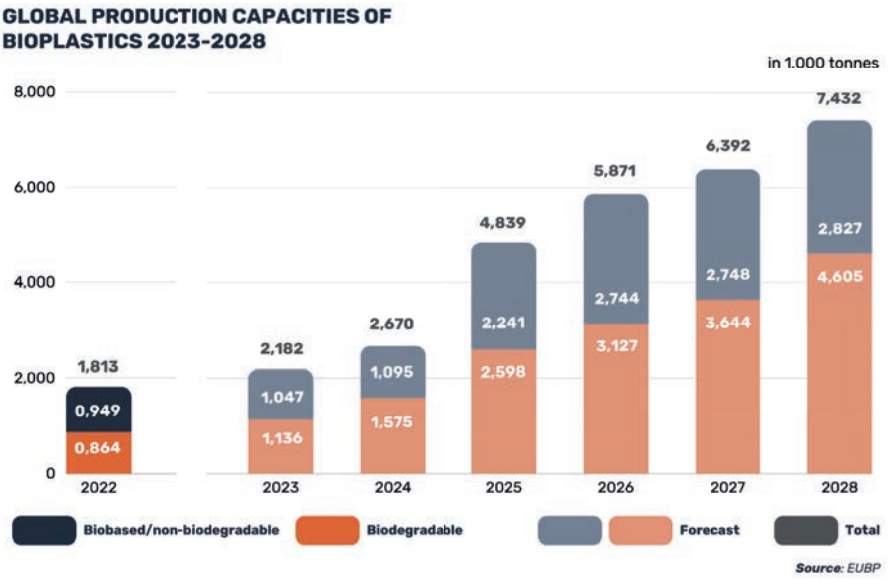
Q&A: Bio-Based Plastics

End-of-life management is the other critical attribute of circularity. Ideally, materials are diverted from landfills so they can recirculate in our economy. Composting diverts materials from landfills but does not keep them available for recirculation. The energy and resources used to make compostable materials are depleted at the end of life. Compostable materials have the potential to contaminate established recycled material streams, like PET, if the consumer places compostable items in a recycling bin. Additionally, consumer access to industrial composting sites that accept packaging items is currently limited but growing.

Bio-based plastics that are recyclable at the end of life, like bio-based PET, do provide a clear pathway to circularity. However, improvements to recycling are necessary to make this vision a reality. Compostable materials can also contribute to a more circular system, especially for packaging items that are heavily contaminated by the product and thus not suitable for recycling.

Q **Should I consider switching to bio-based plastics?**

A Organizations are grappling with the question of whether or not they should switch to bio-based plastic for their packaging portfolio. The global production capacity of bioplastics is projected to grow significantly over the coming years in anticipation of increased market demand, as evidenced in this chart courtesy of European Bioplastics (EUBC)[3]:



The transition to bioplastics may require organizations to accept certain trade-offs, such as increased embodied water consumption. When considering bioplastics for their packaging portfolios, stakeholders should consider how the benefits and trade-offs of bioplastics align with their organization's sustainability goals and the needs of their consumers. For example, if a brand has a goal for recyclable packaging and decreased fossil fuel utilization, bio-based PET may be a viable material solution to consider. Stakeholders should strive to consider the full impact of a transition to bioplastics by conducting a holistic lifecycle assessment. Collaborating with supply chain partners who understand the nuances of bioplastics and can help navigate the landscape is critical for successful implementation.

Sources:

1–Sustainable Packaging Coalition, Understanding the Role of Compostable Packaging

2–Ellen Macarthur Foundation, The New Plastics Economy: Rethinking the future of plastics

3–European Bioplastics, Bioplastics Market Development Update 2023

Myth-Busting Facts

MYTH: PLASTIC PACKAGING IS THE MOST SIGNIFICANT COMPONENT OF MUNICIPAL SOLID WASTE (MSW) BY WEIGHT.

Fact: According to EPA data, plastic containers and packaging accounted for about 5% of the MSW generated in the United States. Discarded food was the most significant component at 21.6%.

Source: United States Environmental Protection Agency (EPA), Guide to the Facts and Figures Report about Materials, Waste and Recycling

MYTH: PEOPLE DO NOT RECYCLE PLASTIC PACKAGING.

Fact: Recycling rates are fairly high when households have access to curbside recycling programs with carts. Recovery rates for common plastic packaging formats include 48% of PET bottles, 39% of non-bottle PET, 60% of natural HDPE bottles, 51% of colored HDPE bottles, and 27% of PP packaging. This highlights the importance of recycling access and designing packaging to be recycled in practice.

Source: The Recycling Partnership, By The Numbers Webinar: Unpacking the Data Behind Plastics Recycling

MYTH: PLASTICS ARE A MAJOR CONTRIBUTOR TO CLIMATE CHANGE.

Fact: Plastics have been found to have a lower carbon footprint than alternatives like glass and aluminum. Plastics account for about 1.5% of global warming potential. The embodied carbon of a product, like food, often vastly exceeds the carbon footprint of the plastic package.

Source: Project Drawdown

MYTH: PEOPLE INGEST A CREDIT CARD'S WORTH OF PLASTIC EVERY WEEK.

Fact: This conclusion was based on a study commissioned by the World Wildlife Federation. A more recent independent study found that microplastic consumption is negligible. It would take approximately 20,000 years to ingest a credit card's worth of plastic.

Source: Lifetime Accumulation of Microplastics

MYTH: I WON'T RECYCLE BECAUSE IT JUST GETS PUT IN THE TRASH.

Fact: The growth of split-body trucks has led to the proliferation of this myth. Split-body trucks can collect recyclables and trash on the same route, creating the illusion of mixing recyclables with trash.

Source: The Recycling Partnership, Incorporating Motivational Messaging for Recycling Education and Outreach Webinar Recording

MYTH: RECYCLING HAS BEEN STAGNANT FOR THE LAST 10 YEARS.

Fact: Domestic recycling of post-consumer waste has increased from roughly 3 billion pounds in 2012 to 4.7 billion pounds in 2021. That's a 54% increase in recycling volume.

Source: The Association of Plastic Recyclers (APR), 2021 U.S. Post-Consumer Plastic Recycling Data Dashboard (https://circularityinaction.com/2021PlasticRecyclingData)

2024

Calendar of Events

We are pleased to announce our attendance at these upcoming events.
We hope to see you there and look forward to connecting.

FEBRUARY 6-8	**MD&M WEST** Anaheim, California
MARCH 6-8	**Smither's Sustainability in Packaging** Chicago, Illinois
MARCH 25-27	**Plastic Recycling Conference** Grapevine, Texas
APRIL 2-4	**SPC Impact** New Orleans, Louisiana
MAY 6-10	**RE|Focus at NPE 2024** Orlando, Florida
MAY 14-16	**the[PACK]out** Coronado, California
SEPTEMBER 16-18	**PMMI Packaging Recycling Summit** Anaheim, California
SEPTEMBER 30- OCTOBER 2	**SPC Advance** Chicago, Illinois
NOVEMBER 3-6	**Pack Expo** Chicago, Illinois

Letter from Sakif Ferdous — Chief Revenue Officer

Thank you for taking the time to read our third annual thermoform circularity report. When we started our sustainability stakeholder study over three years ago, our goals were relatively straightforward. We sought to understand what really mattered to packaging decision-makers and brand managers as they grappled with the evolving sustainability landscape, along with the drivers of change and the roadblocks they faced. Your engagement in this process has been instrumental in shaping our path toward a more sustainable future.

In this pursuit, collaboration, transparency, and a commitment to continuous improvement have been the cornerstones of our approach. By aligning our goals with the insights gained from stakeholders, we aimed not only to make informed decisions within PI but also to contribute to the broader industry's solutions to the plastic waste challenge. By sharing our learnings, we hope others will join us in our effort to create a circular economy.

The PI sustainability team achieved some significant milestones in the past year. We successfully completed our Scope 1, 2, and 3 GHG inventories, established a robust product Life Cycle Assessment practice, and significantly increased the incorporation of Post-Consumer Recycled resin into our products. Our dedication to sustainability has led to new certifications, such as ISO 14001 for Environmental Management Systems and ISCC+ for incorporating advanced recycled feedstocks. Additionally, PI received an EcoVadis medal, solidifying our position as the preferred thermoforming supplier for brands committed to sustainable and ethical business practices. These achievements directly respond to the top requests from our customers in 2022, emphasizing the importance of measuring and reducing GHG emissions and facilitating the incorporation of more PCR content into our offerings.

As we embark on 2024, we will remain focused on these same core goals but are now strengthened by our recent learnings and new capabilities. There is a lot of momentum in the sustainable packaging world, with fresh innovations, some much-needed funding, and new opportunities for collaboration paving the way. PI remains steadfast in our core principle—assisting our customers in making informed decisions tailored to their unique packaging needs. In a year marked by new legislation, impending deadlines, and heightened scrutiny from consumers and retailers, making the right decisions has become paramount. The PI team has already started preparing for these challenges by qualifying new sources of PCR PET, PP, and other resins, advising our customers on the potential impact of California's SB 54 and the European Packaging Waste Reduction directives, and working on novel design and material innovations in anticipation of our customers' future needs.

I hope you enjoyed reading this report as much as our team enjoyed putting it together. As always, feel free to reach out if you have any questions or want to collaborate on creating a truly circular economy. I look forward to celebrating our collective progress with you again next year.

Thank you,

Sakif Ferdous

GLOSSARY OF TERMS

Association of Plastics Recyclers (APR) = International trade association representing the plastics recycling industry.

Advanced Recycling = A suite of novel recycling techniques that turns plastic polymers back into their original molecules so they can be used again in new products. These processes make it possible to recycle formats that are difficult to recycle mechanically.

Carbon Footprint = Total amount of greenhouse gases (including carbon dioxide and methane) that are generated by a product, process, or service. These greenhouse gases are the main contributors to climate change.

Circular Economy = A model of production and consumption that reuses, refurbishes, and recycles existing materials and products as long as possible.

Circular Economy for Flexible (CEFLEX) Packaging Initiative = Collaboration of over 180 European companies, associations, and organizations representing the value chain of flexible packaging, working to make all flexible packaging in Europe circular by 2025.

Circularity = Measure of a product or service's alignment with the objectives of a circular economy.

Environmental Social Governance (ESG) = Stakeholder-centric approach for doing business in an ethical manner, focused on the impact of a company in the areas of Environmental, Social, and Governance.

Environmentally Preferred Purchasing (EPP) = Practice of purchasing products or services that have a less negative effect on human health and the environment.

Group Purchasing Organization (GPO) = Leverages the collective buying power of its members to secure discounted prices from suppliers and retailers.

Healthcare Plastics Recycling Council (HPRC) = Consortium of industry peers across the manufacturing, healthcare, and recycling industries seeking to improve the recyclability of plastic products and packaging within healthcare.

Life Cycle Assessment (LCA) = Methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service.

GLOSSARY OF TERMS

Material Recovery Facility (MRF) = Receives single stream post-consumer waste for communities, typically made of paper, glass, plastic, aluminum, and steel. Sorts those articles into bales for sale to material reclaimers for processing into usable material.

Mechanical Recycling = Process to recover plastics waste via mechanical actions involving grinding, washing, separating, drying, re-granulating, and compounding. The polymers stay intact.

Non-Governmental Organization (NGO) = Nonprofit organization that operates independently of any government, whose purpose is to address a social or political issue.

Post-Consumer Recycled (PCR) Content = Materials made from items that have served their intended purpose in the market.

Post-Industrial Recycled (PIR) Content = material waste generated during mass production that is later used to manufacture new products.

Reclaimer = A company that purchases sorted and baled post-consumer articles from MRFs and processes back into usable material for sale into recycled material end markets.

Recyclable = Per Federal Trade Commission Green Guides, the following criteria must be met to claim a product is recyclable:

Collection = 60% of Americans must have access to collection systems for the item.

Sorting = It must be able to be sorted with like items and materials.

Reprocessing = It can be turned into a reusable material in an economical manner.

End Markets = Robust end markets for the recycled material must be available.

RecyClass = Cross-industry initiative that advances plastic packaging recyclability while promoting the traceability of plastic waste and recycled plastic content in Europe.

Recycled Content = Material derived from recycling a product.

Recycling = The process of converting waste into usable material.

GLOSSARY OF TERMS

Resin ID Code (RIC) = Numbering system managed by American Society for Testing and Materials, known as ASTM International (ASTM), for the identification of plastics for sortation purposes. The RIC is not intended for consumer instruction on the ability to recycle a product.

Sustainable Packaging Coalition (SPC) = Member-based organization whose mission is to bring sustainable packaging stakeholders together to catalyze actionable improvements to packaging systems and lend an authoritative voice on issues related to packaging sustainability

Sustainability = Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

PLASTIC INGENUITY

Thermoform Circularity Report 2024

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