CPCIF | IPE

2024

Building a Circular Ecosystem

Exploring China's Solutions for Post-Consumer Plastic Pollution Control

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Building a Circular Ecosystem : Exploring China's Solutions for Post-Consumer Plastic Pollution Management

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Foreword 1

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In the context of global environmental governance, plastic pollution has emerged as a critical issue that nations around the world must urgently address. As the largest producer and consumer of plastics globally, China faces unprecedented challenges in balancing economic development with environmental protection. Effective control of plastic pollution has become a crucial matter that directly impacts ecological conservation and sustainable development. The China Petroleum and Chemical Industry Federation (CPCIF) has consistently committed itself to exploring and promoting sustainable development strategies within China's petroleum and chemical industries, striving to find the optimal balance between environmental protection and industrial growth.

In collaboration with the Institute of Public & Environmental Affairs (IPE), we have jointly compiled and released the bilingual report, *Building a Circular Ecosystem: Exploring China's Solutions for Post-Consumer Plastic Pollution Control.* This report encapsulates the collective wisdom of the industry, focusing on the recycling of post-consumer plastics, and aims to provide practical recommendations and solutions for plastic pollution control in both China and the global context.

Embracing Green Transition and Adapting to the Times

Since its inception, plastic's superior properties and widespread applications have profoundly transformed human production and lifestyles. However, the surge in plastic usage has led to significant environmental problems, making plastic pollution a major challenge that affects both ecological balance and public health. In light of these challenges, the effective combating of plastic pollution, particularly with regard to the recycling and disposal of post-consumer plastics, has become an urgent priority.

Building a Circular Ecosystem: Exploring China's Solutions for Post-Consumer Plastic Pollution Control was conceived in response to this urgent need. Through in-depth research and analysis, benchmarking against globally representative regions, the report systematically reviews the current state and challenges of plastic pollution control in China and proposes innovative solutions, reflecting the industry's foresight and sense of responsibility.

Systematic, Objective, and Forward-Looking Solutions

At the core of this report is the creation of a circular ecosystem that delivers both environmental and economic benefits. By thoroughly analyzing the current pain points in post-consumer plastic management, the report offers targeted solutions. During the writing process, we placed particular emphasis on ensuring that the proposed solutions are systematic, objective, and forward-looking, aiming to provide strategies that are well-suited to China's national conditions while also offering an international perspective. The report explores full-chain solutions, from source management to end-cycle recycling.

Multi-Party Collaboration for Sustainable Development

The report underscores the importance of multi-party collaboration in tackling plastic pollution. Plastic pollution is not just a problem for one industry or country. it requires the concerted efforts of governments, businesses, the public, and research institutions. The CPCIF has always valued close cooperation with all stakeholders, and this collaboration not only provides robust technical support for plastic pollution control but also injects new vitality into the industry's green transformation.

Furthermore, we have drawn on international best practices and tailored them to China's unique circumstances, delving deeply into and proposing locally applicable pathways for plastic pollution governance. This offers constructive suggestions and insights for relevant policy formulation.

Co-Creating a Green Future

Looking ahead, we aspire to build a more robust green ecosystem. In this ecosystem, the government and industry associations will continue to play guiding and regulatory roles, companies will strengthen their innovation and investment efforts, research institutions will provide cutting-edge technical support, and the public will become more actively engaged in environmental initiatives. Through the collective efforts of all parties, we are confident in achieving effective plastic pollution control and contributing to global sustainable development.

"As ecological prosperity leads to civilization's prosperity, so ecological decline leads to civilization's decline." The 20th National Congress of the Communist Party of China and the Third Plenary Session have focused on building a "Beautiful China", making significant plans for the reform of the ecological civilization system in the new era and journey. These efforts provide powerful momentum and institutional support for constructing a Chinese path to modernization characterized by harmonious coexistence between humanity and nature. The *Opinions on Accelerating the Comprehensive Green Transformation of Economic and Social Development* issued by the Central Committee of the Communist Party of China and the State Council in August 2024 clearly pointed out the need to vigorously develop a circular economy—"to deeply promote circular economy actions that contribute to carbon reduction, to promote resource-circulating production models, to vigorously develop the resource recycling industry, to promote the high-quality development of the remanufacturing industry, to improve the quality of recycled materials and products, and to expand the scale of substitution for virgin resources. To advance household waste sorting and enhance resource utilization rates. To improve the waste recycling system, strengthen waste classification, disposal, and recycling capabilities, and elevate the scale, standardization, and precision of recycling system. By 2030, the annual utilization of bulk solid waste will reach approximately 4.5 billion tons, and the main resource output rate will increase by about 45% compared to 2020." The policy and social environment for building a circular ecosystem is already in place, and we must forge ahead with determination.

In conclusion, I would like to summarize our vision in one sentence: on the road to building a circular ecosystem, we are not only explorers but also practitioners; in the process of driving green development, we are not just witnesses but creators. "The Long March has only just begun, and now is the time to press forward." In the journey to combat plastic pollution, may we move forward together, steadfast and determined, braving the waves to achieve the grand goals of building a "Beautiful China" and global ecological civilization, contributing Chinese wisdom and solutions to global environmental governance.

Foreword 2

Exploring Innovative Chinese Solutions to Address Plastic Pollution

Institute of Public & Environmental Affairs **Ma Jun**

Since its invention in the early 20th century, plastic has gained global popularity due to its low cost and advantageous properties. However, the risks that plastic waste poses to the environment and human health have also escalated significantly. In recent years, the shocking images of marine plastic waste and the potential threats of microplastics have sparked widespread global concern, leading to calls for "plastic reduction" and "plastic bans". In 2017, the United Nations Environment Assembly (UNEA) adopted a resolution to combat marine plastic pollution and microplastics, marking the formal launch of global initiatives to address plastic pollution.

Solutions to end plastic waste must follow general principles, specifically the 3R principles of reduction, reuse, and recycling. A lifecycle analysis of plastics, from raw material extraction, production, and use to disposal, reveals that alternative materials could also have considerable environmental impacts. Additionally, many regions face challenges in sourcing raw materials and managing costs. Therefore, while promoting source reduction and alternatives, it is essential to also focus on plastic recycling and reuse. The European Union has taken the lead by introducing regulations such as *A European Strategy for Plastics in a Circular Economy* and *the Packaging and Packaging Waste Directive*, aiming to make all plastic packaging recyclable or reusable by 2030.

As major producers, users, and sources of plastic waste, companies have increasingly become the focal point of plastic reduction efforts. In October 2018, the New Plastics Economy Global Commitment was launched by the Ellen MacArthur Foundation in collaboration with the United Nations Environment Programme, attracting participation from numerous global companies. Several world-renowned brands made commitments to plastic reduction and recycling. However, our research has shown that many companies face significant challenges due to inadequate recycling infrastructure. Some companies have attempted to establish their recycling systems, but these pilot programs often struggle with high costs and limited regional coverage, failing to create a closed-loop system.

China's initiatives in plastic pollution control and recycling deserve attention as a potential solution to this dilemma. China's plastic waste recycling rate is among the highest in the world, reaching 30% in 2022, and the country has established a vast recycling processing capacity. To achieve the dual carbon goals, the *Action Plan for Carbon Dioxide Peaking Before 2030*, issued by the State Council, calls for comprehensive plastic pollution control throughout the entire chain and the establishment of a resource recycling system. It also sets targets for the recycling of nine major types of recyclable resources, including plastic waste, by 2025 and 2030. By 2025, the urban household waste sorting system should be substantially established, and by 2030, waste sorting should cover all urban areas, with the resource utilization rate increasing to 65%.

To scientifically assess the current state of household waste sortingacross cities, identify key issues, discover best practices, and assist municipal management departments in improving waste sorting management mechanisms, the Institute of Public & Environmental Affairs (IPE) and the Vanke Foundation, under the guidance of the Chinese Forum of Environmental Journalists, jointly launched the "Take a Snapshot for Household Waste Sorting" initiative in 2020. With the support of over 60 organizations, including Green Jiangnan, A'niu Public Welfare, Zero Waste Alliance, and numerous netizens, the number of questionnaires with snapshots submitted by participants has reached 180,000, covering over 100,000 communities across 328 cities.

Evaluation results show that leading cities maintain high levels of waste sorting performance, with Suzhou and Shanghai scoring the highest, based on the stable operation of standardized systems as required by the *14th Five-Year Plan for Urban Household Waste Sorting and Treatment Facilities Development*. Cities such as Beijing have also achieved waste sorting goals by relying on secondary sorting after establishing classification collection and disposal systems. However, our research has revealed that with the rapid expansion of new business models such as food delivery and e-commerce, the proportion of low-value plastics in household waste is gradually increasing, with most being mixed with other waste and either incinerated or landfilled, posing a significant shortfall in resource utilization. During the latter half of the 14th Five-Year Plan, some regions have begun attempting to address this shortfall through financial subsidies, but maintaining such systems in the long term remains a challenge.

Based on the Extended Producer Responsibility (EPR) principle, we recommend pilot programs in cities such as Suzhou, Shanghai, Xiamen, and Beijing, where household waste sorting conditions are relatively mature, to incorporate with major generators of large-volume post-consumer plastic waste, such as delivery services, e-commerce platforms, and food & beverage companies, into the urban recycling system through multi-stakeholder collaboration. The basic approach is as follows: taking plastic waste in household garbage as a starting point, fully utilize the existing foundation of China's waste sorting system and the relatively well-developed recycling industry chain to significantly reduce the cost of recycling and reuse. promote the implementation of corporate responsibilities in plastic reduction, and build a sustainable closed-loop recycling system for post-consumer plastics.

Currently, the global fight to end plastic pollution is urgent. In March 2022, the fifth United Nations Environment Assembly adopted a resolution on ending plastic pollution, and since then, negotiations have been ongoing to finalize a legally binding global plastic treaty by the end of 2024. The *Opinions of the Central Committee of the Communist Party of China and the State Council on Accelerating the Comprehensive Green Transformation of Economic and Social Development*, released in August 2024, explicitly emphasize active participation in the formulation of international rules in areas such as marine pollution control and plastic pollution control, highlighting the role of plastic pollution prevention and global rule-making in driving green transformation.

Our cross-disciplinary research with CPCIF aims to bring attention to the significant progress China has made in household waste sorting and its immense potential in post-consumer plastic recycling . We also seek to identify global best practices that can be used as a reference, laying the foundation for the collaborative construction of a circular recycling system for post-consumer plastics. By exploring innovative solutions that are both ecologically viable and economically sustainable, we hope to collectively address the global challenge of plastic pollution control.

Executive Summary

The United Nations Development Programme (UNDP) has long emphasized that the "production-consumption-disposal" linear economic model exacerbates plastic pollution. Plastic recycling not only reduces environmental pollution but also provides valuable recycled resources, which has been recognized globally as a win-win solution. China is actively building a plastic circular ecosystem, exploring a path that aligns with its interests and maximizes its advantages.

This report provides a detailed analysis of the economic and ecological feasibility of the plastic circular business model, aiming to provide effective solutions for the post-consumer plastic pollution control for China. The report delves into three key initiatives driving the construction of a circular ecosystem: policy incentives, information transparency, and the development of an evaluation system. The evaluation system is to assess and compare brands' performance in plastic circularity initiatives. This system not only offers companies a roadmap for action, helping them formulate strategies, set goals, and implement effective measures, but also encourages systematic participation in the construction of the plastic circular ecosystem.

Through this report, we hope to provide both theoretical foundations and practical guidance for building a green, circular plastic ecosystem, contributing to the resolution of plastic pollution in China and globally.

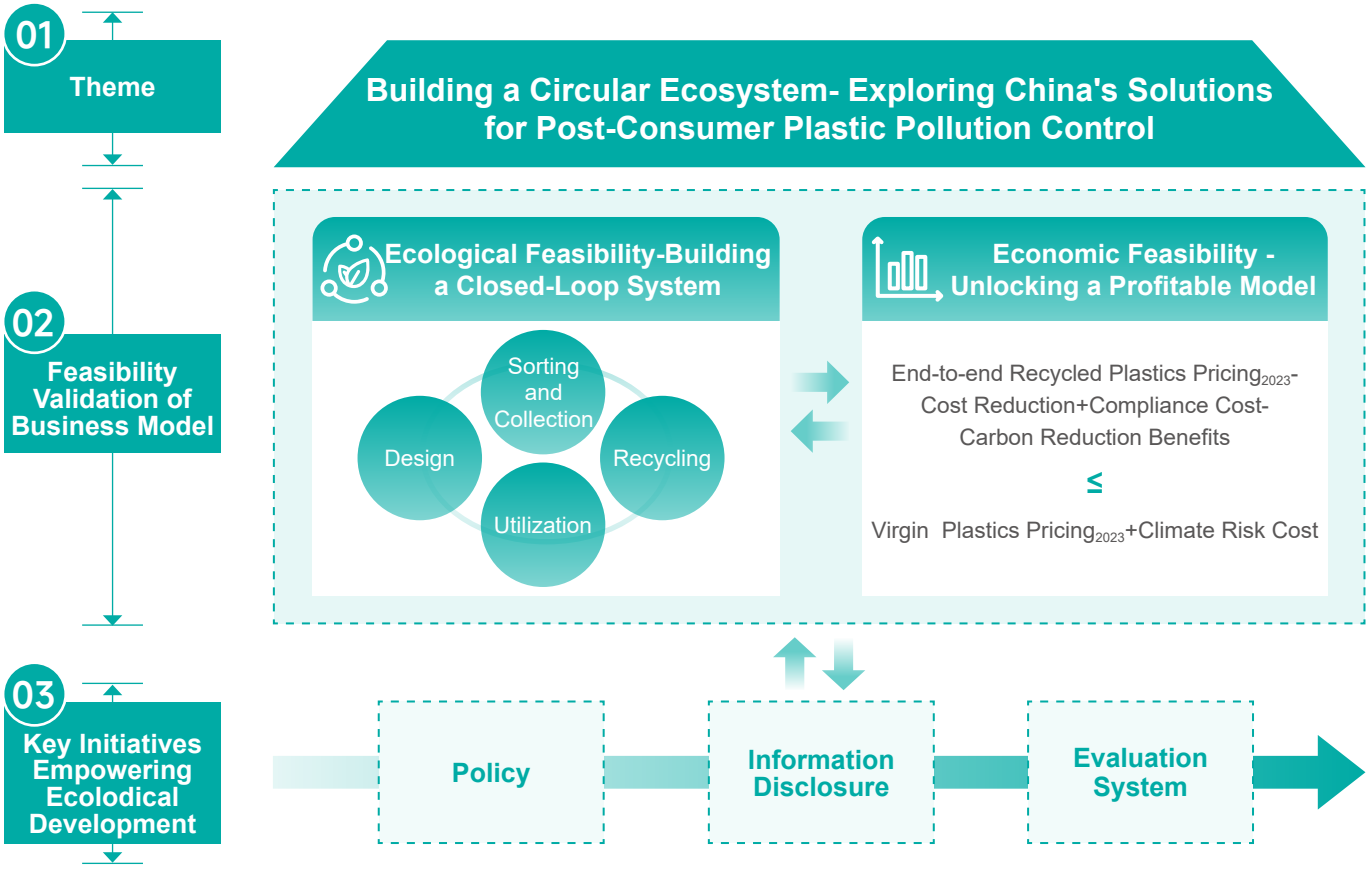

Figure 1 Overview of the Report's Structure

01

Promoting Consensus on Plastic Recycling

As one of the most important inventions of the 20th century, plastics have significantly enhanced modern life. However, the improper treatment of plastic products has led to severe environmental issues. Ending plastic pollution lies at the intersection of slowing climate change, curbing environmental pollution, and preserving biodiversity, making it a focal point of global attention. The long-standing "production-consumption-disposal" linear economic model has exacerbated plastic pollution. The recycling of post-consumer plastics (hereafter referred to as PCR) not only reduces pollution but also provides substantial recycled resources, becoming a globally recognized win-win solution.

In recent years, the environmental impact of plastic waste has increased dramatically. These impacts include challenges in plastic waste treatment, the potential threats of microplastics to ecosystems and human health, and difficulties in resource recovery and reuse. According to the OECD's *Global Plastics Outlook*, global annual plastic production surged from 234 million tons in 2000 to 460 million tons in 2019, with plastic waste increasing from 156 million tons to 353 million tons. Ultimately, only 9% of plastic waste is recycled, 19% is incinerated, nearly 50% is landfilled, and the remaining 22% is neither adequately managed nor effectively disposed of, often leaking into the environment. The figure below illustrates this:

global annual plastic production surged from

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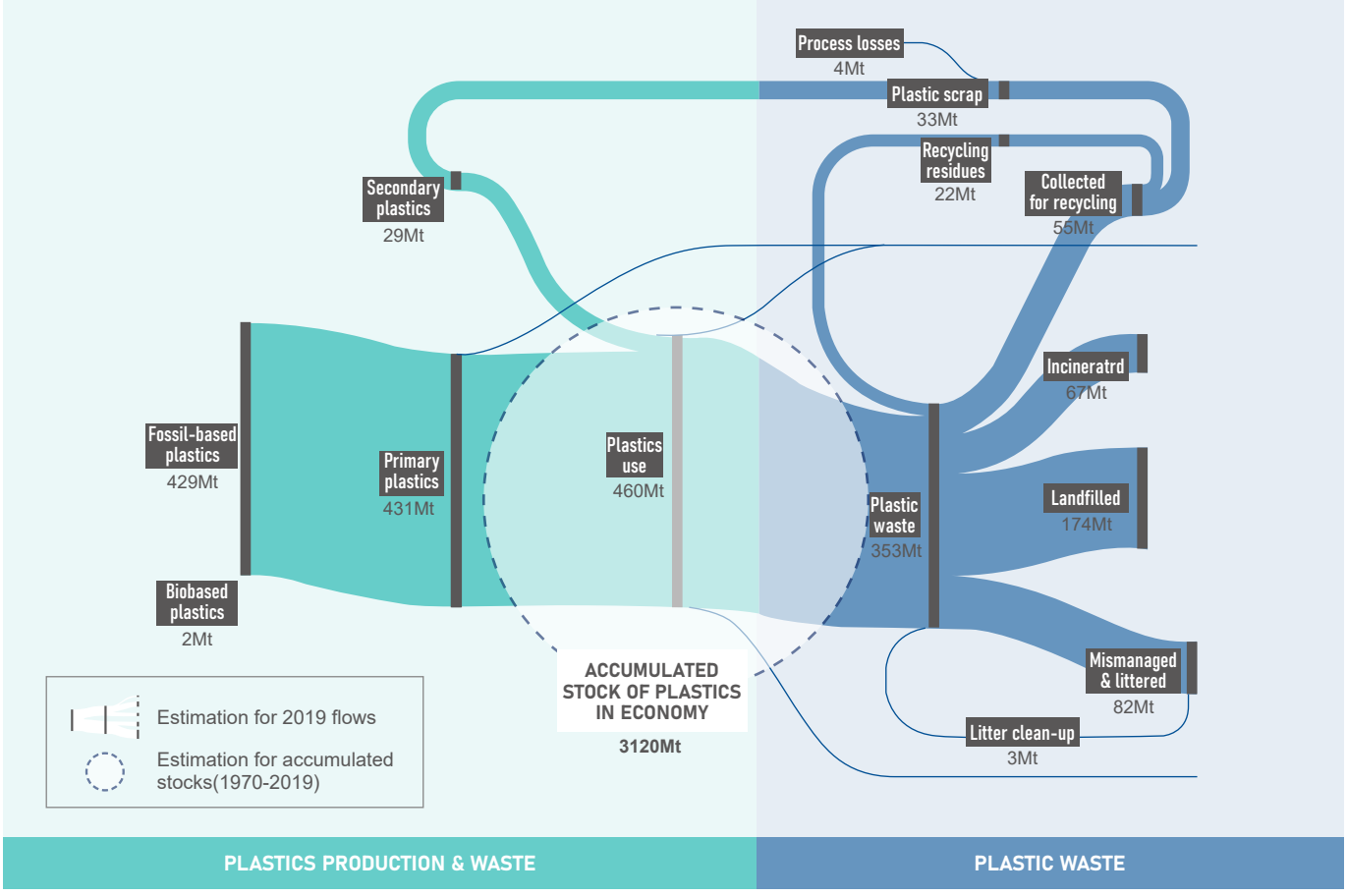

Figure 2 Global Waste Plastic Treatment Flows in 2019[i]

[i] OECD, Global Plastic Outlook[R]. 2022

At the global level, the United Nations Development Programme (UNDP) stresses that the linear economic model exacerbates plastic pollution, highlighting the urgent need for a transition to a circular economy.

At the regional level, the European Union has pioneered regulations such as *A European Strategy for Plastics in a Circular Economy, the Single-Use Plastics Directive*, and the *Packaging and Packaging Waste Directive*, aiming to achieve recyclability for all plastic packaging by 2030 and reduce the use of single-use plastic products. California in the United States has enacted the *Plastic Pollution Prevention and Packaging Producer Responsibility Act* (SB54), one of the most comprehensive plastic legislations passed based on feedback from businesses, environmental organizations, and waste management groups. ASEAN countries are also collectively developing action plans to reduce marine plastic litter.

At the corporate and societal levels, the Ellen MacArthur Foundation, in collaboration with the United Nations Environment Programme, launched the “New Plastics Economy Global Commitment” in 2018. This initiative has seen the participation of numerous internationally renowned brands, each setting ambitious plastic reduction targets. This commitment not only reflects a proactive response to environmental and social responsibilities but also addresses market and policy pressures, meets consumer demand, and drives economic benefits.

As the world’s largest consumer, producer, and exporter of plastics, China is actively participating in global negotiations on plastic treaties. Facing the pressing challenges of climate change, pollution control, and ecological protection, China has adopted a circular economy approach as a critical strategy to achieve synchronized pollution reduction and carbon mitigation. Since the 1980s, China has established an extensive and large-scale post-consumer plastic collection system and a complete industrial chain for recycling. According to the China Plastics Recycling Association of China National Resources Recycling Association, China's post-consumer plastic recycling rate reached 30% in 2022. It is projected that by 2030, recycled plastic utilization will likely surpass incineration and landfill as the primary treatment method.

The urgency to end plastic pollution globally is escalating. We call for heightened attention to China's deep exploration and innovative solutions in various stages of plastic recycling. By fostering multi-stakeholder collaboration, we can build a circular ecosystem for post-consumer plastics, effectively prevent post-consumer plastics from leaking into the environment, and collectively address the complex challenge of plastic pollution control.

Scope of the Report

This report aims to explore how to construct a circular ecosystem for plastics from a full lifecycle perspective and to establish a brand-based plastic evaluation system. It focuses on four critical stages: design, collection, regeneration, and utilization. Among these, the collection stage particularly emphasizes household plastic waste, which, due to its large volume, complex categorization, long recycling chain, multiple industry stakeholders, and varied collection scenarios, represents the biggest challenge in achieving effective post-consumer plastic recycling and utilization.

China's plastic waste recycling rate reached

30% in 2022

02

Building a Sustainable PCR Plastic Circular Ecosystem in China

- Ecological Feasibility Study
- Economic Feasibility Study

Addressing plastic pollution requires more than just technological innovation and policy support; it necessitates a deep exploration and transformation of business models. The business model for constructing a plastic circular ecosystem must balance ecological feasibility with economic viability. This chapter will comprehensively evaluate the ecological feasibility of four key stages: design, collection, regeneration, and utilization. Additionally, by analyzing factors such as the pricing of end-to-end recycled plastics, compliance costs, and green premiums, this chapter aims to explore the economic feasibility of these models. The goal is to identify pathways for achieving a commercially viable plastic circular ecosystem and to explore effective solutions for plastic pollution control tailored to China's needs.

Ecological Feasibility Study

The PCR plastic circular ecosystem primarily encompasses four key stages: design, collection, regeneration, and utilization. Both international and domestic efforts have been made in these areas. When benchmarking against practices in major global economies, China still has room for improvement in certain stages, while demonstrating unique strengths in others. The following analysis will detail the ecological feasibility of these four stages from the perspectives of current status, challenges, and recommendations. The table below compares the maturity of plastic circular ecosystems across major global economies (including North America, Europe, and Asia-Pacific) and China[1].

Table 1 Comparison of Plastic Circular Ecosystem Maturity

Plastics Circular Ecosystem Development		Major global Ecomomies' Current Situations	Current Situations in China
Design		• Major global economies, international organizations, and brand enterprises have reached a consensus to promote the sustainable development of the plastic recycling industry chain through strict design standards, and have achieved certain results. • Some economies, such as North America, EU, Australia, Japan, and Singapore, have established design guidelines or standards based on the characteristics of their plastic recycling systems.	• China's ecological design standards system is still in the process of being established and improved, requiring more time and the accumulation of practical experience. At the same time, it is necessary to strengthen collaboration across the entire industry chain, promote communication and cooperation at all stages, and ensure that standards cover the entire industry chain.
Collection		• The differences among countries are significant. Some countries have implemented a combination of waste sorting systems, Extended Producer Responsibility (EPR), and deposit schemes, leading to higher recycling rates.	• Under the current recycling model (a combination of formal and informal channels), the overall recycling rate is high, with the recycling rate of PET bottles being world-leading. However, the recycling of low-value plastic packaging remains the biggest shortcoming. The existing recycling model needs optimization to achieve sustainability.
Regeneration	Mechanical Recycling	• Developed countries have strict environmental protection requirements, and the physical recycling industry chain has already relocated.	• The mechanical recycling industry in China has entered a phase of rapid growth, characterized by a large number of market players and a relatively fragmented competitive landscape. Companies like Kingfa Science & Technology and INTCO Recycling have achieved profitability through comprehensive strategic deployments.
	Chemical Recycling	• Progress on large-scale commercial projects has slowed due to technical and economic constraints. • In Europe, there are projects under construction, and several industrial demonstration units are successfully operating.	• Due to technical, economic, and regulatory factors, large-scale commercial chemical recycling projects are still in the early stages in China. • In recent years, many leading enterprises have initiated chemical recycling trials, and some companies are preparing to accelerate commercialization.
Utilization		• Due to limitations in usage scenarios, recycling processing capabilities, and market capacity, the cascade utilization system is incomplete. Some countries can achieve "bottle-to-bottle" recycling, while others can only downgrade recycled plastics for use.	• A complete cascade utilization system has been formed. However, due to limitations in technology, economics, and policy, the current focus is primarily on downgraded utilization, and the potential for end-to-end utilization remains to be further explored.

[1]The maturity of a plastic circular ecosystem is assessed across four key stages in the lifecycle of PCR plastics: design, collection, regeneration, and utilization. This assessment evaluates the maturity levels in different regions or countries, identifies current weak points, and outlines directions for improvement. The objective is to advance the PCR plastic circular ecosystem towards higher levels of maturity.

Design Stage: Mature recycling design standards have already been established in Europe and the United States, while China is gradually developing green transformation design standards.

Product eco-design integrates environmental concerns into the design phase, aiming to reduce resource extraction and minimize environmental impact from the outset. This concept drives product design to consider the entire lifecycle, promoting the use of recycled materials and reusable models, and reducing dependence on single-use products. For plastic products, eco-design is a core element in realizing a circular economy, as it ensures that products can seamlessly enter the recycling stream after use, transforming into new raw materials. This concept has gained widespread recognition across the entire industrial chain, requiring upstream and downstream enterprises to consider the recyclability of products from the design stage. Major global economies, international organizations, and brands have reached a consensus on this approach and are advancing the sustainable development of the plastic circular industry chain through stringent design standards, achieving significant results.

Current Landscape

International Representative Recycling Design Standards

Several countries and regions, including North America, Europe, Australia, Japan, Singapore, and other parts of the Asia-Pacific, have established design guidelines or standards tailored to their respective plastic recycling systems. These are outlined below:

North American Standards

The **Association of Plastic Recyclers (APR)** in the United States has issued the **APR Design® Guide for Plastics Recyclability**, a comprehensive set of guidelines developed through extensive feedback from across the value chain. This guide assists packaging designers in creating packaging that is easier to recycle and regenerate, thereby contributing to the production of high-quality PCR that meet preferred design criteria.

European Standards

In Europe, **Plastics Recyclers Europe (PRE)** and **RecyClass** have published design guidelines that focus on optimizing the recyclability of plastic products. The PRE guidelines cover every stage from product design to recycling and processing, providing detailed technical specifications and operational guidance to ensure that new product designs can seamlessly integrate into existing recycling systems.

Asia-Pacific Standards

In the Asia-Pacific region, countries such as Japan and Singapore have developed their own design standards based on their unique recycling systems. These standards consider local recycling capacities and market demands, ensuring that the designed plastic products can be efficiently processed and utilized within the local recycling infrastructure.

Global Institutions and Brand Enterprises: The CGF's Golden Design Rules

Packaging design plays a crucial role in reducing unnecessary packaging materials and ensuring the reuse and recyclability of plastic packaging. In recent years, the rise of technical design guidelines has highlighted the urgent need for globally harmonized design principles to drive the circular plastic economy forward.

In response to the **New Plastics Economy Global Commitment**, jointly led by the Ellen MacArthur Foundation and the United Nations Environment Programme, the **Consumer Goods Forum (CGF)** has developed nine **Golden Design Rules** that cover the majority of plastic packaging.

Table 2 Golden Design Rules Aligned with the New Plastics Economy Global Commitment

Globalcommitment to the New Plastics Economy	Golden Design Rules
01 Eliminate problematic or unnecesary packaging	• Rule 2: Remove Problematic Elements from Packaging • Rule 3: Eliminate Excess Headspace • Rule 4: Reduce Plastic Overwraps
02 Increase the recycling value of packaging types that are already widely recycled in the current system	• Rule 1: Increase Value in PET Recycling • Rule 7: Increase Recycling Value in Rigid HDPE and PP
03 Enhance the recycing value of packaging types that are not yet widely recycled but wil be in future systems	• Rule 5: Increase Recycling Value for PET Thermoformed Trays and Other PET Thermoformed Packaging • Rule 6: Increase Recycling Value in Flexible Consumer Packaging
04 Improve the environmental performance of B2B packaging	• Rule 8: Reduce Virgin Plastic Use in Business-to-Business Plastic Packaging
05 Enhance consumer communication	• Rule 9: Use On-Pack Recycling Instructions

These principles are based on existing eco-design guidelines, including those issued by the Association of Plastic Recyclers and Plastics Recyclers Europe, as well as recommendations from experts and recycling associations, with input from coalition members, some of whom have already implemented portions of these rules. Thirty-three leading multinational companies have endorsed these principles, committing to apply the Golden Design Rules to their plastic packaging portfolios by 2025. These principles can be extended across global value chains and are compatible with technical packaging guidelines in various regions and countries, significantly advancing the development of the circular plastic economy.

Establishment of Green Circular Eco-Design Standards in China

China is gradually constructing a green circular eco-design standard system, and the concept of "green design" is widely applied in policies related to plastic pollution prevention, waste management, and the circular economy. However, there is currently a lack of dedicated policies specifically for green design principles, and green design has not been explicitly recognized as an independent measure to reduce plastic pollution. Although some policies and technical documents advocate for green design in plastic products, overall, China is still in the early stages regarding the definition, standard system, and certification of green product design. Understanding and standardization of design fundamentals across the industry chain need further alignment.

Meanwhile, China is actively exploring the development of a green design system and standards suited to national conditions. Several standards have been established for the design of plastic products, some of which have been elevated to national standards. The "Double E Design System" is a representative practice among these.

The "Double E" Design System

The Plastic Products Easy-to-Recycle and Easy-to-Regenerate Design System (referred to as the "Double E Design System") was jointly released by the China Petroleum and Chemical Industry Federation (CPCIF) and the China National Resources Recycling Association (CRRA). It encompasses standards, certification, and testing systems. Its goal is to enhance the recyclability and regenerability of plastic products by considering lifecycle management during the design phase through the formulation of technical standards and industry norms.

The key to waste plastic recycling and regeneration lies in having a well-established recycling system and regeneration capabilities at the backend. To address the issues of difficult recycling and regeneration of PCR plastics, the "Double E" design standard starts from the end-of-life recycling and regeneration, emphasizing the need to fully consider recyclability and regenerability at the design stage, hence the name "Easy-to-Recycle and Easy-to-Regenerate" (Double E).

The "Double E" design concept is derived from the 3R principles of the circular economy and focuses on three core pain points of plastic recycling: difficulty in front-end collection, high recycling costs, and low regeneration value. Based on these pain points and incorporating the latest technological advancements, the "Double E" design system introduces the new 3A concept, which stipulates that technical processes and business models must be feasible (Available), socially, environmentally, and economically acceptable (Acceptable), and the costs associated with eco-design and green transformation must be affordable (Affordable). Easy recyclability and regenerability are fundamental to achieving the circular use and sustainable value of plastic waste.

The Double E design standard employs a combination of general principles and specific guidelines. Based on the common and characteristic principles of ecological design for plastic products, it initially categorizes plastic products into four major application segments: primary packaging, secondary packaging, engineering, and agricultural construction. Each segment is further subdivided into specific application directions, with detailed Double E evaluation guidelines developed for each.

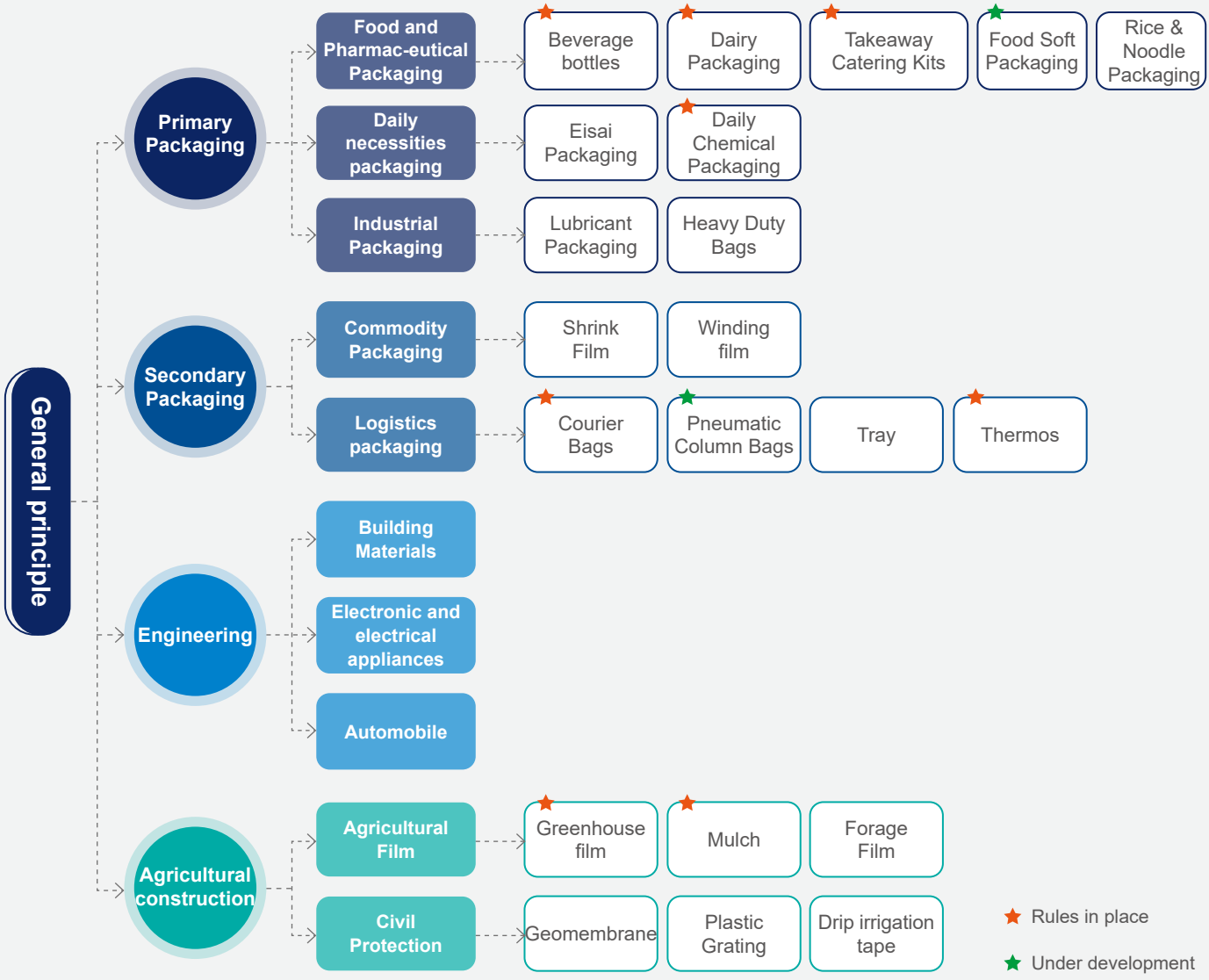

Figure 3 "Double E" Design Standards

Through a comprehensive analysis of the current state of plastic ecological design domestically and internationally, it is evident that recyclable and reusable plastic design has evolved into a mature conceptual framework and widely accepted tool in major global economies, international institutions, and brand enterprises. Simultaneously, in Life Cycle Assessment (LCA) analyses, the end-of-life treatment method for products is recycling rather than incineration, which also shows significant carbon reduction benefits in Scope 3. Therefore, in understanding the implications and logic of recyclable and reusable design, it is crucial to draw from and compare with global best practices to help develop a globally unified recyclable and reusable design system and achieve consensus on circular economy goals across the industry chain.

Issues and Recommendations

Despite notable progress in China's plastic ecological design standards, several challenges and issues persist when compared to internationally mature standards:

Maturity of the Standards System

International recycling design guidelines, such as the APR in the United States and PRE in Europe, have achieved a high level of maturity and broad influence through years of practice and optimization. In contrast, China's standards system is still in the process of establishment and refinement, requiring additional time and practical experience to mature.

Industry-Wide Coordination

International design guidelines often rely on feedback and consensus from the entire industry chain. China's efforts in coordinating and unifying these aspects still need enhancement. There is a need to further promote communication and cooperation across various stages of the industry chain to ensure comprehensive implementation of standards.

Alignment of Technology and Market

When formulating design standards, China must consider local recycling capabilities and market demands to ensure that plastic products can be efficiently processed and reused within the local recycling system. Additionally, standards must be continuously updated and optimized to keep pace with rapid market and technological advancements.

Recommendations to Address These Issues:

Enhance International Cooperation and Communication

Actively adopt and integrate mature international design standards and best practices, tailored to local conditions, to develop recycling design guidelines suited to the Chinese market. Enhancing international cooperation will help elevate the maturity and impact of these standards.

Promote Technological Innovation and Standard Optimization

Continuously pursue technological innovation to improve the design and recycling capabilities of plastic products. Update and refine design standards in response to market and technological developments to ensure they remain relevant in a rapidly evolving environment.

Policy Support and Incentives

The government should advance the implementation of ecological design standards through legislative and policy support. For instance, adopting elements from the EU's Eco-design Directive to mandate environmental considerations in product design and encourage businesses to incorporate circular economy principles at the design stage.

Raise Public Awareness and Market Drive

Enhance public understanding and acceptance of ecological design and the circular economy. Leverage market demand to encourage companies to consider ecological design principles during the design phase, resulting in more products that meet sustainable development requirements.

Facilitate Industry-Wide Collaborative Development

Establish communication and coordination mechanisms across sectors and industries to strengthen cooperation among government, enterprises, research institutions, and industry associations. This collaborative approach will drive the development and implementation of standards, ensuring that green design leads the entire industry chain.

Collection Stage: Learning from Leading Countries to Pilot Multi-stakeholder Collaboration Models

Current Landscape: The collection of low-value plastic packaging remains a significant challenge

In 2022, China produced over **60** million tons of waste plastic[ii], with a recycling volume of approximately **18** million tons[iii], resulting in a comprehensive recycling rate of **30%**. This rate is higher than that of Europe (**26.9%**[iv]), Japan (**21.84%**[v]), and the United States (**8.65%**). However, there is considerable variation in recycling rates among different categories and sources. For instance, high-value post-consumer plastics, such as PET (Polyethylene Terephthalate) bottles, have a high recycling rate. PET bottles account for about **22%** of the total post-consumer plastic recycling volume, making it the largest single category by recycling volume[iii], with a recycling rate of approximately **95.4%**[vi]. This rate exceeds that of Japan (**86.0%** in 2021[vii]), Europe (**75%** in 2022[viii]), and the United States (**38.1%** in 2022[ix]), placing China at the forefront internationally. Conversely, low-value post-consumer plastics, represented by low-value plastic packaging (including non-PET plastic bottles, express packaging, other packaging films, various commodity plastic packaging, and food containers), account for the highest proportion of post-consumer plastic. In 2022, the usage of low-value plastic packaging was **50.66** million tons, with a recycling volume of **8.25** million tons, resulting in a recycling rate of only **16.3%**[x]. This represents the most significant shortcoming in post-consumer plastic recycling.

[ii] 国家发展和改革委员会宏观经济研究院经济体制与管理研究所 . 废塑料化学循环综合性研究报告 [R]. 2024.03

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https://circularityinaction.com/2022plasticrecyclingdata/view/pctrecov.

[x] 国家发展和改革委员会宏观经济研究院 , 经济体制与管理研究所 . 中国低值可回收物回收利用现状研究报告 [R].2023.12

Issues

The large volume, complex categories, long recycling chain, numerous stakeholders, and varied collection scenarios of household plastic waste present significant challenges. Therefore, this report focuses on the collection of household plastic waste, primarily PET bottles and low-value plastic packaging.

PET Bottles

The extremely high recycling rate of PET bottles in China benefits from a parallel model of recycling channels formed by scavengers and private waste collection stations, along with channels established by the government and recycling companies. In many cases, the former even plays a dominant role. This market-driven, flexible, and low-cost model faces challenges such as poor compliance, inefficiency in logistics, and limited traceability. With stricter environmental enforcement, advancements in household waste sorting, and changes in labour structures, the scavenger population is decreasing, which may impact the PET bottle recycling rate. Simultaneously, driven by policies supporting "carbon neutrality" and circular economy, formal recycling systems are being accelerated, and the rise of "Internet+ Recycling" models is improving system efficiency and meeting the recycling industry's demand for high-quality, traceable PET bottles, albeit with increased system costs.

Low-Value Plastic Packaging

Currently, only a few leading cities in household waste sorting are supporting the collection of low-value plastic packaging. However, challenges remain, including heavy government subsidy burdens, poor integration of low-value recyclable material channels led by recycling enterprises with the household waste sorting management system, and suboptimal operation of intelligent sorting and collection systems. At its core, China’s low-value plastic packaging recycling faces three key challenges: First, plastic packaging design does not adequately consider recyclability, leading to incineration or landfill treatment after single-use. Second, the return on investment is low, with collection, sorting, and recycling of low-value plastic packaging struggling to be profitable. It is categorized as "other waste" in the current household waste sorting system, with ineffective sorting and lack of large-scale collection, making it difficult to establish a market-based recycling chain. Third, chemical recycling, a promising method for low-value plastic packaging, requires a relatively stable and concentrated raw material supply. However, current recycling rates for low-value plastic packaging do not meet the requirements for chemical recycling, and chemical recycling projects have yet to achieve effective implementation and scalability, with limited demand stimulation. Addressing these issues requires the implementation of green design standards and, concurrently, the development of an economic feasibility mechanism. This involves enhancing household waste sorting to ensure effective segregation and establishing a collaborative, cost-sharing collection system that enables efficient, large-scale, and intelligent sorting, thus providing stable, high-quality raw materials for mechanical and chemical recycling.

Recommendations: Leveraging Household Waste Sorting to Develop a Multi-stakeholder Collaboration Recycling System

Referring to the experiences of Germany, Japan, South Korea and other countries with good performance in collecting waste plastics from household sources, it can be found that all of them take mandatory separation of household waste as a precursor, supplemented by the EPR system and deposit scheme. Effective household waste sorting significantly reduces the mixing of waste plastics with organic waste, improving collection volume and cleanliness, and enhancing sorting efficiency. EPR systems provide financial support for recycling systems, reducing government subsidy pressures, ensuring recycling rates, and promoting upstream packaging reduction, reuse, and recyclable design. EPR is widely regarded as an effective recycling mechanism and is increasingly accepted by stakeholders in various countries and regions, though the system design and implementation have considerable complexity. Deposit schemes not only offer financial support but also establish independent collection channels for packaging containers like PET bottles, enabling traceability of recycled materials and meeting market demand for food-grade recycled materials. However, setting up collection infrastructure requires significant initial investment, and the allocation of costs needs to be evaluated.

Based on the current state of household waste plastic collection in China and international experience, we recommend adopting an EPR-like system, fully utilizing the existing household waste sorting infrastructure, and developing a multi-stakeholder, eco-friendly collection model. This approach aims to explore economically feasible recycling pathways and improve the recycling rate of household waste plastics, particularly low-value plastics.

Since 2019, China has been implementing a nationwide waste sorting system, which has established a solid foundation. Some cities have implemented effective waste sorting management models, achieving high levels of community participation; others, although residents have not fully adopted self-sorting, have built waste sorting and transportation systems with a "no sorting, no collection" requirement, pushing secondary sorting at waste disposal sites, and ensuring sorting effectiveness. Several leading cites in waste-sorting have developed directories for low-value recyclable materials, including low-value plastic packaging, supporting the construction and operation of collection points and sorting centers for these materials, thus facilitating the sorting and collection of low-value plastic packaging. Some cities have also developed mature digital management models for household waste, enhancing sorting and resource recovery management, and laying the groundwork for traceability certification.

We seek to establish a scientifically reasonable cost-sharing mechanism among brands and other stakeholders within an appropriate cooperation framework to jointly explore the construction of a household waste plastic recycling system. Initially, we recommend selecting regions with a strong foundation in household waste sorting or low-value recyclable material collection, such as Suzhou, Shanghai, Xiamen, and Beijing.

The proposed collaborative model involves multiple brands jointly funding the closed-loop waste collection in areas where the waste sorting system is already well-established. This includes detailed sorting and transportation of plastic waste, with cooperation from property management companies, communities, recycling enterprises, and government. Brands producing and using similar plastic products can establish consistent sorting requirements, enhancing the input-output efficiency of collection in all pilot areas.

Table 3 Multi-stakeholder Collaboration Model

Stakeholder	Responsibilities	Benefits
Government	Implement household waste sorting; support the development of low-value recyclable materials collection systems; facilitate multi-stakeholder pilot projects	Reduced subsidy expenditures; plastic pollution controlled; achievement of circular economy goals
Consumer Brands & E-commerce	Promote eco-design; participate in the development and operation of plastic sorting and collection systems; establish sorting requirements for plastic waste	Fulfillment of plastic commitments; acquisition of high-quality recycled plastics; access to policy support, consumer endorsement, and investor recognition
Property Management & Communities	Manage waste sorting; educate and guide residents; perform necessary sorting tasks	Incentives for collecting low-value recyclable materials; improved performance in waste sorting; enhanced community environment
Recycling Companies	Collect and sort waste plastics according to requirements	Stable financial support for the development of recovery points and sorting capabilities.
Regenerating Companies	Regenerate PCR plastics	Access to a stable, sufficient, high-quality, and traceable supply of PCR plastics
Social Organizations	Advocate for policies; conduct public education and raise awareness; empower grassroots organizations; evaluate brands; coordinate among stakeholders	Achieve the public interest of reducing plastic pollution
Academic Sector& tanks	Conduct research; advocate for policies	Research findings; achieve the public interest of reducing plastic pollution

The principles for funding allocation in the collaborative model should consider that brands whose products or packaging predominantly use low-value plastics bear the major share of the costs. Brands whose products or packaging predominantly use high-recycling-rate categories, such as PET, should contribute based on the proportion of their environmental leakage. Brands using other types of plastics or paper-plastic composite packaging should jointly support recycling efforts in pilot areas. It is important to note that the feasibility of these allocation principles and the management of funds will require extensive discussion among stakeholders including the government, brands, recycling companies, communities, and property management entities during actual implementation.

The multi-stakeholder collaborative model facilitates brands in fulfilling their plastic commitments, boosts the confidence of recycling and regeneration enterprises, encourages property management to engage in plastic waste collection, and promotes front-end waste sorting. It also aids in collecting plastics that have leaked into the environment. The dialogue mechanisms formed among various stakeholders foster mutual understanding, enhance trust, and improve the coordination and development of the recycling system. The experience gained from the pilot operation of the collaborative model will provide valuable insights for the top-level design and implementation of EPR systems in the plastic recycling sector in China. Additionally, this model can alleviate the financial strain on government subsidies for low-value recyclable materials, enable sustained recycling of low-value plastics in more cities, achieve economies of scale, reduce recycling costs, and enhance the quality and recycling rate, thereby establishing a solid foundation for subsequent regeneration processes.

Regeneration Stage: Mature Mechanical Recycling Industry in China with Significant Potential for Chemical Recycling

According to OECD forecasts, by 2060, the global recycling rate of waste plastics (primarily achieved through mechanical and chemical recycling technologies) is expected to reach 60%, making it the predominant treatment method surpassing incineration and landfilling. The following is a comparison of waste plastic treatments:

Table 4 Comparison of Waste Plastic Treatment[xi]

Waste Treatment Methods		Advantages	Disadvantages
Landfill	Refers to the direct landfilling of plastics	• Low Disposal Difficulty	• Causes land encroachment and pollution
Incineration	Refers to the direct incineration of plastics	• Low Disposal Difficulty	• Causes environmental pollution and increases CO_2 emissions • Wasteful consumption of fossil fuels
Mechanical Recycling	Refers to plastics that are collected, sorted, cleaned, ground into flakes, sorted again, and then melted into small pellets for use in the manufacture of new products	• Reduction of environmental pollution(land, sea, air, etc.)and reduction of greenhouse gas emissions • New renewable products	• Requires front-end sorting and is difficult to separate and recycle • Recycling costs are relatively high • Difficult to guarantee the quality of new products and cannot be used in specific areas
Chemical Recycling	Waste plastics are converted through a series of chemical processes into components such as plastic monomers, which in turn create new plastics or other valuable chemical products	• Reduction of environmental pollution(land, sea, air, etc.)and reduction of greenhouse gas emissions • Reduced recycling restrictions • Maintains high quality of new recycled products	• High technical difficulty • Scale-up not yet realized • Economy needs to be improved • Recycling cost is relatively high

The recycling stage is primarily divided into mechanical and chemical recycling. China has made significant progress in mechanical recycling, establishing a relatively comprehensive industry chain and demonstrating a leading position globally. Concurrently, chemical recycling technologies also show immense potential, although they are still in the early stages of development both globally and within China.

[xi] 中国石油和化学工业联合会 , 罗兰贝格 . 废塑料化学循环白皮书 [R].2021-04

Current Landscape

Mechanical Recycling: The Industry Chain in China is Relatively Mature

Mechanical recycling involves processing waste plastics through mechanical routes to produce reusable raw materials. This process includes steps such as cleaning, shredding, melting, and pelletizing. Currently, mechanical recycling in China has become the most developed segment in the field of plastic recycling. Leveraging a robust manufacturing base and technological innovation, China has made significant progress, and the mechanical recycling industry chain is now in a rapid development phase.

Represented by companies such as Kingfa Sci. & Tech. and InnoPlast, China has achieved notable advancements in mechanical recycling. These companies utilize advanced production lines and stringent quality controls to achieve large-scale production and continually optimize cost structures, enabling mechanical PCR plasticsto compete with virgin plastics in the market. Kingfa Sci. & Tech., a global leader in PCR plastics production, has established an efficient production process by adopting advanced equipment and technologies, ensuring the quality and performance of PCR plastics. Similarly, InnoPlast, through independent research and technological innovation, has improved the market competitiveness of PCR plastics while reducing production costs. The successful practices of these companies highlight China's significant potential and global competitiveness in mechanical recycling.

The development of the mechanical recycling industry in China is driven not only by technological and production advancements but also by the improvement of the industry chain and broad market acceptance. Chinese recycled plastic companies, through continuous technological innovation and rigorous quality control, have managed to produce recycled products with performance and quality comparable to virgin plastics. These products are widely welcomed in the market, further accelerating the rapid development of the mechanical recycling industry.

Chemical Recycling: Promising Technological Breakthroughs

Chemical recycling involves the transformation of waste plastics into basic chemical raw materials or fuels through chemical reactions. Compared to mechanical recycling, chemical recycling offers the potential to process a variety of complex plastics that are difficult to recycle mechanically, particularly mixed and heavily contaminated plastics. However, due to its technical complexity, high costs, and limitations in policy and market acceptance, chemical recycling has not yet seen widespread commercialization in China.

The advantages of chemical recycling lie in its ability to handle complex and mixed waste plastics, which is crucial for improving the overall plastic recycling rate. Additionally, chemical recycling can produce high-quality chemical raw materials, providing new pathways for the high-value utilization of waste plastics. With ongoing technological advancements and progress in commercialization, chemical recycling is poised to become a significant component of the plastic circular economy.

Currently, chemical recycling technology in China is still in its nascent stages but has already demonstrated significant potential. Several pilot projects and research initiatives are underway, with leading companies such as Sinopec accelerating their efforts to commercialize this technology. Through collaboration with research institutions, these companies are addressing technical challenges, reducing production costs, and enhancing the economic feasibility of chemical recycling. In the future, with advancements in technology and supportive policies, chemical recycling is expected to see broader application across China.

Issues and Recommendations

Despite the significant progress China has made in the field of plastic recycling, the industry continues to face several challenges. In the relatively mature area of mechanical recycling, industry concentration remains low, with a predominance of small, fragmented enterprises. This fragmentation drives up raw material prices and leads to phenomena such as the displacement of high-quality materials by lower-quality ones. Additionally, the broad range of waste plastic sources, types, and colors increases the complexity and difficulty of recycling processes, making the establishment of unified quality standards and evaluation systems particularly crucial. Furthermore, fluctuations in policy and market conditions introduce uncertainty for the recycling industry, necessitating ongoing policy support to ensure that the industry remains flexible in the face of these changes.

To address these challenges, the following recommendations are proposed:

Establish a Waste Plastic Recycling System Aligned with Regeneration and Utilization Requirements

Plastics are often mixed with household waste, leading to the wastage of valuable resources. It is advisable for regions with the capability to revise their current household waste sorting systems by removing low-value recyclable plastics from the "other waste" category and establishing a directory for low-value recyclables that includes these plastics. Additionally, we suggest providing dedicated plastic recycling containers, and encouraging the development of plastic sorting centers to enhance sorting efficiency and recycling rates.

Promote Sustainable Plastic Packaging Design

Some plastic packaging poses safety risks due to harmful additives such as phthalates and bisphenols, which impact recycling efficiency and safety. It is recommended to adopt "easy-to-recycle and easy-to-regenerater" design principles, reduce the use of composite packaging, and encourage the widespread use of high-strength mulch films and soft plastic packaging.

Accelerate the Commercialization of Regenerating Technologies

Current regenerating technologies demonstrate potential for scaling-up but require further validation and refinement of key technical aspects. It is recommended to optimize sorting and pretreatment technologies for plastics in household waste to enhance regeneration efficiency, upgrade mechanical recycling technologies, and promote the dissemination and improvement of chemical recycling technologies to achieve more efficient regeneration.

Establish a Traceable Management System for PCR

To ensure the authenticity and reliability of PCR plastics, a comprehensive traceability management system should be established. Modern information technologies such as big data and blockchain can facilitate compliant, controllable, and traceable management of the entire process of plastic waste collection, regeneration, and utilization, ensuring data accuracy and reliability.

In summary, as global environmental awareness grows and policies continue to evolve, China's PCR plastics industry is on the brink of new development opportunities. Advances in the regenerating stage can enhance upstream eco-design and regeneration processes, while also paving the way for high-value utilization technologies and commercialization in downstream applications.

[2]The current methods of dealing with "other waste" are incineration or landfill, where low-value recyclable plastics are not being recycled.

Utilization Stage: Comprehensive Cascading Utilization System, with Significant Potential for end-to-end Utilization

Current Landscape

Over the past decades, China has leveraged its vast plastics industry to establish a complete PCR plastics utilization system. PCR plastics are extensively used across various sectors including textiles, automotive, packaging, consumer electronics, agriculture, and construction materials. This comprehensive system not only ensures 100% domestic utilization of plastic waste but also managed to handle 106 million tons of plastic waste from the European Union, the United States, and other regions from 1992 to 2018, converting it into recycled plastic materials and making a significant contribution to global plastic pollution management.

This comprehensive system not only ensures 100% domestic utilization of plastic waste but also managed to handle

106 million tons of plastic waste from the European Union

China's post-consumer plastic recycling system is characterized by its cascading utilization approach. Cascading utilization involves processing and converting PCR plastics into intermediate or final products with different properties and uses through a series of steps, maximizing the use of PCR plastics and promoting sustainable resource utilization. Within this cascading utilization system, the process begins with end-to-end utilization. High-quality post-consumer plastics, which are clean and well-sorted with low impurity levels, high purity, good modifiability, and high value, are recycled into new products with performance or functionality comparable to virgin plastics. These include plastic packaging materials, household items, consumer goods, and plastic components in automobiles and electronics, with “bottle-to-bottle” recycling being a notable example of same-level utilization. Following this is downgraded utilization, where PCR plastics are recycled into products for gardening, landscaping, construction materials, and recycled fiber textiles. Finally, as a fallback, heavily contaminated, difficult-to-clean, or compositionally complex plastics are subjected to chemical recycling, extracting products like pyrolysis oil. With ongoing advancements in chemical recycling technology, efforts are also being made to explore the refinement of low-value plastics into monomers for end-to-end utilization, turning "low value" into "high value".

China boasts the world's most comprehensive range of plastics industry sectors and the most diverse applications for PCR plastics. The cascading utilization system optimally matches PCR plastics with their best applications scenarios, not only extending the life cycle of plastics but also generating additional economic value. It also helps control the overall cost of plastic recycling within socially acceptable limits, enhancing the scale and environmental benefits of PCR plastics. For China, the cascading utilization system represents a significant advantage in addressing plastic waste pollution and should remain a long-term strategy. However, due to technological, economic, policy, and regulatory factors, the current primary focus of China’s PCR plastics cascading utilization is on downgraded utilization, resulting in low product added value and a saturated low-end product market. To increase the value of PCR plastics, enhance the level of PCR plastic recycling, and achieve industry upgrades, further exploration of end-to-end utilization potential is needed.

[xii] Zhang Deyuan et.al..Plastic Pollution Prevention and Control in China: Principles and Practice[R].Economic Science Press.2022

Issues and Recommendations

Exploring the potential of end-to-end utilization faces several structural challenges:

The current inadequacies in waste sorting and plastic recycling systems result in significant contamination of plastics. Mechanical recycling processes, which dominate the industry, have limited capability in addressing surface contaminants, affecting the quality of recycled materials.

The regeneration industry is primarily composed of small and medium-sized enterprises, with a significant number of informal producers still in operation. This leads to inconsistent product quality and stability.

Systematic investigations into the safety of using recycled plastics in food-contact materials, concerning both the final products and and the efficiency of decontamination processes, has not yet been conducted. The evaluation systems for such safety concerns are still under development.

Same-level utilization, particularly in applications involving food-contact materials, demands high standards of traceability for PCR plastics. However, current traceability policies are weak, and there is insufficient motivation for businesses to participate. Additionally, consumer awareness, recognition, and acceptance of traceability systems need improvemen.[xiii]

There is a lack of clear regulations governing the use of PCR plastics, leading to instability in the scale of recycling. Furthermore, the absence of sufficient incentives for PCR plastics at the consumer level diminishes market demand for recycled products.

Despite advancements in technology, the cost of converting PCR plastics into products with equivalent or superior quality compared to virgin plastics remains high. Combined with consumer concerns about the performance and safety of recycled products, this limits the further adoption of end-to-end utilization.

[xiii] Du Huanzheng,Lu Sha,Sun Jian.et.al. Construction of High-value Plastics Tracing System[J].China Plastics,2021,35(08):37-43.DOI:10.19491/j.issn.1001-9278.2021.08.006.

Learning from Leading Countries

The United States, the European Union, Japan, and South Korea have established relatively mature management measures for recycled plastics used in food contact materials, with targeted control based on risk assessment. Since the repeal of the Licensing and Review Rules to Produce Plastic Packaging, Containers, Tools and Other Products for Food issued by the former Ministry of Health in 2018, China has lacked specific measures for recycled plastics used in food contact materials. Only one company has been approved by the former General Administration of Quality Supervision, Inspection and Quarantine and the former Ministry of Health to produce rPET (recycled PET) for food contact use.

Table 5 Management Measures for Recycled Plastics Used in Food Contact in the EU, USA, Japan, and South Korea*

Region	Regulations	Safety Assessment Agency	Entities Under Management
EU	*REGULATION (EC) No 1935/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 October 2004 on materials and articles intended to come into contact with food and repealing Directives 80/590/EEC and 89/109/EEC;* *Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food;* *Commission Regulation (EU)2022/2016 of 15 September 2022 on recycled plastic materials and articles intended to come into contact with foods, and repealing Regulation (EC) No 282/2008*	European Food Safety Authority	Only recycled plastics produced by "appropriate recycling technologies" may be used for food contact, including rPET produced by physical recycling processes (however, different process flows still require separate authorization) and closed-loop recycled plastics from production lines (different process flows do not require separate authorization). All other new technologies must be evaluated before use.
USA	No specific regulations for recycled plastics used in food contact, requiring recycled plastics to meet the same requirements as virgin plastics *(21 Code federal regulation, 21 CFR) ;* *Guidance for industry: preparation of premarket submissions for food contact substances (chemistry recommendations)* provides guidance for companies to voluntarily apply for safety evaluation of recycled plastic materials to the FDA	Food and Drug Administration	Level 1 products (scraps not entering the market within the factory) are considered to pose acceptable risks to consumers and do not require special safety evaluation. Level 2 (produced by mechanical recycling processes like crushing, washing, and melting without changing the basic polymer type) and Level 3 (produced by chemical recycling processes like hydrolysis, methanolysis, or glycolysis that depolymerize plastic products into monomers and re-polymerize them) recycled plastics should undergo safety evaluation. rPET and rPEN produced by Level 3 processes do not need safety evaluation.
Japan	*Guidelines on the Use of Recycled Plastic Materials in Food Utensils, Containers, and Packaging*: It is required that recycled plastics comply with the provisions of the Food Sanitation Law, meaning they must meet the same standards as virgin plastics.	Ministry of Health, Labour and Welfare	Mechanical recycling processes should choose level 1 (scraps recycled from production lines) and level 2 (post-consumer food-grade containers that have not been contaminated) raw materials; chemical recycling processes are not restricted by raw material types.
Korea	*Standards and Specifications for Utensils, Containers, and Packaging*	Ministry of Food and Drug Safety	rPET produced by mechanical recycling processes and recycled plastic materials and products produced by chemical recycling processes.

*XING Hang, ZHANG Hong, LI Qianyun, ZHU Lei.. Research and analysis on management mode of recycled plastics for food contact at home and abroad.[J]. Chinese Journal of Food Hygiene,2022,34(06):1179-1184.

We recommend the prompt establishment of comprehensive technical standards, safety assessment criteria, and traceability certification systems for PCR plastics. These measures will provide the necessary technical and safety assurances for both government supervision and industrial production. To stimulate market demand, it is advisable to implement measures such as setting PCR plastics content targets, providing tax incentives, and establishing government green procurement standards.

Moreover, it is essential to ensure full transparency throughout the traceability process, including methods, standards, and certification procedures. Engaging consumers in the traceability value chain will enhance their awareness and participation in plastic product traceability, while also leveraging public oversight.[xiii]

Government and leading brands should actively work to raise consumer recognition and acceptance of PCR plastics. For usage in food contact materials, it is recommended to initiate pilot projects to refine practices, enhance the recycling system, and progressively develop regulations and standards. This approach will establish a market entry and regulatory framework to address food safety risks and support the domestic use of food contact PCR plastics and related products.

Case Study: Traceable Marine Plastics

The "Blue Circle" marine plastic recycling project in China has pioneered a comprehensive traceability system using IoT and blockchain technologies to create a "from ocean to shelf" visual tracking network. This system records every stage of the marine waste process—from collection and sorting to transportation, recycling, and final sale—effectively addressing the challenges of marine plastic certification and enhancing the added value of recycled plastics and products.

The "Blue Circle" initiative has been implemented across nine counties and districts in Zhejiang Province. It has engaged over 60,000 participants and more than 10,000 fishing vessels in the collection of marine waste, resulting in over 10,000 tons of recovered marine debris, including more than 2,000 tons of marine plastic waste. The project has connected over 230 upstream and downstream enterprises, including recycled plastic processing factories, textile mills, and apparel brands.

In recognition of its achievements, the "Blue Circle" project was awarded the "Champion of the Earth" award by the United Nations Environment Programme in 2023.

The project has connected over

230 upstream and downstream enterprises

As can be seen from the above analysis, to promote end-to-end utilization, it is essential to further enhance the plastic circular economy and foster close collaboration among upstream and downstream industries, government, and the public. The expansion of end-to-end recycling and the healthy development of the PCR plastics industry hinge on establishing economically viable models that ensure PCR plastics of comparable quality to virgin plastics are competitively priced. Currently, achieving this goal is both realistic and feasible.

Economic Feasibility Study

Under the global consensus on environmental protection and sustainable development, China's PCR plastics industry is at a critical turning point, facing challenges such as difficulty in front-end collection, high recycling costs, and low regenerating value. These issues significantly impact and limit the development and economic viability of the industry. In the process of building a plastic circular economy, economic feasibility is crucial. This article will delve into the price structure of PCR plastics and future price trends, exploring the economic feasibility of the plastic circular business model through quantitative research, with the aim of establishing a profitable model across the entire value chain and ultimately achieving a truly sustainable plastic circular economy.

Price Composition of Recycled Plastic

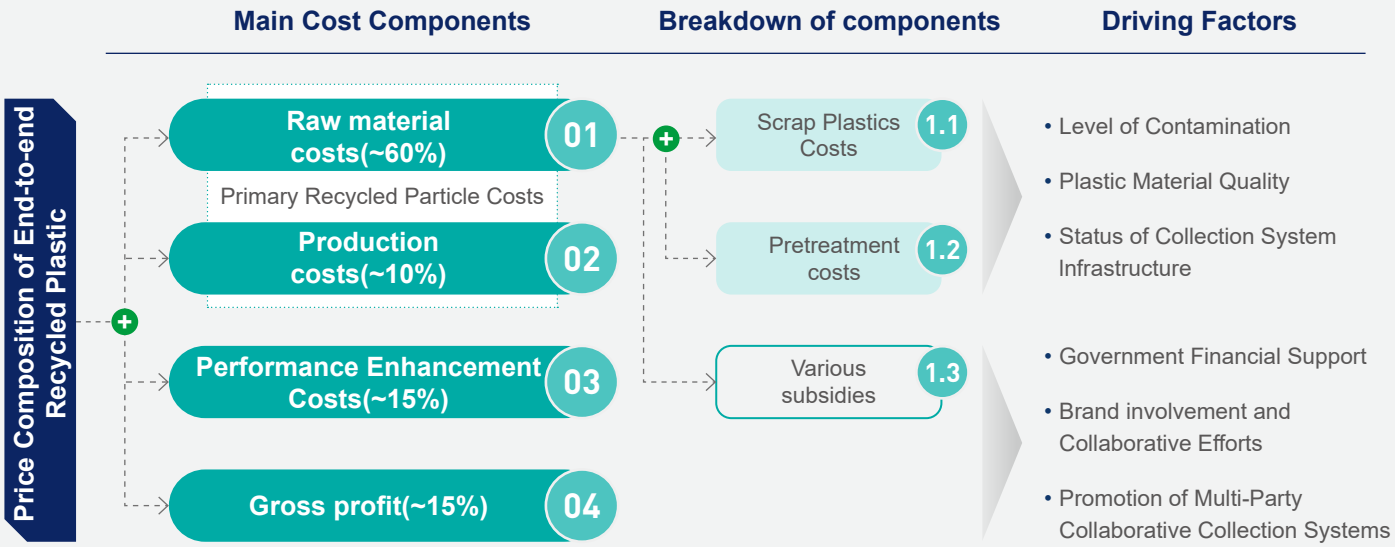

Figure 4 Price Composition of End-to-end Recycled Plastic[3]

Definition

End-to-end recycled plastics are produced through special processing techniques, such as compatibility modification, enhancement, or blending of different types of recycled plastics pellets. The production process of this type of recycled plastics is more complex than that of primary recycled plastics, aiming to improve the performance of recycled plastics so that they can be used in the same or similar applications as virgin plastics.

Primary recycled plastics are processed directly from the recycled waste plastics. The process typically involves washing, crushing, and melting the collected waste plastics, then processing them into pellets through extrusion or other forms. Primary recycled plastics are characterized by a relatively simple processing procedure, mainly used for recycling single-type or high-quality PCR plastics.

[3]Downgraded utilization yields low profits, and the market is becoming saturated. This chapter uses the economic model of end-to-end recycling as an example to explore how to achieve economic viability. Figure 4 is based on the mechanical recycling process.

Raw Material Cost (Approximately 60%)

Raw material cost constitutes the largest portion of the total cost of end-to-end recycled plastics, typically exceeding 60%. This cost includes the direct procurement cost of waste plastics and the pre-treatment cost.

The price of waste plastics

The price of waste plastics fluctuates significantly, ranging from a few hundred to several thousand RMB per ton, depending on the material and level of contamination. For example, PET is often priced higher than PE (Polyethylene) due to its superior performance and wide range of applications. At the same level of contamination, the price of waste PET may be higher than that of PE. Additionally, the procurement cost of waste plastics is largely influenced by their source, quality, and market supply-demand conditions. For instance, waste plastics from industrial and commercial sources are typically of higher quality and less contaminated, thus commanding a higher procurement price compared to waste plastics from residential sources. Currently, due to the lack of a systematic traceability mechanism in waste plastic collection and trading, the inconsistency in raw material standards increases the uncertainty in procurement costs and makes accurate quality assessment of waste plastics challenging.

Pre-treatment costs

Pre-treatment costs include steps such as washing, crushing, sorting, and resorting, which are essential for removing impurities and ensuring the quality of recycled plastic pellets. For lower-quality waste plastics, pre-treatment is particularly complex and relatively costly. In some cases, pre-treatment costs account for more than half of the raw material costs, especially for mixed or heavily contaminated waste plastics. Therefore, building a profitable recycling model can effectively enhance the economic viability of the plastic circular economy.

Subsidies for Raw Materials

Subsidies for Raw Materials: In the cost structure of recycled plastics, the cost of the collection (pre-treatment) process occupies a significant proportion. Currently, this portion of the cost is partially offset by government subsidies. Drawing from excellent practices both domestically and internationally, here are two important sources of subsidies:

Government Subsidies

To promote circular economy and environmental projects, government-provided subsidies can directly reduce the production cost of end-to-end recycled plastics. At present, these subsidies are implemented only in selected pilot areas, with forms and amounts varying by region. Expanding and standardizing these subsidy policies will significantly enhance the economic competitiveness of recycled plastics.

Case Study: Low-Value Recyclables Disposal Project in an Urban District

Project Background

An urban district government launched a low-value recyclables disposal project to improve the recycling rate of low-value recyclables. This project aims to select qualified third-party companies through government procurement to be responsible for the collection, sorting, storage, packaging, transportation, and resource reuse of low-value recyclables.

Government Subsidies

- **Project Budget:** The total budget is RMB 4 million.
- **Service Term:** The contract period is 2 years, covering 18 subdistricts and townships in the district.
- **Subsidy Targets:** The focus is on general low-value recyclables (such as waste glass, waste textiles, low-value waste plastics, paper-based composite packaging, etc.) as well as special low-value recyclables (such as takeout plastic containers and utensils, low-value discarded electrical and electronic products).

Specific Requirements

- **Overall Requirements:** During the project execution, all target recyclables must be effectively handled, ensuring comprehensive collection.
- **Sites and Methodologies:** The successful bidding company must set up disposal points, equip them with necessary facilities and personnel, and carry out sorting, storage, packaging, transportation, and resource reuse. The district government is responsible for organizing relevant departments to collect and transport the recyclables to the processing bases designated by the bidding company.
- **Expected Recycling Target:** Based on preliminary research, the project is expected to recycle approximately 8,030 tons of low-value recyclables annually, aiming to significantly increase the recycling resource utilization rate of waste through the implementation of this project.

Policy Direction and Future Trends

The low-value recyclables disposal project in this urban district not only demonstrates the government's commitment to environmental protection and resource recycling but also indicates that subsidy policies and practical measures in the environmental field will continue to be optimized and expanded in the future.

Multi-stakeholder Collaborative Model

As analyzed in section 2.1.2 regarding the recycling stage, the coordinated cooperation of stakeholders such as brands, government, recycling enterprises, and communities, especially in areas with a strong foundation of waste sorting, can promote the refinement of waste sorting and collection channels, further improving the efficiency and quality of post-consumer plastic collection. Multi-stakeholder participation in the construction of a collection system, through subsidies or joint efforts in the raw material stage, can effectively reduce the costs in the preprocessing stage, improving the economic viability and market competitiveness of recycled plastics.

Overall, multi-stakeholder collaboration contributes to establishing a sustainable circular economy system, reducing the pressure on government subsidies, while encouraging enterprises to fulfill their social responsibilities, ultimately achieving long-term sustainable development of plastic recycling.

Production Cost (Approximately 10%)

Production cost involves transforming pre-treated plastics into plastic pellets through processes like high-temperature melting and extrusion. This process includes energy consumption, equipment depreciation, and maintenance. Energy costs constitute a significant portion of production costs, especially in regions with high electricity and fuel prices. Additionally, with increasingly stringent environmental regulations, investments in environmental protection equipment are becoming an increasingly important part of production costs.

Performance Enhancement Cost (Approximately 15%)

To achieve performance standards similar to virgin plastics, recycled plastic materials need to be enhanced by adding compatibilizers, reinforcements, and other chemical additives. These costs depend on the required performance standards and the prices of additives, which can vary significantly depending on the type of additives used.

Gross Profit Margin (Approximately 15%)

Based on data from representative companies in the plastic recycling industry, the gross profit margin for primary recycled plastic materials is less than 15%. However, for end-to-end recycled plastics , the gross profit margin can reach 15%-20%, reflecting their higher market value compared to primary recycled materials.

the gross profit margin for primary recycled plastics is less than

15%

However, for end-to-end recycled plastics, the gross profit margin can reach

15%–20%

PCR Pricing Trend Forecast

The economic feasibility of recycled plastics depends on the total cost that consumers are willing to pay, which must not exceed the cost of virgin plastics. As climate risks and sustainability factors increasingly affect corporate revenues and costs, we reasonably predict that by 2030, the price composition of recycled plastics and virgin plastics will be determined by the following factors (the left side of the inequality represents the price composition of end-to-end recycled plastics by 2030, while the right side represents the price composition of virgin plastics by 2030). By exploring ways to narrow or even eliminate the price gap between end-to-end recycled plastics and virgin plastics, we can promote the economic viability of recycled plastics.

End-to-end Recycled Plastics Pricing$_{2023}$ − Cost Reduction + Compliance Cost − Carbon Reduction Benefits

≤

Virgin Plastics Pricing$_{2023}$ + Climate Risk Cost

Price Trend Forecast for End-to-end Recycled Plastics Indicative

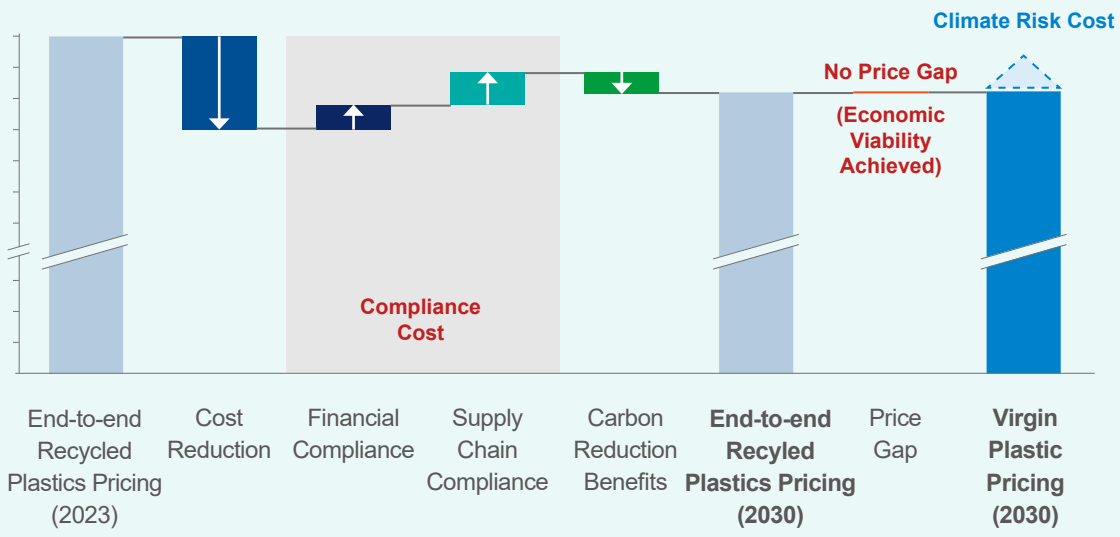

Figure 5 The Price Trend Forecast for End-to-end Recycled Plastics

Explanation

Cost Reduction

Rapid growth in demand will drive improvements in recycling systems and production scale effects, significantly reducing raw material procurement and production costs for recycling companies.

Compliance Costs

To meet increasingly stringent legal and environmental standards for recycled plastics, companies will incur additional expenses, mainly referring to financial and supply chain compliance.

Carbon Reduction Benefits

The carbon reduction benefits from using recycled plastics can be realized through carbon trading or government subsidies, effectively reducing the total cost for companies.

Climate Risk Costs

The extensive use of virgin plastics faces financial impacts from regulatory policies, market risks, and reputational risks associated with transition risks, such as plastic bans and packaging taxes, leading to increased procurement costs.

Cost Reduction

The cost composition of recycled plastics is approximately 60% raw material costs, 10% production costs, 15% performance enhancement costs, and 15% gross profit margin. To effectively reduce costs, it is crucial to address the following key areas:

Lowering Raw Material Costs: Multi-stakeholder Collaborative Model

Reducing raw material costs is the core of cost reduction in the plastic recycling industry. This requires the establishment of a Multi-stakeholders Collaborative system among governments, recycling companies, and brands to achieve lower costs in obtaining and pre-treating waste plastics:

Government

Continuously implement waste sorting, promote the construction of sorting centers and multi-stakeholder collaborative systems, and enhance recycling efficiency and quality through policy incentives and financial support, empowering recycling companies.

Recycling Companies

Strengthen cooperation with upstream and downstream enterprises in the industrial chain, establish long-term partnerships to stabilize raw material sources, further reduce the cost of waste plastics, and improve the quality of recycled plastics. At the same time, optimize processes to increase the precision and efficiency of waste plastic sorting, reduce energy consumption and production losses, directly lowering the pre-treatment costs of waste plastics, and ensure the efficient utilization of waste plastic resources.

Brands

At the product design stage, brands should consider the use of recycled plastics, promoting designs that are easy to recycle and regenerate, reducing the complexity of plastics used, and lowering subsequent treatment costs. Additionally, they should participate in the multi-stakeholder collaborative recycling system to support the sustainable and high-quality development of the recycling system.

Through Multi-stakeholder Collaborative Model and joint efforts from all parties, the raw material costs of waste plastics can be effectively reduced, significantly enhancing the price competitiveness of recycled plastics.

Reducing Production and Performance Enhancement Costs: Technological Advancement

Production costs and performance enhancement costs account for 10% and 15% of the total cost of recycled plastics respectively. Technological advancements can significantly reduce these costs:

Production Cost

Adopting more efficient production processes and equipment can improve the production efficiency of recycled plastics. For example, optimizing the melting and extrusion process can reduce energy consumption and material waste. Applying automation technology can further reduce labor costs, thus lowering overall production costs.

Performance Enhancement Cost

Modification technology is key to improving the performance of recycled plastics. Introducing advanced modification techniques, such as efficient blending, toughening, and reinforcement, can enhance the performance of recycled plastics, making it suitable for a wider range of applications. This not only increases the market value of recycled plastics but also reduces additional processing and handling costs due to inadequate performance.

Increasing Gross Profit Margin: Based on Demand Growth

As market demand for recycled plastics grows, companies will gain more pricing power and profit margins. The scale economies brought about by demand growth will further reduce unit costs and increase overall gross profit margins.

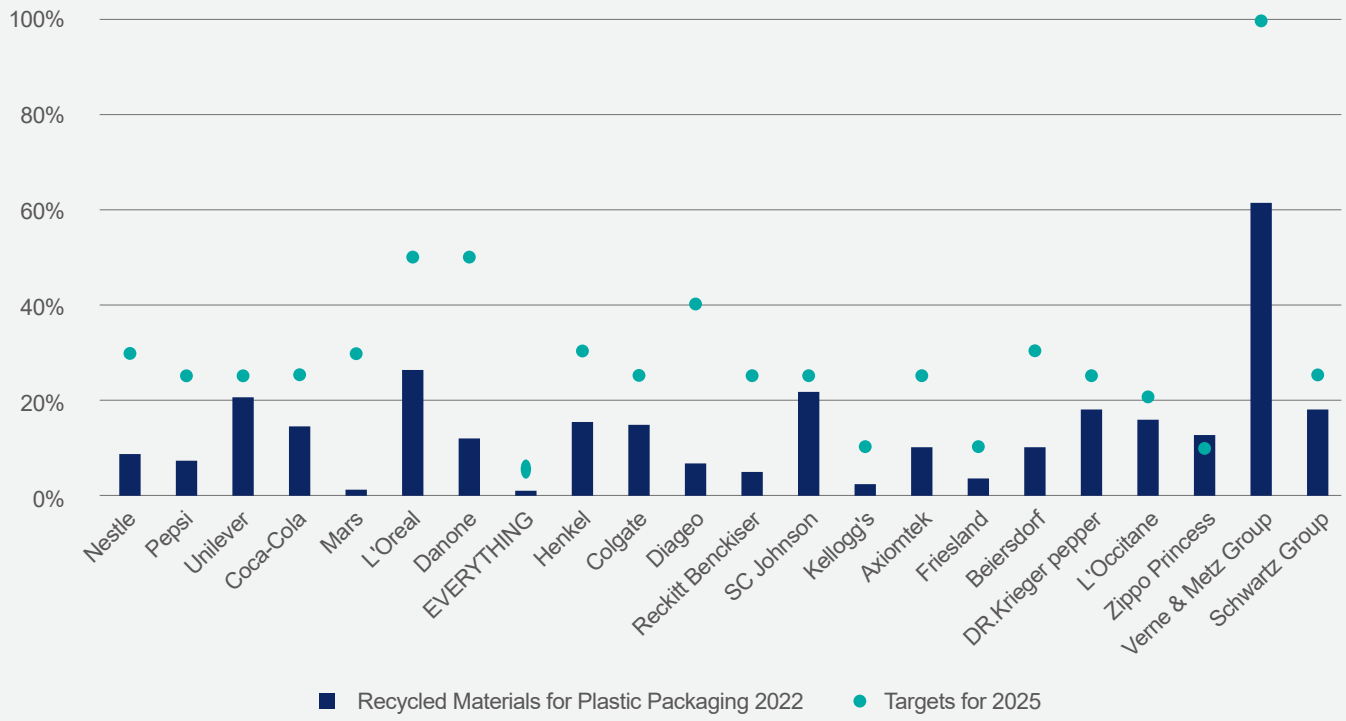

Figure 6 New Plastics Economy Global Commitment 2018-2022 Progress vs. 2025 Targets

The Ellen MacArthur Foundation launched the "New Plastics Economy Global Commitment", aiming for an average of 25% of plastic packaging to be composed of recycled plastics by 2025. Many brands have joined this commitment. However, 2022 data indicate that there is still a significant gap between the current level and this target. This means that major brands face a substantial demand gap in achieving their goals, further driving the rapid growth of recycled plastics market demand.

In summary, as demand for recycled plastics grows rapidly, the improvement of recycling systems, technological advancements, and production scale expansion will effectively reduce raw material and production costs, driving the plastic recycling industry towards greater economic efficiency.

Compliance Cost

As global demands for sustainable production continue to rise, industry compliance has become a critical issue. This includes not only improved financial transparency but also stringent supply chain management, both of which can significantly increase costs.

Financial Compliance	In the recycled plastics supply chain, issues such as non-standard invoice management have been prevalent, particularly among small and medium-sized enterprises (SMEs), including tax transparency issues or false transaction records. These practices have led to reduced trust from governments and partners. As government regulation intensifies, the entire industry is likely to undergo financial compliance reform. SMEs will need to allocate more resources to improve financial systems and auditing processes, ensuring that every transaction is correctly recorded and reported. These necessary investments and adjustments will inevitably increase operational costs.
Supply Chain Compliance	With the growing focus on social responsibility and sustainability worldwide, brand owners increasingly demand rigorous standards for human rights protection, environmental protection, and material traceability within their supply chains. For instance, they may require suppliers to prove that the plastics used were recycled under legal and ethical conditions without violating labor rights. Moreover, brand owners want to ensure that raw materials are not sourced from suppliers who pollute or damage ecosystems. These demands prompt companies to conduct stricter supplier audits and introduce more complex monitoring systems to trace the origin of raw materials. For example, IQTC is developing a method to detect recycled content, combining machine learning algorithms with actual test results to verify the recycled content in materials. This process requires technological investment and may affect procurement strategies. Furthermore, recycled plastic products must pass specific certifications, such as the Global Recycle Standard (GRS), which entails additional costs.

Although these compliance requirements increase operational complexity and costs in the short term, they also drive the industry toward a more equitable and sustainable direction. Companies must balance the increasingly stringent compliance requirements while maintaining competitiveness.

Carbon Reduction Benefits

By using recycled plastics to replace virgin plastics and implementing energy-saving and emission reduction measures, companies can gain economic benefits in the carbon emission trading market or through government incentive policies. For example, companies can obtain carbon credits, subsidies, or tax incentives by reducing carbon emissions. As the carbon market becomes more mature, these measures are expected to provide new revenue sources for companies while further reducing the actual cost of recycled plastics.

According to the report "Circular Economy: The Other Half of the Blueprint for Addressing Climate Change," recycling 1 ton of plastic compared to producing 1 ton of plastic from fossil raw materials can reduce carbon dioxide equivalent emissions by 1.1 to 3.0 tons. The Center for Energy and Environmental Policy Research at Beijing Institute of Technology published China Carbon Market Development: Achievements and Prospects (2024), predicting that in the final phase of the 14th Five-Year Plan, the average transaction price of allowances in the national carbon market is expected to exceed 105 RMB/ton. In the 15th Five-Year Plan period, this average price is expected to further exceed 200 RMB/ton. Looking ahead to 2030, the average transaction price of China's Certified Emission Reduction (CCER) projects is expected to rise to 150 RMB/ton.

Based on this, the reduction in carbon dioxide equivalent emissions during the production process of companies using recycled plastics can be converted into carbon credits and traded on the market, potentially generating more than 100 RMB/ton in carbon reduction revenue. This will help reduce the overall cost of recycled plastics and improve its economic viability.

Climate Risk Cost

Extensive use of virgin plastics faces severe climate risks in the current and future business environment. These risks include not only direct financial outlays but also broader transition risks, such as the long-term impacts of regulatory policies, market risks, and reputational risks.

Financial Impact of Regulatory Policies

With growing global environmental awareness, many countries and regions have introduced strict plastic restrictions and packaging tax policies. Plastic restrictions force companies to seek alternatives, while packaging taxes increase the tax burden on virgin plastic products. These policies are aimed at pushing companies to reduce their reliance on virgin plastics but also lead to a significant rise in the cost of procuring virgin plastics. In the short term, China may not implement packaging taxes, but for an increasing number of "going global" companies, plastic taxes and related policies in destination countries will have a significant financial impact.

Case Study

The following is a model for estimating the premium of recycled plastics when considering only packaging tax and carbon tax (referencing the UK Plastic Packaging Tax and the average carbon trading price on the Intercontinental Exchange in 2022).

Table 6 Model for estimating the premium for PCR when only packaging and carbon taxes are considered

Makings	Price of 100% virgin material (GBP)		Price of 70% virgin + 30% recycled plastics (£)		Recycled Plastics Premium (considering only packaging and carbontaxes)
	Virgin Plastic	Post-Packaging Tax	Price components (carbon price is around £50 per tonne, chemical recycling plastics saves around 2 tons of carbon per tonne)	Recycled Plastics Price	
PP	Approx.1060	Approx.1260	1060x70%+(PCR material price-100)x30%	Approx.1826.7	Approx.172%
LDPE	Approx.970	Approx.1170	970x70%+(PCR material price-100)x30%	Approx.1736.7	Approx.179%
HDPE	Approx.980	Approx.1180	980x70%+(PCR material price-100)x30%	Approx.1746.7	Approx.178%
PS	Approx.1100	Approx.1300	1100x70%+(PCR material price-100)x30%	Approx.1866.7	Approx.170%

Source:Comy Research Institute

Plastic consumers can opt to use entirely virgin plastic, but they will have to pay the packaging tax; alternatively, they can choose to use plastic containing 30% recycled plastics, thereby avoiding the packaging tax and potentially earning carbon trading subsidies. Ideally, the price of recycled plastics should be determined where the cost of plastic containing 30% recycled plastics is equal to the cost of 100% virgin plastic. Based on the data above, the calculated price of recycled plastics is £1,826.7 per ton, which is 172% of the price of virgin plastic.

**According to a Life Cycle Assessment (LCA) report released by SABIC in 2021, using chemical recycling to process waste plastics to produce 1 ton of new plastic can reduce carbon emissions by 2 tons compared to incinerating waste plastics and producing new plastics using fossil fuels. With the current carbon price in the UK at around £50, each ton of chemically recycled plastics can earn approximately £100 in carbon trading subsidies, equivalent to a £100 premium per ton of recycled plastics.*

Overview of European Plastic Tax

Under the EU's new plastic waste legislation, each EU Member State (MS) is gradually implementing its national regulations and measures to address the plastic waste issue. These measures mainly fall into four categories: the first category includes taxes on plastics and their packaging; the second category involves regulations on single-use plastics (SUP), including bans and labelling requirements; the third category covers fees and licensing requirements under EPR systems to strengthen waste management; and the fourth category is waste disposal fees under landfill taxes.

In recent years, many European countries have made significant updates to plastic taxation, covering various measures from 2023 to 2024. These updates include the introduction of new tax policies, the expansion of EPR systems, and adjustments to regulations concerning single-use plastics and related products. Different countries have taken specific actions in these areas to address the environmental challenges and economic impacts of plastic pollution.

Table 7 European Countries Implementing Plastic Taxes

Country	Scope	Effective Date
Bulgaria	Certain single-use plastic products	March 31, 2024
Denmark	Luggage bags and single-use tableware	January 2024
Germany	Single-use food packaging	2026(Expected)
United Kingdom	All plastics and plastic packaging	April 1, 2024
Hungary	Packaging products and other plastic items	July 1, 2023

Source: Official websites of respective countries

Financial Impact of Market Risk

Market risk is mainly reflected in changes in consumer preferences and market demand. As environmental awareness grows, consumers increasingly prefer products made from recycled materials. Companies that continue to rely on virgin plastics may face a decline in market share. Moreover, investors are increasingly valuing a company's environmental performance, with investment preferences gradually shifting toward sustainable development companies. Companies using virgin plastics may face difficulties in financing or higher financing costs, further exacerbating financial pressure.

According to Deloitte's latest *China Consumer Insights and Market Outlook White Paper*, the number of consumers who are willing to pay more for sustainable products continues to rise. Specifically, 72% of surveyed consumers are willing to pay more for brands with sustainable products, and 68% believe that sustainability factors directly influence their purchasing decisions. Therefore, for brands, relying solely on virgin plastics may gradually lose competitive advantage and market share.

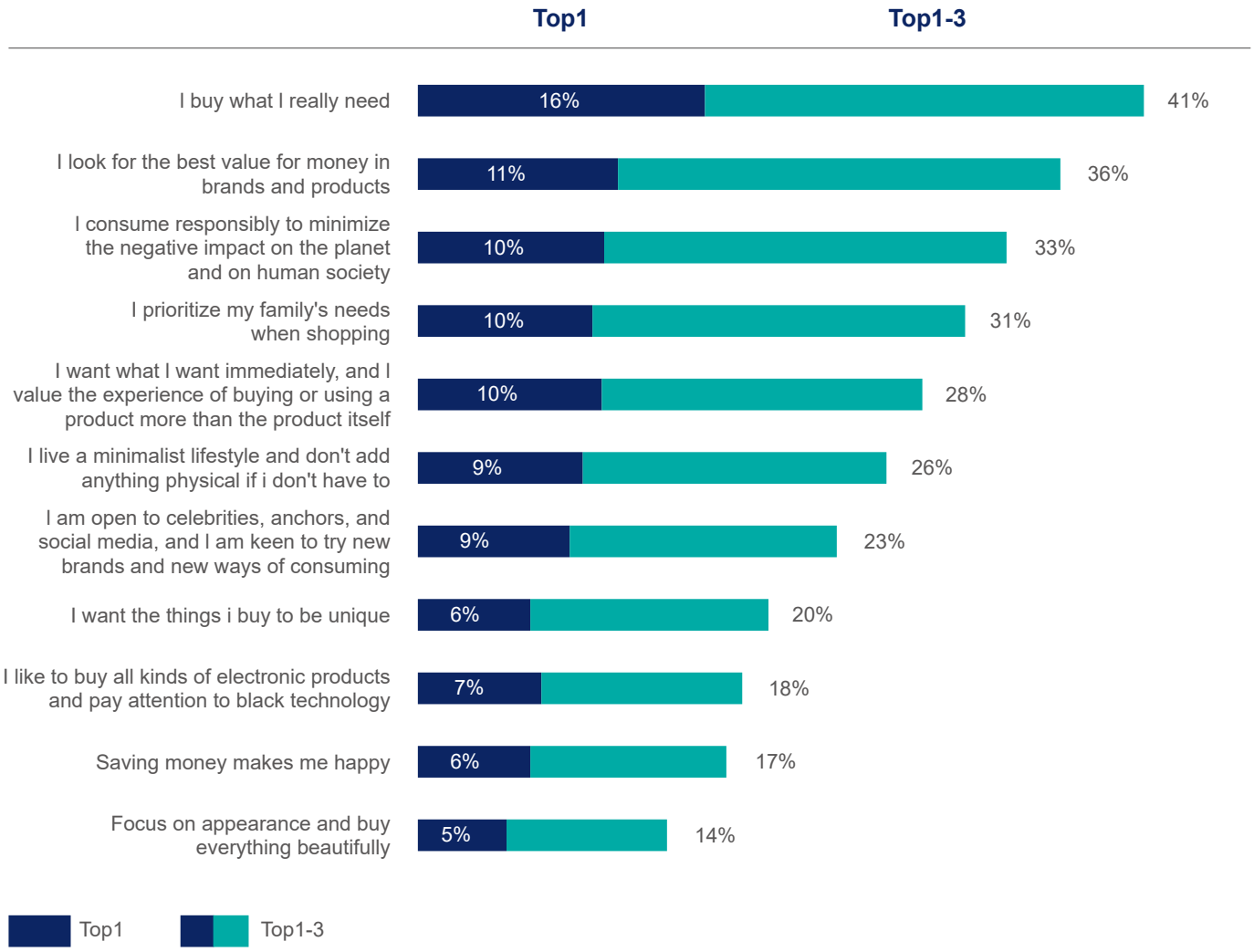

Figure 7 Depicts Consumer Attitudes Towards Responsible Consumption

Source: Deloite Questionnaire: which 1~3 of the following descriptions best match your consumption concept? Please click on thecorresponding description in the order of first match, second match, and third match. [Sort by]

Reputational Risk

In an era of rapid information dissemination, a company's environmental practices directly impact its reputation. Companies that heavily rely on virgin plastics may be perceived by consumers and environmental organizations as irresponsible environmental actors, leading to public criticism or boycotts. This reputational damage can not only affect the company's brand image but also result in declining sales, customer loss, and even legal actions and fines. The financial impact of reputational risks may be subtle, but their long-term effects are not to be underestimated.

In conclusion, the continued heavy use of virgin plastics will expose companies to multiple climate risk costs. These costs are not only reflected in short-term procurement and operational expenses but can also have far-reaching impacts on the company's long-term financial health through market and reputational risks.

Recommendations for Achieving Economic Viability

Reducing Raw Material and Production Costs

Firstly, improving waste sorting systems, along with promoting a Multi-stakeholder Collaborative Model for collection, can increase the recycling rate and quality of waste plastics, thereby reducing acquisition and preprocessing costs. Secondly, encouraging the adoption of easily recyclable designs and incentivizing brands to implement such designs can help lower the costs of processing waste plastics and increase their recycling value. Establishing an ecosystem co-built by producers, consumers, and the recycling sectors can effectively reduce costs across all stages, and further reduce unit production costs through economies of scale.

In addition, improving technology and process standards can significantly lower the costs of recycled plastics. By optimizing production processes, equipment, and incorporating automation technologies, production efficiency can be enhanced, reducing energy consumption and material waste, thereby lowering production costs. Moreover, the adoption of advanced modification technologies can enhance the performance of recycled plastics, expand its application scenarios, increase market value, and reduce additional processing and handling costs.

Reducing Compliance Cost

Leveraging digital tools can effectively reduce compliance costs, improve operational efficiency, and meet brand owners' requirements for product traceability. By introducing advanced digital tools and platforms, end-to-end tracking and management of waste plastics can be achieved, enhancing the transparency and traceability of the entire recycling chain, reducing unnecessary intermediaries, and lowering costs. Meanwhile, the government can maintain a fair competitive environment through effective regulatory measures such as reverse invoicing, motivating recycling companies and fostering the sustainable development of the entire industry.

Enhancing Carbon Reduction Benefits

It is crucial to establish a carbon accounting methodology that applies to the entire lifecycle of PCR, accurately quantifying and assessing the emissions reduction achieved during the recycling process, thereby providing a scientific basis for participating in the carbon market. Collaborating with governments, environmental organizations, and industry associations can also help drive policy-making and standardization in the plastic recycling sector.

In China, thanks to strong domestic policy support and rapid technological innovation, the recycling of PCR plastics have increasingly become an economically viable option. Although the industry currently faces challenges such as high raw material costs and limited high-end applications, continued policy support and industrial upgrades are enabling companies and research institutions to collaborate on developing more efficient recycling technologies and more economical processing methods, reducing production costs and improving the quality of recycled materials. Additionally, growing consumer demand for environmentally friendly products is providing strong momentum for the recycled plastics market. As technology matures and the market expands, the development of the recycled plastics industry in China will become healthier and more sustainable, with a promising future ahead.

03

Key Initiatives to Empower the Construction of a Circular Ecosystem for PCR Plastics

- Empowerment Through Policies and Regulations
- Building Information Transparency
- Establishing an Evaluation System to Develop an Action Roadmap and Promote the Construction of a Circular Ecosystem

Building a circular ecosystem for PCR plastics that is both ecologically and economically viable requires coordinated internal and external efforts. By leveraging policies, information transparency, and the establishment of evaluation systems, empowerment can be achieved on macro, meso, and micro levels. Policies and regulations provide legal safeguards and guidelines for the circular ecosystem of PCR plastics. Information transparency helps enhance decision-making quality and efficiency across all levels, strengthens public awareness and participation, and fosters communication and collaboration among stakeholders. Evaluation systems assess the progress and position of value chain enterprises in the construction of a circular ecosystem for PCR plastics, providing clear directions and steps for companies to engage in the development of the circular ecosystem.

Empowerment Through Policies and Regulations

The key policies driving waste plastics circularity in major global economies can be summarized in the fifteen aspects outlined in Table 8. The overall policies of the EU and Japan are relatively more comprehensive, with clear objectives and well-developed support measures, though there are disparities in specific policies across different regions. The United States has fewer federal-level regulations, relying primarily on state-level laws and market-driven initiatives, with varying policy priorities across states. China, while emphasizing the construction of waste sorting systems and recycling infrastructure, still lacks sufficient policy support for green design and recycled plastics usage, and needs to optimize subsidy models for waste sorting and recycling systems.

Table 8 Comparison of Key Policies Across Four Major Economies[4]

Stage	Key Policy	EU	Japan	USA		China
				Federal	State	
Design	Use of recyclable materials	✓	✓	—	✓*	✓*
	Use of easy to recycle materials	✓	✓	—	✓*	✓*
	Labelling for disposal instructions/material type	✓	✓	✓	✓*	✓*
Collection	Set recycling targets for different packaging	✓	✓	—	✓*	—
	Supporting industry development	✓	✓	✓	✓*	✓
	Mandatory waste sorting	✓*	✓	—	✓*	✓
	Implement deposit scheme	✓*	✓*	—	✓*	—
	Enforce mandatory, paid EPR system	✓*	✓	—	✓*	—
	Subsidies, tax incentives	✓	✓	—	✓*	✓
Regeneration	Set recycled plastic usage proportion	✓	✓	—	✓*	—
	Set targets for recycled plastic utilization	✓	✓	—	✓*	—
	Support for industry development	✓	✓	—	✓	✓
	Government procurement preference	✓	✓	✓	✓*	✓*
	Subsidies, tax incentives	✓	✓	—	✓*	✓
Utilization	Traceability certification system	✓	✓*	✓	—	—

[4]To focus on waste plastics, the relevant policies supporting reuse, seeking alternative materials, and reducing the use of single-use plastics have been omitted here.

Note*:Indicates that there are relevant regulations, but they are either incomplete or not applicable in all regions.

Based on both international and domestic experiences, it is recommended that China strengthen policy empowerment in the following aspects of plastic product and packaging design, recycling, regeneration, and cascading use:

Promoting Eco-Design

Through legislation and policy support, enforce eco-design standards that mandate the consideration of environmental factors in product design, requiring companies to integrate circular economy principles during the design phase.

Advancing the EPR System

In the long term, establish an EPR system tailored to China’s context, reinforcing the responsibilities of producers, distributors, consumers, and the government to provide financial support for the recycling and resource recovery of waste plastics. Set up recycling targets and traceability systems, and formulate waste plastic recycling goals based on the regulation and tracking of plastic packaging production, waste plastic generation, recycling rates, and recycling pathways.

Establishing Systematic Incentive Mechanisms

In conjunction with the establishment of the EPR system, gradually develop systematic economic incentives, such as waste metering and charging systems, deposit scheme systems, and carbon reduction subsidies for the recycling of plastics. Effective regulatory and penalty systems should also be developed and optimized to ensure the effective implementation of the EPR system.

Standardizing Industry Development

Promote the integration of the "two networks" (the collection and recycling networks). Improve land-use protection mechanisms for recycling projects by incorporating the construction of waste collection, transfer, and storage facilities into public infrastructure land-use plans to ensure reasonable land-use demands and support the establishment of sorting centers to enhance PCR plastic preprocessing capabilities. Strengthen the regulation of the plastics recycling industry by optimizing industry standards and market access mechanisms, ensuring strict supervision of enterprises to prevent the phenomenon of bad performers driving out good. Support leading companies in the recycling sector by encouraging economies of scale and intensification, thereby improving the recycling rates of post-consumer plastics, reducing costs, and ultimately forming a set of replicable and scalable recycling models and best practices.

Enhancing Government-Market Collaboration to Foster the Recycled Plastics Market

trengthen the establishment of government green procurement systems, cultivating demand to drive the supply of recycled plastics products and breaking through the development bottleneck caused by market failures. Optimize relevant technical standards in the field of recycled plastic products, establish traceability and certification systems for PCR plastics, and consider forming a PCR plastics certification alliance. Publish directories of government-preferred certified products with eco-labels to enhance the market competitiveness of recycled plastic products.

Building High-Value Utilization Platforms for PCR Plastics and Mobilizing Resource Circulation

Governments can provide financial, policy, and information support for the technological research and development of recycling technologies within the "vein industry"[5] value chain, encouraging collaboration among producers, industry alliances, research institutions, and recycling companies. The creation of a high-value utilization center for PCR plastics could integrate resources across the board, refine each link in the value chain for PCR plastics, and efficiently drive the development and upgrading of the vein industry.

Aligning with New Carbon Reduction Goals to Enhance Market-Driven Dynamics

Integrate the recycling of waste plastics with the dual carbon goals and carbon market trading. The recycling process, compared to traditional landfill and incineration, generates fewer carbon emissions. Explore the accounting mechanism for these emission reductions and apply them to carbon market trading. This approach not only aligns with the new era's green development requirements but also further strengthens the market's intrinsic motivation.[xiv]

[5] According to the Standard for Venous Industry Based Eco-Industrial Parks (On trial) (HJ/T 275-2006), the vein industry (recycling industry) is an industry that prioritizes environmental safety and aims to conserve resources and protect the environment. It uses advanced technologies to convert waste generated during production and consumption into reusable resources and products, thus achieving the recycling and resource utilization of various types of waste. This industry includes two processes: converting waste into recycled resources and processing those recycled resources into products.

[xiv] 韩月 . 黄文芳 . 他山之石：废塑料高值化利用，我们可借鉴德国哪些经验 [N]. 澎湃新闻 .2023-11-19. https://www.cenews.com.cn/news.html?aid=1096197

Building Information Transparency

Information transparency is the cornerstone of constructing a plastic recycling ecosystem. Transparent information provides a reliable basis for policy-making, optimizes decision-making processes, fosters innovation and technological advancement, supports the smooth and efficient operation of the ecosystem, and upholds supply chain supervision and compliance. This not only promotes fair competition in the market but also reduces compliance costs within the supply chain. Additionally, it helps increase consumer recognition, guiding them toward more responsible consumption choices, and enhances trust and collaboration among governments, businesses, and the public, thereby facilitating international communication and cooperation.

To advance the construction of information transparency, efforts can be made in three areas: promoting government information disclosure, advancing corporate reporting and disclosure, and building an information-sharing platform.

Government Information Disclosure

Government disclosure of plastic management information includes relevant policies (laws, regulations, standards, plans, action schemes, etc.), macro-level statistical data on the stock and flow of plastics (plastic material flow) across different spaces, time periods, and life cycles, as well as various regulatory measures executed on individual enterprises and records of violations.

The collection and disclosure of plastic material flow data assist enterprises and research institutions in understanding the current state of plastic flows, enabling better planning of resources and technological investments, thereby driving the development of plastic recycling technologies and markets. The disclosure of regulatory measures and violation records can enhance regulatory transparency and government credibility, empower public oversight, and urge enterprises to comply with relevant regulations, avoiding economic and reputational losses due to violations. Government information disclosure can also raise public awareness of plastic pollution issues and support for the circular plastic economy.

Currently, the disclosure of plastic-related policy information is relatively sufficient, but due to the complexity of the policy system, which involves numerous categories and multiple central and local government departments, the information is highly dispersed. The shortcomings in the disclosure of macro-level plastic material flow data and regulatory information on individual enterprises are even more apparent.

Plastic material flow data covers the entire process of the production, distribution, usage, recycling, and final disposal of plastics and plastic products. The dimensions of plastic material flow data include plastic categories, inductries, regions, years, and total amounts. Currently, data on the production of plastics and plastic products in China is primarily published by statistical departments and industry associations through annual reports and yearbooks, which can be viewed by sub-category and region; recycling and regeneration data is published by the Ministry of Commerce and industry associations in annual reports. However, data on distribution, usage, and disposal is lacking. The European Union, the United States, Canada, Australia, Japan, South Korea, India, Turkey, Brazil, Egypt, South Africa, and international organizations such as the United Nations, OECD, and the World Bank also publish varying degrees of plastic material flow information. Among these, data on the production stage is the most abundant. Some countries and international organizations publish information specifically on waste plastics rather than on total waste, while data on distribution, usage, and disposal is scarce. Overall, current data collection and publication on plastic material flows in China and other countries face common issues: incomplete data classification, data gaps, inconsistent classification methods, non-standardized statistical approaches, and fragmented data sources that often conflict. The continuity of data is weak, information is dispersed, and it is difficult to query and obtain.

At the corporate level, companies across the entire plastic recycling chain are regulated by environmental protection departments as "pollution sources", with relatively sufficient disclosure of regulatory information. However, the disclosure of regulatory information regarding their market operations requires improvement. For example, the Ministry of Commerce does not disclose the implementation status of the *Measures for the Administration of the Use and Reporting of Single-Use Plastic Products by Business Operators in the Commercial Sector*. The number of companies participating in reporting, the quality of the reported data, and the penalties imposed on companies that violate regulations have not been made public.

Table 9 Government Disclosure on Plastic Management

level	Type		Source	Gov. Control	Disclosure Level	Channel	Publication Density
region	Policy		National and local People's Congress, Government, Industry Associations	High	High	Government website	Low
	Plastics material flow	plastics material and plastics products	Government, Industry	High	High	statistical yearbooks, industry reports	High
		usage	Associations	Low	Low	industry reports	Low
		recycling	Government	Low	Low	industry reports	Low
		plastics waste	Government, Industry	Low	Low	industry reports	Low
		MSW treatment	Associations	Low	Low	industry reports	Low
Enterprises	Supervision of Enterprises	industry tentry	local Department of Inductry and Information	High	High	Government website	Low
		Production Standards and Quality Control	local Department of Inductry and Information	High	Medium	Government website	Low
		Restricting Plastic Usage	local Department of Commerce	Low	Low	Government website	Low
		Market Order, Product Quality, and Consumer Rights Protection	Market Supervision Bureaus	High	Medium	Government website	Low
		Environment Protection	local Department of Ecology and Environment	High	High	Government website	Medium
		Safety	local Department of Emergency Management	High	Medium	Government website	Low
		Occupational health	local Health Commitions and Department of Emergency Management	High	Medium	Government website	Low
	Certification	certification agencies		High	——	certification agencies website	Low

To advance the disclosure of government plastic management information, it is necessary to optimize plastic information statistical rules, refine statistical categories, unify statistical standards, and establish inter-departmental data-sharing mechanisms to ensure the complete, accurate, and timely aggregation of plastic material flow data across all stages of the plastic lifecycle. The platforms for publishing national and local statistical data should be improved to include more categories of plastic material flow data, and data that is currently available only through paid access, such as industry statistical yearbooks, should be made freely accessible to the public and easy to query. Cross-departmental information disclosure policies should be formulated in the field of plastic management, stipulating the responsibilities, scope, content, format, and frequency of information disclosure by all relevant management departments, and an information disclosure evaluation mechanism should be established to ensure that each level and department discloses information as required.

Corporate Reporting and Disclosure

Within the plastic recycling ecosystem, corporate disclosure of information can internally promote process optimization and technological innovation, improving management efficiency, and externally enhance the overall level of information disclosure in the supply chain, reduce compliance costs within the supply chain, increase trust among customers and consumers, enhance brand image, and attract investment in environmental responsibility. At a macro level, it contributes to improving resource allocation efficiency, enabling the government to formulate more effective industrial policies and plastic pollution control policies based on accurate data, thus promoting the industry's and society's transition to sustainable development.

There are two main information transparency systems for Chinese enterprises. The first is the mandatory environmental information disclosure system under the environmental law framework. Key pollution sources, key monitored enterprises, enterprises subject to mandatory cleaner production audits, listed companies, and bond-issuing enterprises are required to disclose environmental information in accordance with the *Administrative Measures for the Legal Disclosure of Corporate Environmental Information and the Format Guidelines for Legal Disclosure of Enterprise Environmental Information*. The main content includes the generation, treatment, and discharge of pollutants, waste disposal, environmental compliance, and carbon emissions. Enterprises publish environmental information in a unified format on government-built integrated information platforms, improving the quality of information release and significantly facilitating public query and access. The *Administrative Measures for the Legal Disclosure of Corporate Environmental Information* also marked the first mandatory environmental information disclosure regulation for listed companies and bond-issuing enterprises, addressing the lack of a mandatory environmental information disclosure system in the securities market at that time. Today, China's corporate environmental information disclosure and government environmental information disclosure systems and practices are among the most advanced in the world.

The second tranparency system is the sustainable development information (or ESG) disclosure system. Faced with increasingly severe global issues, sustainable development has become a global trend, receiving significant attention and being actively incorporated into national strategies by many countries. Governments, industry associations, and capital markets have heightened their focus on the disclosure of ESG information by listed companies. Increasing evidence suggests that companies with strong ESG performance have better risk resilience and are more likely to achieve long-term stable growth. Additionally, consumers are increasingly supportive of companies' sustainable development efforts, showing a preference for purchasing and supporting sustainable products.[xv] In this context, the trend towards standardized, regulated, and mandatory sustainable development information disclosure frameworks is becoming increasingly prominent.

Under the influence of international trends and China's "dual carbon" goals, regulatory requirements for corporate sustainable development in China are also improving and accelerating, with the scope of mandatory disclosure continuously expanding and the depth of disclosure progressively increasing. On April 12, 2024, the Shanghai Stock Exchange, Shenzhen Stock Exchange, and Beijing Stock Exchange officially released the *Guidelines for Self-Regulation of Listed Companies - Sustainability Report*, marking the first systematic and standardized sustainable disclosure guidelines issued by regulatory authorities in mainland China. On April 26, 2024, the State-owned Assets Supervision and Administration Commission of the State Council officially issued the *Guiding Opinions on High-Standard Fulfillment of Social Responsibility by Central State-owned Enterprises*, requiring central state-owned enterprises to establish a standardized system for the regular preparation and publication of social responsibility reports. On May 27, 2024, the Ministry of Finance issued a draft for comments on the Corporate Sustainability Disclosure Standards—Basic Standards, marking a significant milestone in the development of a long-awaited, unified, and comparable sustainability disclosure standard tailored to China.[xvi]

[xv] 朱睿 . 企业可持续发展报告编制标准的对比与选择建议 [EB/OL]. 财新网

[xvi] 中国企业改革与发展研究会 , 责任云研究院 . 中国企业可持续发展报告指南 CASS-ESG 6.0 一般框架 .2024.06

Table 10 Corporate Information Disclosure

Type of Disclosure	Entities Subject to Disclosure	Basis for Disclosure	mplemen-tation Year	Enforce-ment Level	Disclosure Topics
Environmental Information Disclosure	Key pollution sources, key monitored enterprises, enterprises subject to mandatory cleaner production audits, listed companies, and bond-issuing enterprises	Measures for the Administration of Legal Disclosure of Enterprise Environmental Information; Format Guidelines for Legal Disclosure of Enterprise Environmental Information	2022	Mandatory	Pollutant generation, treatment and discharge, waste disposal, environmental compliance, and carbon emissions
Sustainability-related Information Disclosure	Entities preparing financial statements based on International Financial Reporting Standards (IFRS) and other recognized accounting principles	IFRS S1 - General Requirements for Disclosure of Sustainability-related Financial Information; IFRS S2 - Climate-related Disclosures	2024	Voluntary	S1: Conceptual foundation and general requirements S2: GHG emissions, financed emissions, use of climate scenario analysis to assess corporate climate adaptability
	Listed companies in the EU capital markets and large companies meeting certain thresholds (revenue, assets, and number of employees)	European Sustainability Reporting Standards (ESRS) (a companion standard to the Corporate Sustainability Reporting Directive (CSRD))	Phased implemen-tation from 2024 to 2029	Mandatory	Climate, pollution, water and marine resources, resource use and circular economy
	Listed companies	Guidelines for Self-Regulation of Listed Companies - Sustainability Report	2024	Mandatory+ Voluntary	Climate change response, pollutant emissions, waste disposal, ecosystem and biodiversity protection, environmental compliance management, energy use, water resources, circular economy
	Expanding from listed companies to non-listed companies, and from large enterprises to SMEs	Corporate Sustainability Disclosure Standards - Basic Standards (Draft for Comments)	TBD	Transition from voluntary to mandatory disclosure	Framework guidelines and principle-based provisions for sustainable development disclosure
Plastic Information Disclosure	Operators of retail locations, e-commerce platforms (including food delivery platforms), food delivery companies	Administrative Measures for the Management of the Use and Reporting of Single-use Plastics by Business Operators	2023	Mandatory	Usage and recycling of single-use plastics
	Enterprises in the plastic value chain	CDP Water Security Questionnaire - Plastics	2023	Voluntary	The use and/or production of plastics within the value chain
					Potential environmental and human health impacts of plastic use and/or production
					Risks related to plastics that may have material financial or strategic impacts on the business
					Plastics-related targets
					Total weight of sold plastic polymers, indicating raw material content
					Total weight of sold plastic durables/ components, indicating raw material content
					Total weight of plastic packaging available for sale and/or use, indicating raw material content
					Recycling potential of sold and/or used plastic packaging

However, neither the corporate environmental information disclosure system nor the ESG disclosure standard system can fully support the empowerment of the plastic recycling ecosystem. In terms of disclosure content, the former only involves environmental emissions and compliance during business operations, while the latter's indicators vary greatly across industries, allowing enterprises to independently choose indicators and accounting methods, leading to inconsistent and discontinuous data across different companies and industries. Regarding disclosure entities, the corporate environmental information disclosure system primarily considers environmental impact, with companies involved in sales, distribution, and collection within the plastic value chain often not subject to mandatory disclosure. The ESG disclosure system mainly focuses capital markets, with the disclosure entities primarily being listed companies and large enterprises, while most of the enterprises in China's plastic industry chain are micro, small and medium-sized enterprises, which often fall outside the view of capital markets.

To address these issues, international efforts in recent years have led to the emergence of specialized plastic information disclosure collaboration mechanisms, such as the Global Plastic Action Partnership (GPAP) and the New Plastics Economy Global Commitment, as well as disclosure frameworks like the Carbon Disclosure Project (CDP)'s Plastic Disclosure Checklist and Plastic Disclosure Project (PDP). However, these overseas disclosure standards and collaboration mechanisms face challenges in adapting to local contexts. Currently, China has yet to develop a localized plastic information disclosure collaboration mechanism and disclosure checklist, and domestic enterprises' levels of plastic information disclosure remain low, with few companies disclosing information and the quality of disclosure being poor. According to CDP, in 2023, 3,100 companies worldwide disclosed plastic information with CDP's checklist, including over 350 Chinese companies. This number is negligible compared to China's vast number of enterprises. The government, industry associations, academia, and civil organizations must act together to learn from and adapt overseas experiences, collectively building a plastic information disclosure framework suitable for China's plastic recycling industry. This framework should clarify the content, indicators, and accounting methods that enterprises at each stage of the plastic recycling chain must disclose and establish a common platform for centralized information disclosure to realize the transparent flow of plastic-related information among various entities.

According to CDP, in 2023,

3100

companies worldwide disclosed CDP plastic module information

including over

350 Chinese companies

Building an Information Sharing Platform

As previously mentioned, information disclosure plays a unique role in establishing a circular ecosystem for plastic waste. Currently, due to the large number of information release entities, the complexity of the information, and the highly decentralized channels through which government and corporate information is disseminated, there are significant difficulties in querying, accessing, and using this information. This results in an underutilization of the information's potential, making a unified platform for information release and sharing essential.

Current Data Platforms

Plastic Material Flow Information

Referencing the research by Wang.C. et al.[xvii], the following are global data sources for plastic materials:

[xvii] Wang C, Liu Y, Chen W Q, et al. Critical review of global plastics stock and flow data[J]. Journal of Industrial Ecology, 2021, 25(5): 1300-1317.

Table 11 Global Data Sources for Plastic Materials

Country/ region	Source	plastics material production	plastics products	plastics consumption	recycle	plastics waste	MSW treatmen*
China	China Petroleum and Chemical Industry Federation, China Plastics Processing Industry Association	✓	✓	—	—	—	—
	China National Resources Recycling Association	—	—	—	✓	—	—
	National Bureau of Statistics	✓	✓	—	—	—	—
Europe	Plastics Europe	✓	—	✓	—	—	✓
	European Commission	✓	✓	—	✓	✓	✓
Norway	Statistics Norway	✓	✓	—	—	—	—
U.S.A	American Chemistry Council	✓	✓	✓	—	—	—
	Environmental Protection Agency (EPA)	—	—	—	—	✓	—
Canada	Statistics Canada	✓	—	—	—	—	—
Japan	Japan Plastics Industry Federation	✓	✓	—	—	—	—
	Ministry of Economy Trade and Industry	✓	✓	—	—	—	—
	Statistics Bureau of Japan	—	—	—	—	✓	—
Korea	Bank of Korea	✓	—	—	—	—	—
India	Indiastat	✓	✓	—	—	—	—
Brazil	Instituto Brasileiro de Geografia e Estatística (IBGE)	✓	✓	—	—	—	—
Egypt	Ministry of Planning (Egypt)	✓	✓	—	—	—	—
South Africa	Statistics South Africa	—	✓	✓	—	—	—
	Environmental Affairs	—	—	—	—	✓	—
Turkey	Turkey Statistical Institute	✓	✓	—	—	—	—
Australia	Australian Bureau of Statistics	✓	—	✓	✓	✓	✓
	Department of the Environment and Energy	✓	—	—	✓	✓	—
Municipal	United Nations	✓	✓	—	—	✓	—
	OECD	—	—	—	—	—	—
	World Bank	—	—	—	—	✓	—
	Waste Atlas	—	—	—	—	✓	—

*Refers only to plastic

Representative Data Platforms:

Plastic and Plastic Products Data: China Economic and Social Big Data Research Platform

This platform includes the *Petroleum and Chemical Industry Statistical Yearbook, China Chemical Industry Yearbook, and China Plastics Industry Statistical Yearbook*, which publish annual production data for plastics and plastic products by region and category. Some data trace back to the 1970s. Downloading data from this platform requires a fee, and the plastic-related statistical data is not structured for easy processing.

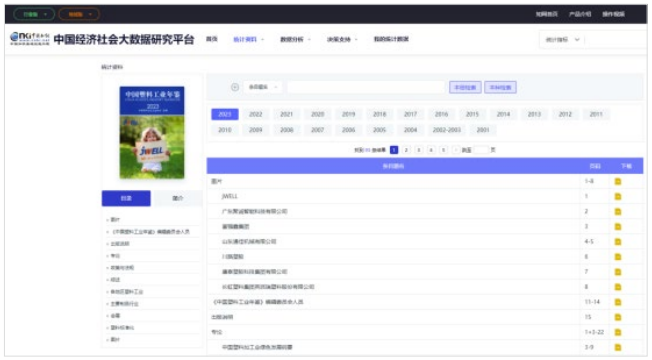

Figure 8 China Economic and Social Big Data Research Platform - China Plastics Industry Statistical Yearbook

Plastic Packaging Waste: Eurostat

The Eurostat website publishes multi-year statistical information on packaging waste for the EU-28 countries, offering convenient query and retrieval options.

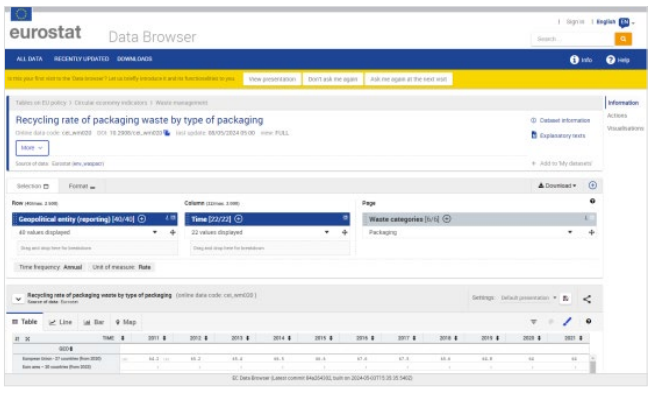

Figure 9 Eurostat – recycling rate of packaging waste

Plastic Waste Data: "Plastic Pollution", an NGO-developed platform

"Plastic Pollution", published online at OurWorldInData.org., provides country-specific statistics on plastic waste generation, improper disposal, marine plastics, and plastic waste trade, available for viewing and download in maps, tables, and data charts, with good user-friendliness.

Figure 10 "Plastic Pollution" Map

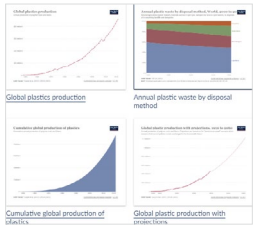

Figure 11 Interactive Charts on Plastic Pollution

Key Issues with These Data Sources:

Some data sources present data in an unstructured format, making it difficult to quickly conduct cross-regional or cross-year queries.

Data from the same country may be published across multiple platforms, with differing classification methods, making it cumbersome for users to piece together relatively complete and coherent data.

In some countries, plastic statistics are integrated into comprehensive statistical data platforms, where the data catalog is extensive, requiring users to have in-depth knowledge to gather all relevant plastic data.

Some data sources have low levels of data openness, preventing bulk downloads or requiring registration and payment for access.

Corporate Environmental Information

As previously noted, among the information disclosed by governments and corporations, ecological and environmental information is relatively comprehensive, but the low concentration of its release has led to the emergence of third-party platforms that integrate government and corporate environmental information.

Integrated Government Environmental Information and Corporate Environmental Information Disclosure Platform: The Blue Map

The Blue Map database, developed by the Institute of Public & Environmental Affairs (IPE), is the largest public environmental database in China. It has been collecting and collating environmental data disclosed by government and companies since 2004. As of June 2024, the Blue Map has included over 230,000 plastic product enterprises and more than 120,000 plastic recycling enterprises across the country.

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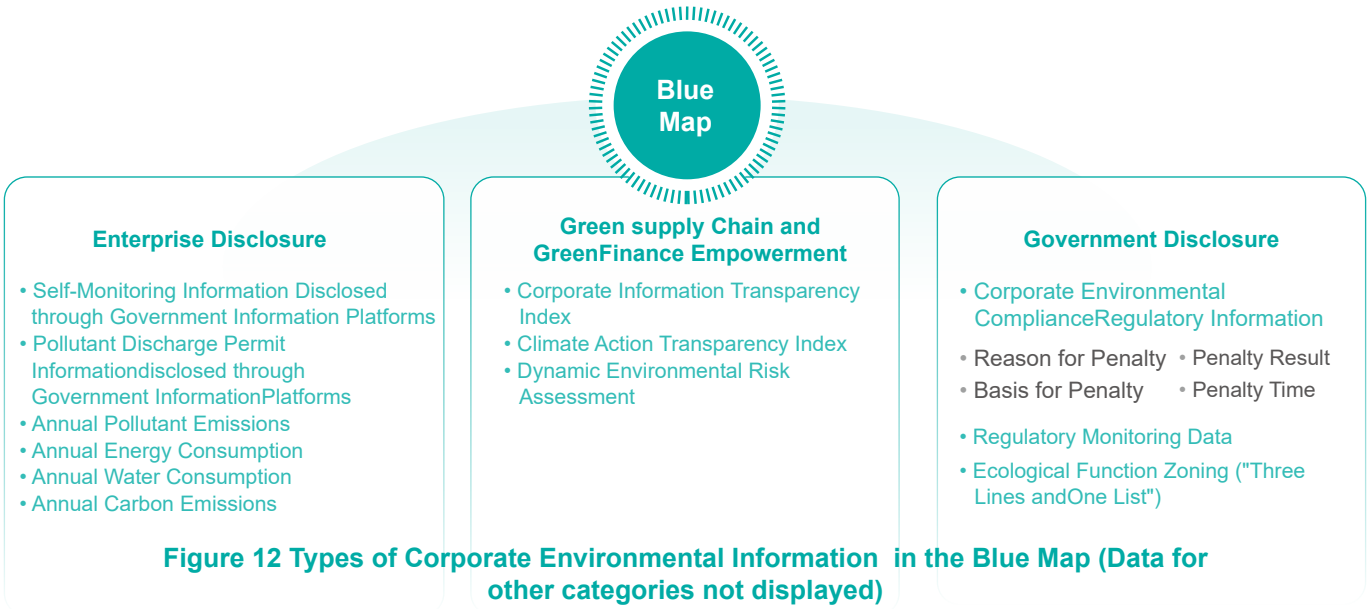


Figure 12 Types of Corporate Environmental Information in the Blue Map (Data for other categories not displayed)

For the construction of a circular ecosystem for PCR plastics, Blue Map's integrated corporate environmental information has various application scenarios. For instance, environmental supervision records can be used to assess the characteristics and trends of environmental supervision faced by companies in the plastic industry chain, estimate corporate environmental compliance costs, or understand the environmental compliance status of suppliers to inform procurement decisions. The Corporate Information Transparency Index(CITI) can be used to understand the green supply chain management requirements of clients (brands or procurement companies). The Dynamic Environmental Performance Assessment (DEPA) can be used to assess green investment and financing risks; and the Blue Map for Ecology can be used to evaluate site selection for companies. If government information disclosure and corporate information disclosure were enhanced, the dimensions of data analysis would be greatly expanded, and the application scenarios would be more extensive.

Figure 13 Distribution of Plastic Recycling Enterprises in the Blue Map

Data Analysis Illustration

The environmental management authorities have several regulatory measures for supervising enterprises, including orders to rectify within a specified period, fines, shutdowns, seizures, and detentions. An analysis of the environmental penalties imposed on plastic production and recycling companies nationwide, as recorded by the Blue Map from 2020 to June 2024, reveals a year-on-year increase in the frequency of fines among the regulatory measures implemented.

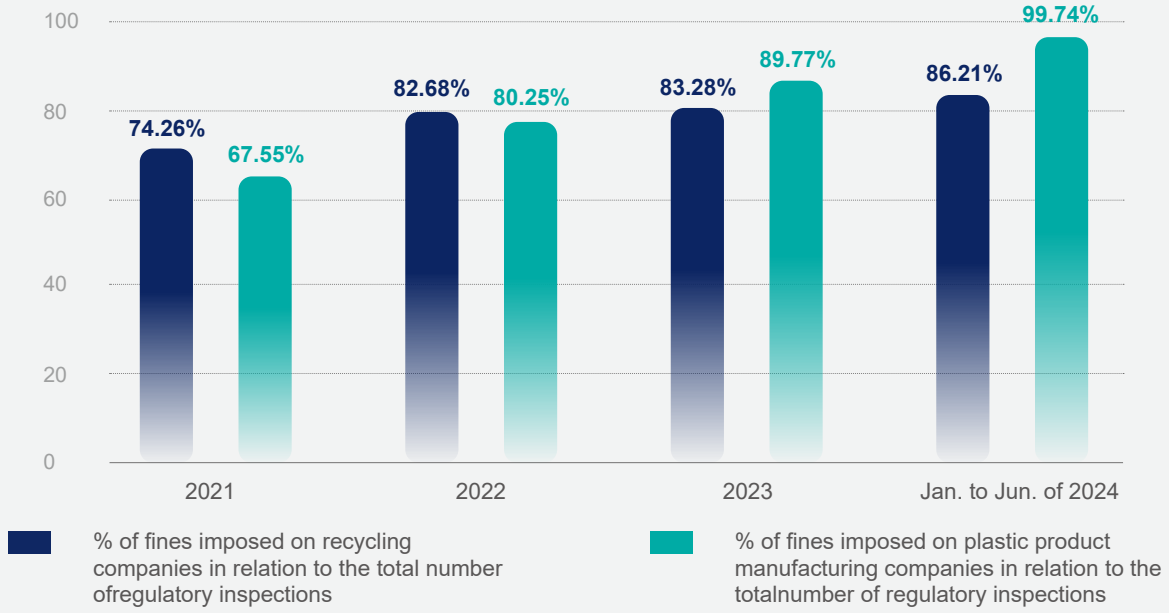


Figure 14 Number of Penalties from 2021 to June 2024

Blueprint for the Information Sharing Platform

Based on domestic and international government and corporate information release policies, current conditions, best practices, and the need for information transparency in the circular ecosystem for PCR plastic, we propose the construction of an open, comprehensive plastic information platform. This platform would promote the disclosure, access, and use of plastic-related information, and further incentivize the development of new data analysis applications. The comprehensive plastic information platform would help raise societal awareness of the plastic waste circular ecosystem, support scientific decision-making, enhance accountability mechanisms, and market incentives, and foster innovative solutions.

Building a comprehensive plastic data platform can be achieved through the following steps. First, considering the differences in data ownership, format, and sensitivity from different regions, departments, and sources, an initial phase could involve constructing a data catalog, with various participants and collaborators establishing coordination mechanisms to review and select highly relevant and high-quality data. Next, identify existing plastic data from publicly available sources and integrate it into a data platform with maps and other visualization tools to enhance data accessibility and transparency. Third, encourage participation and data contribution from domestic and international industry organizations, research institutions, and NGOs, promoting the sharing of best practices among stakeholders, which would, in turn, incentivize broader data collection, measurement, and disclosure. Fourth, analyze data and present best practice cases, assessing companies' performance in plastic recycling activities to provide references for macro, meso, and micro-level decision-making. Fifth, facilitate discussions among regions and companies on data disclosure standards, statistical rules, and data reporting formats to achieve standardization, consistency, and mutual recognition, thereby improving data usability.

Through these steps, the plastic information platform can facilitate the seamless sharing of plastic data, information, and knowledge among stakeholders in the plastic waste circular ecosystem, promoting communication and collaboration, and better empowering the construction of a plastic waste circular ecosystem.

Establishing an Evaluation System to Develop an Action Roadmap and Promote the Construction of a Circular Ecosystem

The previous analysis indicates that building a circular ecosystem for plastic waste requires coordinated efforts across multiple areas, including design, collection, recycling, and high-value utilization. However, despite the introduction of relevant policies in China, the lack of mandatory constraints and policy incentives has led to low participation from some companies. Attempts by some multinational corporations in other countries have yet to be introduced into the Chinese market. Although many companies are willing to participate, they feel overwhelmed by the complexity of the policies. Some industry leaders have begun their practices but lack a systematic plan for constructing a plastic recycling action plan. Additionally, the absence of evaluation standards makes it impossible to compare across industries and sectors.

Currently, internationally recognized sustainability evaluation standards have begun to address the issue of plastic pollution. For instance, leading international ESG evaluation standards like MSCI often place plastic pollution control under topics like circular economy, packaging, or waste management. The Circulytics assessment tool, developed by the Ellen MacArthur Foundation, guides companies in understanding their circular economy potential and performance by measuring material flows, including packaging materials. Since 2023, the CDP questionnaire has required companies to disclose plastic-related information, focusing on the company's plastic use, target setting, and waste disposal.

Evaluation Standard Name	Strategies and Policies	Data Measurement and Disclosure	Measurable Targets	Building a Circular Ecosystem
MSCI ESG Rating Indicators	• Strategies to reduce • environmental • impact of packaging	• Amount of packaging materials used	• Setting packaging related targets and outcomes • Setting product recycling-related targets and outcomes	• Supporting the construction of recycling facilities • Consumer education • Promoting technological innovation
Ellen MacArthur Foundation Circulytics Indicators	• Circular economy incorporated into sustainability strategy	• Amount of packaging materials used • Amount of packaging waste generated		
CDP Water Questionnaire	• Plastic-related risks in the value chain	• Total amount of plastic used • Amount of virgin plastic used • Amount of recycled plastic used	• Setting plastic-related targets	

Table 12 Plastic-Related Issues Covered in Mainstream Evaluation Standards

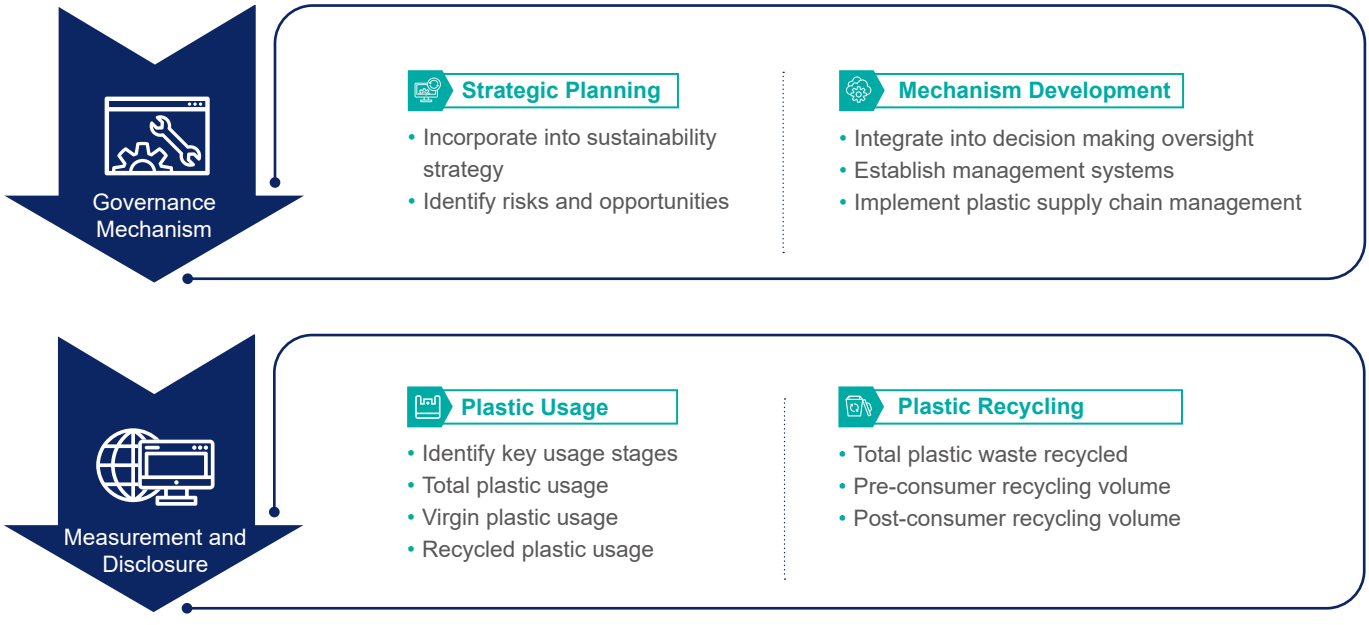
Building a plastic circular ecosystem is not only a crucial measure to address plastic pollution but also a key step in the transition towards a circular economy for society and the economy. This requires consensus, close collaboration, and coordinated efforts across the entire industry value chain. However, as it stands, there is no evaluation standard tailored to China's national conditions and environmental policies, with the specific aim of controlling plastic pollution and building a plastic circular ecosystem.

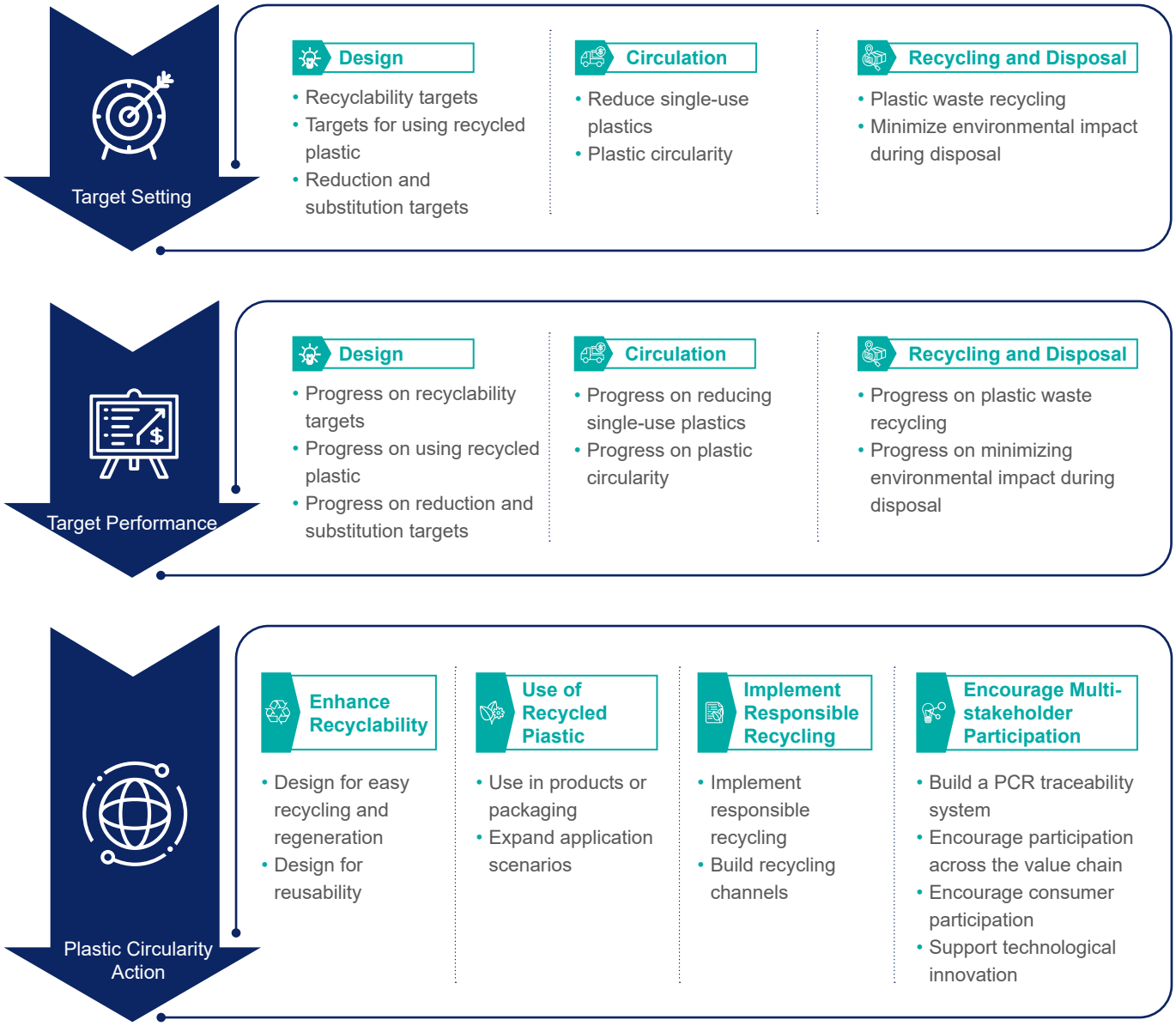
In light of this, and based on the feasibility analysis mentioned earlier, we have developed a preliminary evaluation framework for plastic circular action. This framework is informed by the requirements related to waste design, recycling, and regeneration outlined in various domestic and international policies and regulations, such as the 14th Five-Year Plan Action Plan for Plastic Pollution Control, the Extended Producer Responsibility (EPR) Implementation Plan, the EU's Packaging and Packaging Waste Directive, the Hong Kong Stock Exchange's Environmental, Social and Governance (ESG) Reporting Guide, and the SASB® Standards set by the International Sustainability Standards Board (ISSB), which include relevant disclosure requirements for packaging and circular economy in sustainability reports.

The evaluation framework is structured around five dimensions and fourteen key processes, comprehensively considering the full lifecycle management of plastics and the multi-stakeholder collaboration for building a plastic circular ecosystem. Its purpose is to assist enterprises in developing and implementing roadmaps for plastic pollution control and circular action: incorporating the prevention of plastic leakage and the achievement of plastic recycling into their sustainability strategies, and providing institutional support for the implementation of these strategies; setting clear targets based on the calculation of plastic usage and recycling potential, and tracking the progress of these targets; starting from product packaging design and the use of recycled plastics, actively promoting the diversified participation in the recycling of PCR plastics, while encouraging and enabling the entire value chain and consumers to engage in the process, thereby fostering the establishment of a complete plastic circular ecosystem.

We anticipate that this evaluation framework will help brand enterprises identify their potential capabilities in plastic circularity, reduce their environmental impact from plastic waste, and guide them in driving close collaboration with upstream and downstream partners to jointly advance the construction of a plastic circular system. Additionally, the framework aims to improve the industry's level of information disclosure regarding plastic usage and recycling, gradually forming a unified standard for disclosures, enabling policymakers to gain a better understanding of the industry landscape through comprehensive data and to develop more scientifically sound industry policies. Furthermore, we hope the evaluation will encourage brand enterprises to collaborate with consumers, communities, and other stakeholders, thereby driving the multi-party participation in the plastic pollution control process.

Plastic Circularity Evaluation
Five Dimensions, Fourteen Key Stages and Main Evaluation Content





Based on this plastic circularity evaluation framework, we have examined six industries that generate significant plastic waste: household and personal care, food and beverage, retail, express delivery, computer, communication and consumer electronics (hereinafter referred to as 3C), and apparel. From each industry, we selected three well-known companies from either China or developed countries such as those in Europe and the United States, to conduct in-depth research and analysis on their plastic circularity actions. The aim is to observe the current key focus areas and action directions of leading companies in each industry regarding plastic circularity, while also identifying any aspects that may not yet be receiving sufficient attention, to provide a reference for further industry action.

Table 13 Survey Results of Six Industries[6]

Industry	Brand	Measurement & Disclosure				Target Setting				Target Performance				Plastic Circularity Actions			
		Total Plastic Usage	Virgin Plastic Usage	Recycled Plastic Usage	Plastic Recycling	Recyclability	Use of Recycled Plastic	Responsible Recycling	Reduction& Substitution	Recyclability	Use of Recycled Plastic	Responsible Recycling	Reduction& Substitution	Enhance Recyclability	Use of Recycled Plastic	Implement Responsible Recycling	Co-build a Circular Ecosystem
Household and Personal Care	P&G	—	●	●	—	●	—	—	●	●	—	—	—	▲	▲	▲	▲
	Unilever	●	●	●	—	●	●	●	●	●	●	●	●	▲	▲	▲	▲
	Liby	—	—	—	—	—	—	—	—	—	—	—	—	—	—	▲	▲
Food and Beverage	Nestlé	●	●	●	—	●	●	—	●	●	●	—	●	▲	▲	▲	▲
	Danone	●	●	●	●	—	—	—	●	—	—	—	●	▲	—	▲	▲
	Coca-Cola	●	●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲
Retail	Carrefour	—	—	—	—	●	●	—	●	●	●	—	●	▲	▲	▲	▲
	Walmart	●	—	—	—	●	●	—	●	●	●	—	●	▲	—	▲	▲
	Yonghui	—	—	—	—	—	—	—	—	—	—	—	—	▲	—	—	▲

[6]The survey channels include brand official websites, as well as publicly available reports such as sustainability reports, social responsibility reports, and CDP questionnaires published within the last year. Due to space limitations in this report, only evaluation results related to plastic circularity actions are presented. In the table, ● indicates that the surveyed company has disclosed the relevant content. ▲ indicates that the surveyed company has undertaken related actions, but these are limited to specific products or regions and do not have scalability or sustainability. — indicates that the surveyed company has not yet disclosed the relevant content.

Industry	Brand	Measurement & Disclosure				Target Setting				Target Performance				Plastic Circularity Actions			
		Total Plastic Usage	Virgin Plastic Usage	Recycled Plastic Usage	Plastic Recycling	Recyclability	Use of Recycled Plastic	Responsible Recycling	Reduction& Substitution	Recyclability	Use of Recycled Plastic	Responsible Recycling	Reduction& Substitution	Enhance Recyclability	Use of Recycled Plastic	Implement Responsible Recycling	Co-build a Circular Ecosystem
Express Delivery	SF Express	●	—	—	●	—	●	—	●	—	—	—	—	▲	—	▲	▲
	JD.COM	●	—	—	●	●	—	—	●	—	—	—	—	▲	—	▲	▲
	UPS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3C	Apple	—	—	—	—	—	—	—	●	—	—	—	●	—	▲	—	—
	HUAWEI	—	—	—	—	—	—	—	—	—	—	—	—	▲	—	—	—
	OPPO	●	—	—	—	—	—	—	—	—	—	—	—	▲	—	—	—
Apparel	NIKE	●		●	—	—	—	—	—	—	—	—	—		▲	▲	▲
	ANTA	—	—	—	—	—	—	—	●	—	—	—	—	▲	▲	—	—
	Inditex	—	—	—	—	—	●	—	●	—	●	—	●	—	▲	▲	▲

As illustrated above, companies have explored and practiced across four dimensions: measurement and disclosure, target setting, target performance, and plastic circularity action, covering multiple stages of the plastic product lifecycle. These stages include reducing virgin plastic usage during the design and production phases, increasing the use of recycled plastics, developing reusable, easily recyclable, or biodegradable packaging, reducing excessive packaging in the distribution phase, and organizing the recycling and reuse of post-consumer products and packaging. Some companies have further set specific goals for controlling plastic pollution. However, there are differences in focus and the extent of action across industries.

Household and Personal Care Industry

Plastic waste in the household and personal care industry primarily originates from product packaging materials. The companies surveyed in this industry have relatively comprehensive disclosures regarding plastic usage, including both total plastic usage and the breakdown of virgin and PCR use, indicating that these companies have established preliminary data collection systems related to plastic usage. Given that plastic waste mainly comes from product packaging, the surveyed companies focus on enhancing the recyclability of products or packaging. This includes obtaining "Double E Design System" certification or improving the landfillability, compostability, and recyclability of packaging. Two companies have further set goals to enhance packaging recyclability. The use of recycled plastics is also a key focus area, though it is primarily concentrated among multinational corporations, with Chinese companies needing to diversify the application scenarios and commercial solutions for recycled plastics. Additionally, all surveyed companies are actively exploring the responsible recycling for products and packaging, although only one company has set specific responsible recycling targets, and none have disclosed plastic recycling data. The industry should place more emphasis on the recycling of post-consumer plastics and the collection of relevant data to understand recycling potential and set responsibility recycling targets.

Food and Beverage Industry

The plastic waste in the food and beverage industry also mainly originates from product packaging materials. This industry has been the most proactive in plastic circularity action, with the three companies surveyed engaging in actions across all four areas: measurement and disclosure, target setting, target performance, and plastic circularity action. Notably, these companies have achieved a high level of data transparency related to plastics, with disclosures covering virgin and recycled plastics use, and some even reporting on plastic recycling data. In terms of plastic circularity action, the surveyed companies mainly focus on enhancing the recyclability of products and packaging and increasing the use of recycled plastics, with corresponding targets in place. However, similar to the household and personal care industry, although all three companies are actively exploring recycling initiatives, only one company has set specific recycling targets. Widely used single-use plastic packaging and low-value flexible plastics, such as films and bags, are key sources of plastic waste that need to be carefully managed in the food and beverage industry. Therefore, leading companies could consider actively participating in the joint construction of recycling systems in regions where consumer awareness and community sorting systems are well-established, thus increasing the recycling rate of flexible plastics and other low-value recyclables. Doing so would not only help reduce plastic pollution but also enable companies to better track recycling data and further expand recycling potential.

Retail Industry

Plastic waste from large retail enterprises mainly originates from external product packaging, leading to a strong focus on reducing plastic use and seeking alternatives, with public commitments made in this regard. Enhancing packaging recyclability and using recycled plastics are also widely emphasized, with companies disclosing related targets. However, in terms of data collection and disclosure related to plastics, the surveyed companies lag significantly behind those in the household and personal care industry, as well as the food and beverage industry, indicating that the retail industry still has room for improvement in its plastic-related data collection systems. Additionally, as more retail companies begin to develop their own products, some plastic packaging manufacturers have gradually become direct suppliers to brand companies. In this context, brand companies should extend their responsibility and actions to control plastic pollution along the supply chain, encouraging suppliers to improve the recyclability of packaging materials, increase the proportion of recycled plastics used, and gradually engage them in plastic circularity actions.

Express Delivery Industry

Plastic waste generated in the express delivery industry is mainly concentrated in logistics packaging. Under the issue of plastic pollution control, the industry places greater emphasis on reducing plastic packaging and seeking alternatives, while also striving to enhance packaging recyclability. They have also leveraged their industry advantages to actively explore responsible recycling models for plastic packaging. It is worth noting that although the overall transparency of plastic usage data in the surveyed companies is lower than that in the household and personal care industry, and the food and beverage industry, some companies have begun to calculate and publicly disclose plastic recycling data, which is relatively rare among the six industries surveyed. However, no companies have yet mentioned the use of recycled plastics in packaging, and there is room to further enhance the use and disclosure of recycled plastics in packaging in the future.

3C Industry

Plastic waste in the 3C (computer, communication, and consumer electronics) industry is partially embedded in products and partially in packaging materials, but few companies disclose data related to plastic usage. The surveyed companies primarily focus on improving the recyclability of packaging materials, with some mentioning the use of recycled plastics in products and the reduction and substitution of plastic packaging. Although the recycling value of waste electronic products is high, and the plastic components in products may be recycled and reused after the dismantling of waste products, industry players should also pay attention to the recycling and reuse of product packaging. Furthermore, they could explore application scenarios for recycled plastics in both products and packaging.

Apparel Industry

Plastic waste in the apparel industry primarily comes from product packaging, with a portion also derived from polyester fibers used in fabrics. Regarding packaging, the surveyed companies focus on reduction and substitution, setting targets to eliminate single-use plastic packaging, and some have publicly disclosed the completion of recycled plastic substitutions for product packaging. Regarding polyester fibers used in products, the focus is on recycling and circular use of waste products, such as encouraging consumer participation in waste product recycling through stores. Some companies have also attempted to recycle plastic bottles from the environment, processing them into textile products, thereby reducing plastic waste in the environment. However, industry players should strengthen collaboration with suppliers to continuously reduce plastic packaging in logistics or engage in the circular use of logistics packaging materials. Additionally, they should promote technological innovation to continuously improve the recycling and regeneration capacity of waste products, gradually perfecting related data collection and disclosure mechanisms.

Overall, companies in the household and personal care and food and beverage industries are relatively more proactive, taking action across all four evaluation dimensions. The retail industry follows closely behind but shows a gap in data collection and disclosure. Although companies in the express delivery, 3C, and apparel industries have explored specific actions based on their industry characteristics, such as improving packaging recyclability, using recycled plastics, or engaging in responsible recycling. There is still room for further enhancement in their overall focus on plastic circularity.

We also observe that multinational corporations, having started earlier in the field of sustainability, generally exhibit higher levels of action and information disclosure in plastic circularity compared to Chinese companies. We hope that this evaluation framework will inspire more Chinese companies to actively engage in plastic pollution control and circular economy construction, while also leading the industry to work together to achieve greater breakthroughs in plastic pollution control.

Conclusion

This report has explored how a plastic circular economy provides an effective solution for tackling plastic pollution in China. It has demonstrated the viability of commercial models for implementing this circular economy, assessing both economic and ecological feasibility, and has outlined essential strategies to support and enhance the post-consumer plastic circular ecosystem.

In a post-consumer plastic circular economy, the four stages, design, collection, regeneration, and utilization, interact and reinforce each other, creating a robust synergistic effect. "Design" focuses on optimizing recyclability, while "collection" ensures a steady supply of raw materials. "Regeneration" technologies enhance the utility and quality of recycled plastics, and "utilization" completes the closed-loop cycle for plastics. We expect that the effective integration of these stages will drive industrial advancement, boost the economic, environmental, and social benefits of plastic recycling, and foster a mutually beneficial outcome for both the economy and the environment.

Appendix 1

Table 14 Suggested Data Directory for Plastic Data Platform

Category	Subcategory
Plastic Material Flow Statistics	By Region
	By Industry
	By Type of Plastic
	By Life Cycle Stage
Supervision Information	Environmental, Safety, and Fire Protection
	Plastic Limitation and Ban
	Industry Entry, Quality Control, Market Supervision, Standard Certification
Policy Database	Laws, Regulations, Measures, etc.
	Standards, Guidelines, Manuals, etc.
	Planning
	Action Plans, Guiding Opinions, Implementation Plans, etc.
Plastic Information Disclosed by Companies	Usage of Virgin and Recycled Plastics
	Plastic Recycling Status
	Plastic Circularity Targets and Progress
	Actions Supporting Plastic Circularity and Progress
ESG Information Disclosed by Companies	Climate Change Response
	Pollution Control
	Ecological Protection and Biodiversity
	Circular Economy
Corporate Responsibility Evaluation Results	Scores
	Reports
Plastic Information Disclosure Guidelines	Plastic Information Disclosure Guidelines
Citizen Actions	Data and Statistical Results from Citizen Science Activities and Public Supervision Related to Plastic Pollution Prevention

Appendix 2

Table 15 Plastic Circularity Evaluation System

Primary Indicator	Secondary Indicator	Tertiary Indicator
Governance Mechanism	Strategic Planning	Incorporate plastic leakage prevention and circular economy into the company's sustainability strategy
		Identify plastic-related risks and opportunities in the value chain
	Mechanism Development	Incorporate plastic leakage prevention and circular economy into the oversight responsibilities of the highest decision-making level; clarify management structures, scopes of authority, and work objectives
		Develop plastic-related management systems and implementation plans
		Implement plastic supply chain management, tracking plastic monomer and polymer production, plastic product and/or packaging manufacturing, and plastic waste disposal
Measurement and Disclosure	Plastic Usage	Identify and disclose key stages of plastic usage
		Measure and disclose total plastic usage
		Measure and disclose the volume or proportion of virgin plastic within total plastic usage
		Measure and disclose the volume or proportion of recyclate[7] within total plastic usage
	Plastic Recycling	Measure and disclose total recycled plastic waste
		Measure and disclose the volume or proportion of pre-consumer[8] recycled plastic waste
		Measure and disclose the volume or proportion of post-consumer[9] recycled plastic waste

[7] Recycled Plastic (Recyclate): Plastic material generated from the reuse of plastic waste (refer to GB/T 30102-2024).

[8] Pre-consumer: Refers to materials diverted from the waste stream during the production process. This definition excludes materials such as rework or scrap that are generated and capable of being reclaimed within the same process (refer to SASB® Standards, GB/T 30102-2024).

[9] Post-Consumer: Refers to materials generated by end-users that can no longer be used for their intended purpose. This includes materials returned from the distribution chain (refer to SASB® Standards, GB/T 30102-2024).

Table 15 Plastic Circularity Evaluation System

Primary Indicator	Secondary Indicator	Tertiary Indicator
Target Setting	Design	Set and disclose targets for recyclable[10] plastic products and/or packaging
		Set and disclose targets for the use of recycled plastic in products and/or packaging
		Set and disclose targets for plastic reduction and/or substitution
	Circulation	Set and disclose targets for reducing and/or avoiding the use of single-use plastics
		Set and disclose targets for circular use of plastics
	Recycling and Disposal	Set and disclose targets for the recycling of plastic products and/or packaging
		Set and disclose targets for minimizing the environmental impact during plastic waste disposal
Target Performance	Design	Set and disclose progress towards achieving recyclability targets for plastic products and/or packaging
		Set and disclose progress towards achieving targets for the use of recycled plastic in products and/or packaging
		Set and disclose progress towards achieving plastic reduction and/or substitution targets
	Circulation	Set and disclose progress towards achieving targets for reducing and/or avoiding the use of single-use plastics
		Set and disclose progress on achieving targets for circular use of plastics
	Recycling and Disposal	Set and disclose progress on achieving recycling targets for plastic products and/or packaging
		Set and disclose progress towards achieving targets for minimizing the environmental impact during plastic waste disposal
Plastic Circularity Actions	Enhancing Recyclability	Implement designs for easy recycling and regeneration of products and/or packaging
		Implement designs for reusability, recyclability, and compostability of products and/or packaging
	Using Recycled Plastic	Use recycled plastic in products and/or packaging
		Expand application scenarios for recycled plastic
	Implementing Responsible Recycling	Implement responsible recycling for plastic products and/or packaging
		Participate in building recycling channels and scaling up recycling efforts
	Encouraging Multi-stakeholder Participation in Building a Plastic Circular Economy	Participate in building PCR plastic traceability systems
		Guide and empower the value chain to address plastic pollution and engage in plastic circularity
		Conduct consumer education and guide consumer participation in plastic circularity
		Support technological innovation

[10] Recyclable: Refers to products or packaging that can be diverted from the waste stream through existing processes and programs, and can be collected, processed, and returned for use in the form of raw materials or products (refer to SASB® Standards).

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