

[A Baseline Report on Plastics]

Plastic Production, Consumption, Discarding, and Recycling Across China and Across the World



中华环保联合会
All-China Environment Federation



This report is part of the project of Plastic Pollution Prevention and Control Through the Entire Value Chain Modality (Project No.: CPR/SGP/OP6/Y7/CORE/PLA/2022/01)

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About the Project of Plastic Pollution Prevention and Control Through the Entire Value Chain Modality

The Global Environment Facility (GEF) Small Grants Programme implemented by United Nations Development Programme (UNDP) launched the Plastic Innovation Programme (PIP) at the end of 2021 to solicit systematic solutions to plastic pollution globally. After a public call for proposals and a vetting and selection process, the project of Plastic Pollution Prevention and Control Through the Entire Value Chain Modality, co-designed by the All-China Environment Federation (ACEF) and the GRPG, was selected by the National Steering Committee of GEF SGP in China in April 2022. The project will work with stakeholders in the plastic value chain to explore and practise solutions to upstream, midstream and downstream management of plastic pollution. It will analyze the baseline of the entire plastics industry chain, and identify the key challenges and problems in China's plastic pollution control; develop demonstration sites for zero-waste management system and plastic pollution reduction models at the community level; organize policy communication and advocacy to address the key issues in plastic pollution control, and facilitate the formulation and implementation of relevant policies; and at the same time carry out publicity and communication campaigns with stakeholders to increase the public awareness on the issue of plastic pollution and spur the public actions on reducing plastic pollution. The outputs of the project will serve as a reference for relevant policymakers, city administrators, businesses and citizens at home and abroad, and therefore enable stakeholders from all sectors of society to gain insights into the state of plastic pollution and take effective measures to put an end to pollution and waste of resources from the source. Meanwhile, the project will also contribute non-governmental Chinese solutions to the conclusion of a legally binding international agreement on plastic pollution by 2024, as proposed by the United Nations Environment Assembly (UNEA).

GEF Small Grants Programme (SGP)

Established in 1992 as a corporate programme of the Global Environment Facility (GEF), the GEF Small Grants Programme is implemented by the United Nations Development Programme (UNDP). SGP funds sustainable development projects implemented by local non-governmental organizations, especially for the good of indigenous peoples, women and youth, in 125 countries around the world to promote community-based innovation, capacity building and empowerment. SGP has supported over 20,000 community projects globally in biodiversity conservation, climate change mitigation and adaptation, prevention of land degradation, protection of international waters, and reduction of the impact of chemicals, while developing sustainable lifestyles.

All-China Environment Federation (ACEF)

Founded in 2005, the All-China Environment Federation (ACEF) is a nationwide non-profitable civil society organization (CSO) composed of individuals, businesses and public institutions that are enthusiastic about and support environmental protection on a voluntary basis. ACEF is approved by the State Council of the People's Republic of China, registered with the Ministry of Civil Affairs, and guided and regulated by the Ministry of Ecology and Environment and the Ministry of Civil Affairs. With the aim of building a platform for unified effort to protect the ecological environment in China, ACEF has been committed to liaison and coordination, international exchanges, and environmental rights protection for environmental non-governmental organizations (NGOs) nationwide since its founding, by keeping in mind the philosophy of uniting all the people of the whole China to protect the environment. It strives to promote the development of environmental undertakings in China and for all humanity by giving full play to its role as a bridge between the government and society.

Green Recycled Plastic Supply Chain Joint Working Group (GRPG)

The Green Recycled Plastic Supply Chain Joint Working Group (GRPG) is China's first collaborative industrial chain platform, co-initiated by China Petroleum and Chemical Industry Federation (CPCIF), China National Resources Recycling Association (CRRA) and China Plastic Processing Industry Association (CPPIA) in partnership with leading enterprises in the industrial chain in June 2020. GRPG aims to address bottlenecks in the circular plastics economy through collaboration among upstream and downstream enterprises in the plastics industry, including those engaged in production, processing, branding, recycling and disposal. It has strong policy advocacy and industrial influence on plastics-related issues.

INTRODUCTION

INTRODUCTION

Plastic is an important raw material that has been used in various areas of daily life and production. It is used to ensure food safety, promote grain production, manufacture logistics containers, reduce social operating costs, and make daily life more convenient, proven to be a widely applicable, highly reliable and affordable material. Per capita consumption of plastics also reflects the economic development level of a country. China is already a major country in the production, processing and consumption of plastic raw materials and products. According to statistics, China's plastic production in 2020 was more than 100 million tons, in which plastic products from industrial enterprises above designated size exceeded 76 million tons, indicating a growing demand for raw materials, an expanding economic scale, and an improving living standard in the country.

The huge consumption of plastics will generate a massive volume of plastic wastes, but not all plastic wastes will cause pollution. The root cause of plastic pollution lies not in the increase in plastic consumption or waste, but whether plastics have been properly recycled and disposed of after being discarded. Plastic pollution is caused by plastic waste leaking into the environment, and the fundamental causes of environmental leakage are the lack of garbage removal capacity and littering.

It has become a global consensus that we should see plastic pollution scientifically and rationally, actively and effectively control man-made leakage, build a scientific and precise waste management system, properly manage and control plastic waste, relieve disposal burden, and increase the proportion of recycling. It should be noted that with enhancement of public awareness of environmental protection, problem-oriented and precise policy implementation, improvement of garbage removal capacity, and changes in garbage disposal methods, the capacity in safe disposal of plastic waste will be greatly improved. Also, as waste management system gets improved and new recycling technology developed, recycling rate will continue to rise, hence high-value utilization of plastic waste. Under a precise and scientific management system, plastic pollution is generally controllable and recycling of plastic waste can be much more efficient.

At the same time, the recycling of plastic waste has provided considerable plastic raw materials for China's economic development. Statistics from China Plastics Recycling Association of China National Resources Recycling Association (CRRA) show that China's domestic recycled plastic production in 2021 was 13.77 million tons, and that in the past five years, plastic materials generated from recycled plastic waste in China has amounted to 86 million tons, equivalent to China's annual plastic products production. This saved a large amount of oil resources, reduced dependence on oil, and made substantial contributions to China's economic development.

Through decades of efforts, China has achieved remarkable results in plastic pollution control. First, it established an extensive market-based plastic waste recycling system, ranking first in the world in recycling plastic waste. Second, relying on a solid plastics industry system, it built a complete circular system covering collection, recycling and utilization. Third, China not only achieved 100% local utilization of its own plastic waste, but also disposed of plastic waste from developed countries between 1992 and 2018, contributing greatly to global plastic pollution control. By developing a circular plastics economy, China has explored a feasible path for proper use of plastics worldwide and sustainable development of mankind. This report provides an overview of the production, consumption, waste and recycling of plastics around the world and in key countries and regions. It systematically sorts out China's plastics industry and plastic waste recycling, as well as China's urban plastic pollution control and sustainable consumption among the public. Through this report, readers will have a comprehensive understanding of the plastics industry, plastic pollution, plastic waste recycling, and plastic waste disposal across the world and in China.

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Overview of Global Plastic Production and Plastic Waste Disposal

(i) Global Plastic Production and Supply

The demand for plastics has been rising significantly year by year, as global population increases and world economy develops in a fast manner. Statistics from OECD show that global production of all types of resins and chemical fibers climbed from 234 million tons in 2000 to 431 million tons in 2019, nearly doubling in less than 20 years. In 2019, 429 million tons of plastic raw materials were produced from petroleum sources and 2 million tons from bio-based sources. In 2021, the United Nations Environment Programme (UNEP) released a report titled *From Pollution To Solution: A Global Assessment Of Marine Litter And Plastic Pollution*, noting that the global cumulative production of virgin plastics was about 9.2 billion tons between 1950 and 2017 and could reach 34 billion tons by 2050, with an average annual growth rate of about 7.9%.

I. Global Plastic Consumption and Plastic Waste Disposal

Table 1-1. Global Production of Virgin Plastics and Per Capita Consumption in 2015-2050

	2015	2016	2017	2018	2019	2020	2035 (Predicted)	2050 (Predicted)
Global Per Capita Consumption (kg/person)	43.63	44.88	46.11	47.04	47.71	46.60	84.37	113.51
Global Total Production (10 ⁶ tons)	322	335	348	359	368	367	734	1101

Note: PET fiber/acrylic fibre/nylon fiber are excluded; thermoplastics/PU/thermoset plastics/elastomer/adhesive/coating material/sealant/PP fiber, etc. are included.

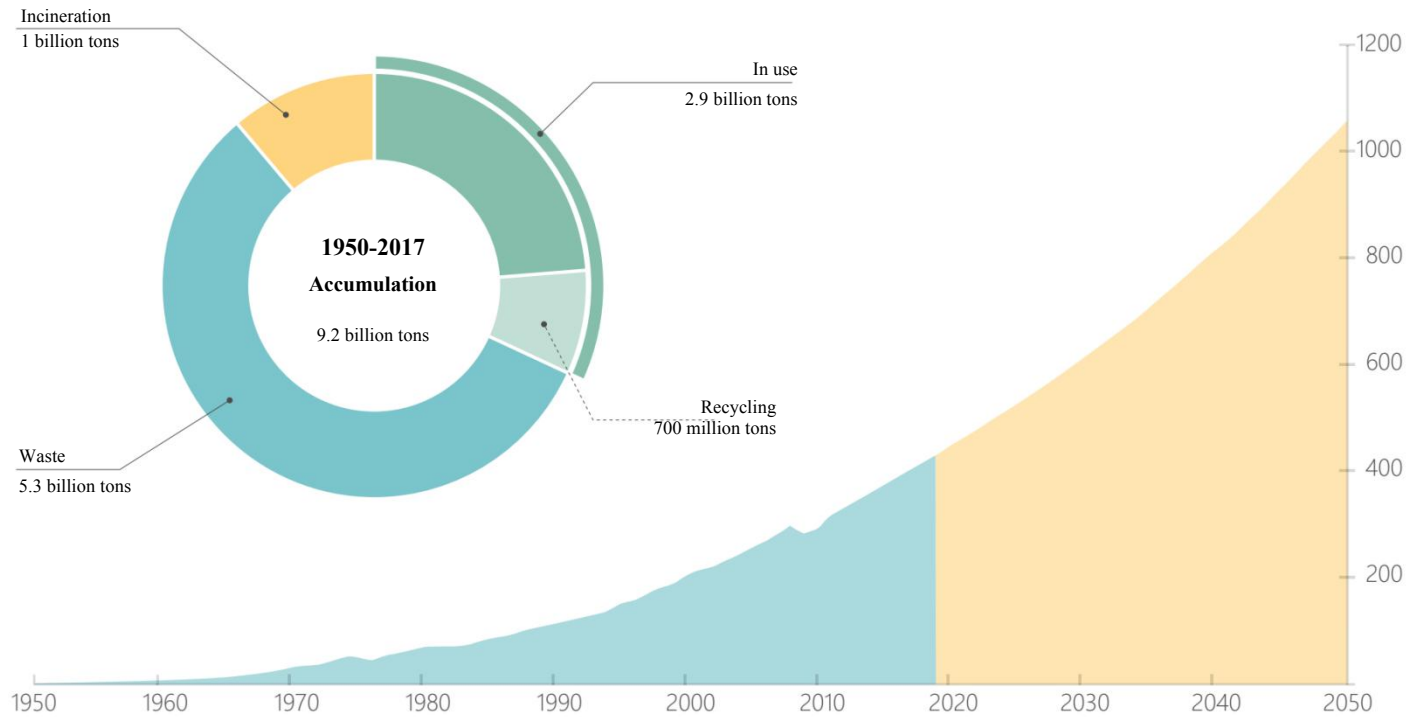


Figure 1-1. Global Plastic Production, Accumulation and Future Trend

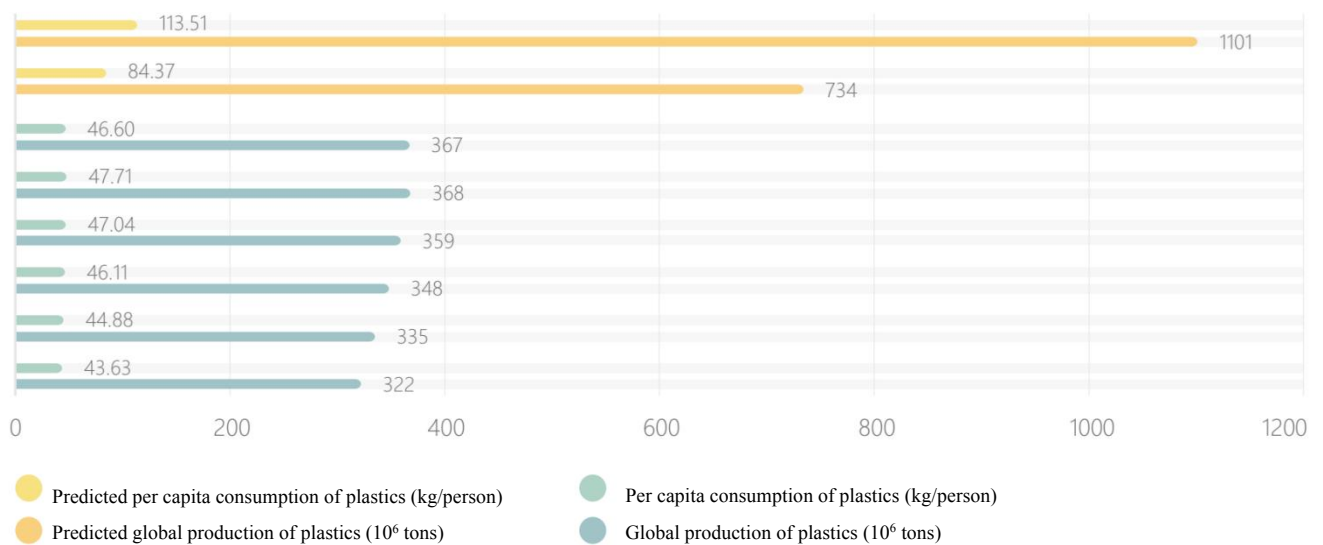


Figure 1-2. Global Plastic Production and Consumption

Source: PlasticsEurope

1. Global plastic waste and their collection

(1) Global plastic waste

Since 1950, about 8.3 billion tons of plastics have been discarded globally. The OECD, in its 2022 released *Global Plastics Outlook*, estimated that total global plastic wastes in 2019 were 353 million tons, in which 55 million tons (15.58%) entered the plastic waste collection systems in countries around the world. However, due to losses in sorting and processing, only 29 million tons of recycled plastics re-entered the circular system, which means the global recycling rate of plastic waste in that year was only 8.22%.

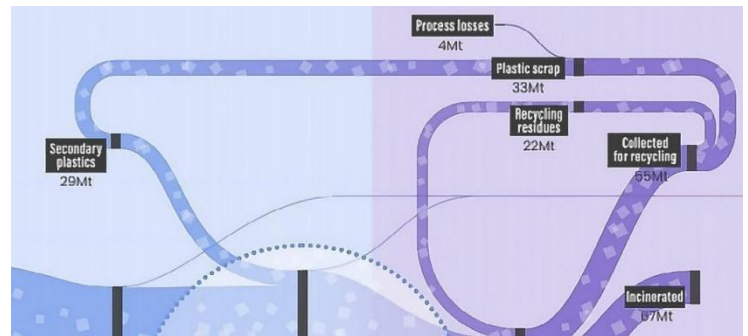


Figure 1-3. Plastics Recycling Chain

Table 1-2. Global Plastic Waste Collection and Recycling in 2019 (Unit: 10⁶ tons)

Plastic waste	Collected for recycling	Recycling residues	Plastic scrap	Process losses	Recycled plastics	Recycling rate
353	55	22	33	4	29	8.22%

Note: Recycling residues are mostly hard to be recycled and are generally incinerated or landfilled.

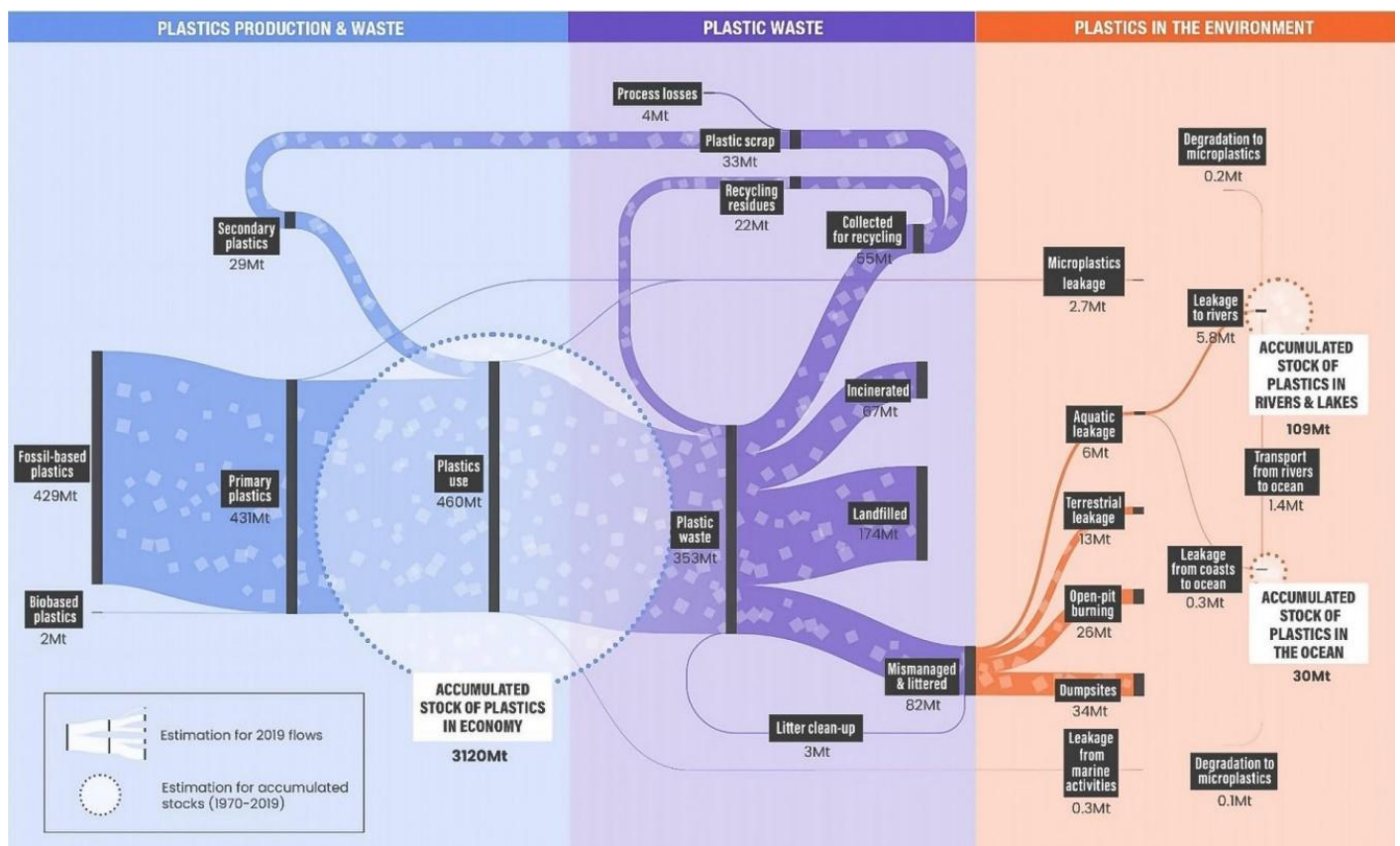


Figure 1-4. Global Plastics Industry Chain

(2) Global transfer of plastic waste

The world's major developed economies have long been exporting plastic waste to developing countries. By 2016, about 120 countries had been involved in international trade in plastic waste. From 1987 to 2017, China imported a total of 170 million tons of plastic waste, accounting for 72% of the world's total export.

In 2017, China announced that it will gradually end the import of plastic waste and basically stop the import by 2019. China's ban on import of plastic waste and the amendments to the *Basel Convention* led to dramatic changes in the global cross-border trade of plastic waste. Because traditional plastic waste exporting countries have long been dependent on exporting to China, their own plastic recycling capacity has been developing slowly. With this huge gap, these countries found it hard to develop alternative capacity over a short time period, which is why they gradually changed their export destinations to Southeast Asia as well as other parts of the world.

In 2019, the world's major plastic waste exporters were still the European Union, the United States and Japan, with the export rates at 47.15%, 38.21% and 42.76%, respectively, all much higher than their rates of local mechanical recycling of plastic waste.

Table 1-3. A Comparison of Rates of Local Mechanical Recycling in China, the EU, the US and Japan in 2019 (Unit: 10⁴ tons)

Country	Plastic waste	Apparent recycling volume	Apparent recycling rate	Export volume	Export rate	Local mechanical recycling of plastic waste	Rate of local mechanical recycling of plastic waste	Data source
China	6300	1890	30.00%	0	0.00%	1890	30%	China Recycled Plastics Industry Development Report
The EU	2910	946	32.51%	446	47.15%	500	17.2%	PlasticsEurope 2020 Report
The US	3237	280	8.65%	107	38.21%	173	5.3%	Website of U.S. Environmental Protection Agency (epa.gov)
Japan	850.1	185.7	21.84%	79.4	42.76%	106.3	12.5%	Plastic Waste Management Institute (PWMI)
Worldwide	35300	--	--	--	--	3300	9%	Organization for Economic Cooperation and Development (OECD)





(ii) Global Recycling and Disposal of Plastic Waste

Global collection and recycling of plastic waste have remained at low rates and cannot meet disposal needs. Consequently, landfilling and incineration of plastic waste have maintained a significant proportion globally, which are usually higher than the scale of local recycling in most regions. Regions with different economic development and plastics consumption capacity also have varied disposal capacity and routes. Excluding the exported plastic waste, the scale of mechanical recycling, chemical recycling, landfilling, and incineration varies from region to region. Among major economies, the United States has the highest landfilling rate, and Japan has the highest rate of power generation by incineration.

1. Mechanical recycling

In 2019, 55 million tons of plastic waste entered the recycling system globally. After sorting, only 33 million tons can be processed into recycled plastics. With process losses deducted, the global production of recycled plastics was 29 million tons.

Limited by existing business models of plastics recycling and the profitability of the industry, the vast majority of plastic waste worldwide are converted into recycled plastics through mechanical recycling. Mechanical recycling does not change the chemical structure of the plastic, instead, it remolds the plastic based on its thermoplasticity at a certain temperature. Being relatively low-cost, mechanical recycling has a profit margin that can basically sustain the operation of the plastics recycling business model. In particular, for higher-quality plastic waste from industrial and commercial sources, the costs of collection, transportation, sorting, cleaning, as well as the level of technical difficulties, are relatively low, and the resulting recycled plastics are often of consistent quality and higher value.

Recycling of plastic waste from domestic sources is a major challenge worldwide. The sources are scattered, and the plastic wastes usually come in a variety of forms and are highly mixed with other wastes, requiring huge collection and sorting costs.

Collection rates and local recycling rates with plastic waste were not high in major plastics consuming countries and regions in 2019. Among them, collection rates in the European Union (2018), the United States (2018), and Japan were 32.51%, 8.65%, and 21.84%, respectively. However, excluding the plastic waste exported to other countries for recycling, their local recycling rates were only 17.18%, 5.34%, and 12.50%, respectively.

2. Chemical recycling

As defined in *Plastics — Guidelines for the recovery and recycling of plastics waste* (ISO 15270: 2008), chemical recycling refers to conversion to monomer or production of new raw materials by changing the chemical structure of plastics waste through cracking, gasification or depolymerization. Energy recovery or incineration do not fall into the category of chemical recycling.

From a global perspective, chemical recycling is still in its infancy. A few companies in Europe, the United States and China have begun to explore chemical recycling and have achieved a certain production volume. Compared with mechanical recycling, however, this volume is far from being comparable. Chemical recycling helps reduce reliance on virgin fossil raw materials and avoids the generation of greenhouse gas emissions from raw material-based production and plastic waste incineration. A growing number of pilot and demonstration plants in chemical recycling industry are being built. Chemical recycling is an important technical route to address plastic waste.

3. Landfilling

Landfilling is not a complete disposal of plastic waste. Generally, landfilling shall be safe and sanitary, which means plastic waste shall be buried in specific landfills that have anti-seepage measures.

Plastic wastes ending up in landfills usually come from daily life and are highly mixed with other wastes. In landfills in urban areas, the proportion of plastic waste can generally reach 15%-20%. Landfilled plastic wastes are mainly film-type flexible packaging, as well as various rigid containers. Such plastic wastes cannot make their way to commercial recycling because generally, they are highly contaminated and low-value, and separating them from other wastes is difficult. In places where garbage classification is implemented, plastic wastes not put into recyclable bins are usually landfilled.

Landfilling cannot fundamentally solve the problem of plastic waste disposal. The degradation cycle of plastic waste is generally much longer than the service life of landfills. Once the anti-seepage function of the landfill fails, a large amount of microplastics will seep out through precipitation and enter water bodies.

The landfilling proportions in major plastics consuming countries and regions were relatively high in 2019. In the European Union (2018), landfilling proportion reached 24.9%, and the total landfilling was 7.25 million tons. The United States had a high landfilling proportion of 75.59%, and the total landfilling was 24.47 million tons. Japan had a high recycling rate. As non-recycling means, landfilling and direct incineration totalled 1.246 million tons, a non-recycling rate of 14.66%.

4. Incineration

Incineration is a more complete disposal method that has a great environmental impact. It is a one-time use of resources. Therefore, major plastics consuming countries and regions are more focused on energy recovery through incineration, in a bid to improve efficiency of resource utilization.

The European Union sees energy recovery as an important method of recycling. In 2018, a total of 12.4 million tons of plastic waste, accounting for 42.6%, were incinerated for power (heat) generation. In the United States, 5.1 million tons (15.76%) were incinerated for power generation. Japan puts recycling at an important position. In 2019, a total of 5.131 million tons of plastic waste (accounting for 60.36%) were incinerated for power generation.

In 2019, global plastic waste totalled 353 million tons (OECD data). Among them, 55 million tons entered the plastics recycling system (including difficult-to-recycle plastics), with a collection rate of approximately 15.58%; 67 million tons were incinerated to generate electric power, with an energy recovery rate of 18.98%; 174 million tons were landfilled, a landfilling rate of 49.29%; up to 82 million tons were directly discarded or improperly disposed of (including environmental leakage, direct discarding, direct incineration, etc.), an improper disposal rate of 23.23%.

These data show that globally speaking, landfilling is still the major method to dispose of plastic waste, followed by improper disposal, the main cause of the existing plastic pollution. Therefore, improving the efficiency of garbage classification and reducing landfilling and improper disposal should be the main directions in reducing the environmental impact of plastic waste at the current stage.



II

Overview of Plastic Production and Plastic Waste Disposal in China

(i) Plastic Production and Supply in China

According to data from China's National Bureau of Statistics (NBS), China's virgin plastic production in 2021 was 110.39 million tons, a year-on-year increase of 6.6%. Chinese customs data show that China imported 33.97 million tons of virgin plastic raw materials in 2021, a year-on-year decrease of 16.39%; supply of virgin plastic raw materials in China in 2021 was 144.36 million tons, a year-on-year increase of 0.12%. Supply of virgin plastic raw materials in China continued to grow between 2017 and 2021, with an average growth rate of 5.98% in the five years.

II. Plastic Industry and Plastic Waste Recycling in China

According to NBS statistics, China's total production of plastic products in 2021 was 80.04 million tons, a year-on-year increase of 5.9%. With the plastic production beyond those by model companies of plastic products included, China's consumption of plastic raw materials continues to grow.

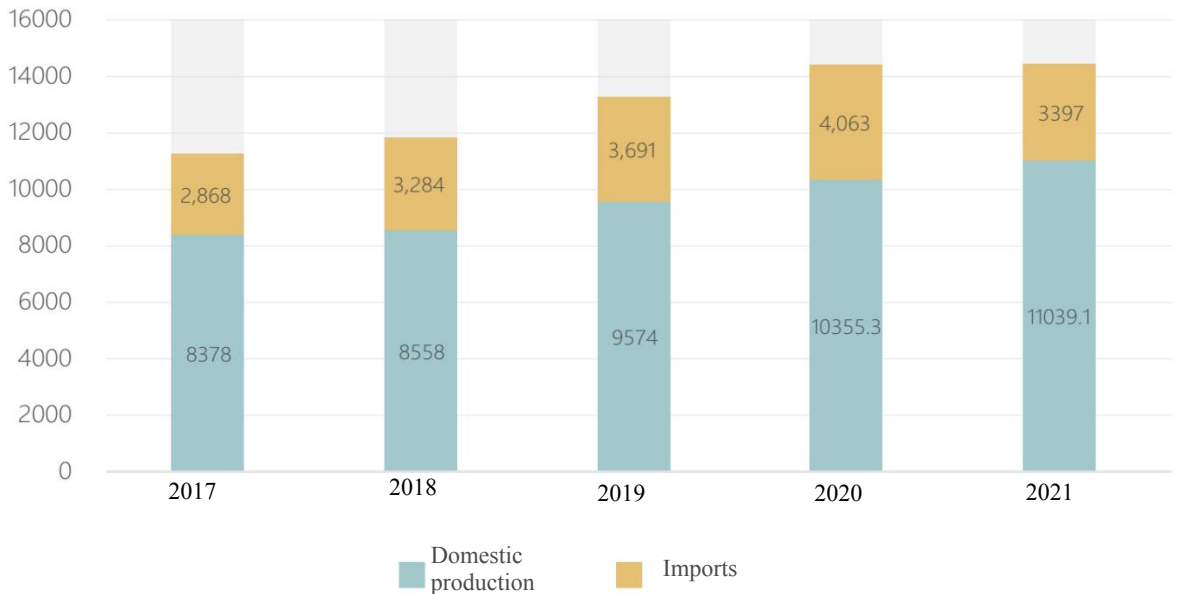


Figure 2-1. Supply of Virgin Plastic Raw Materials in China in 2017-2021 (Unit: 10⁴ tons)
 Source: National Bureau of Statistics (NBS); General Administration of Customs of the People's Republic of China (GACC)

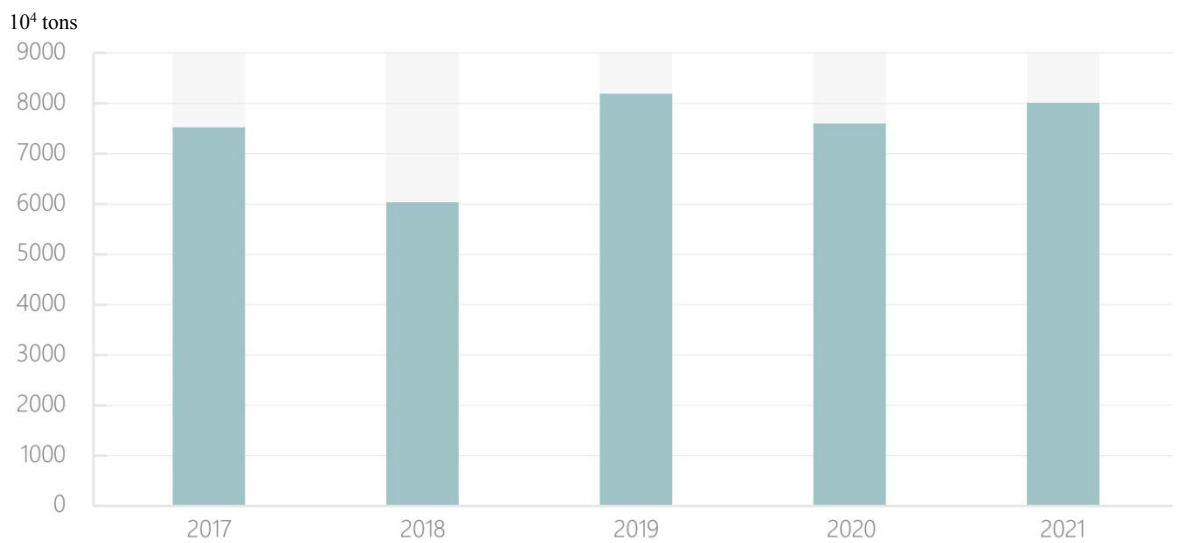


Figure 2-2 Production of Plastic Products in China in 2017-2021 (Unit: 10⁴ tons)
 Source: National Bureau of Statistics (NBS)



(ii) Recycling and Disposal of Plastic Waste in China

Statistics and calculations from China Plastics Recycling Association of CRRA show that in 2021, China generated about 62 million tons of plastic waste, in which about 15.4 million tons (25%) were landfilled, about 27.6 million tons (44%) were incinerated, and about 19 million tons (31%) were recycled.

Table 2-1. Disposal of Plastic Waste in China in 2021

Method of disposal	Landfilling	Incineration	Recycling
Volume	1540	2760	1900

Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA)

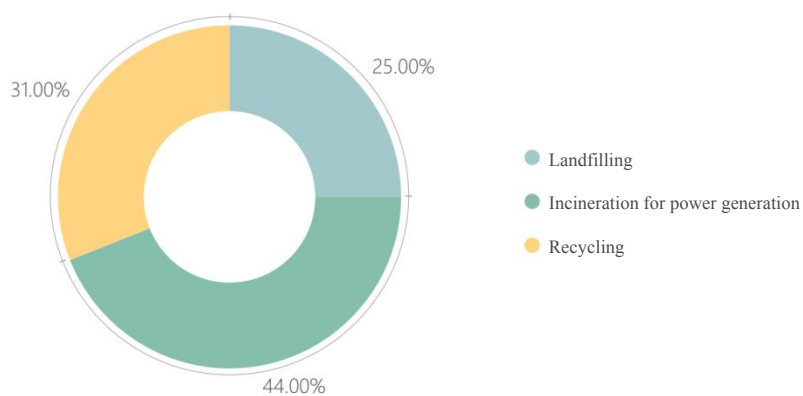


Figure 2-3. Proportions of Methods of Disposal of Plastic Waste in China in 2021

Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA)



Figure 2-4. A Landfill in China

1. Landfilling

In 2021, a total of 15.4 million tons of plastic waste, accounting for 25% of the total plastic waste that year, were landfilled in China, a significant decrease from the 21 million tons in 2020.

In recent years, landfilling of plastic waste in China has been slowly decreasing because of several reasons. First, landfills around cities face increasing land use cost. Second, after China stopped importing plastic waste, the gap in supply of recycled plastics in China has continued to exist, and domestic demand for raw materials has been rising. Due to this stimulus, sorting capacity has been improved and the country began to dispose of low-value recyclables based on their conditions. Third, as China is pushing forward a garbage classification system, volume of household waste removal in some cities has dropped significantly, and supply of recyclables has increased. Fourth, demand from incineration-based power generation companies is rising.

2. Incineration

In 2021, 27.6 million tons of plastic waste were incinerated in China for power generation, up by 25.45% from the 22 million tons in 2020.

Because the high heat value of plastic waste can help maintain furnace temperature, incineration and power generation companies have begun to compete with plastics recycling companies for household waste with high plastic waste content in recent years. This also led to a year-by-year increase in plastic waste incineration and power generation in China.



Figure 2-5. An Incineration Plant in China

3. Recycling of plastic waste in China

(1) Recycling of plastic waste in China

Statistics and calculations from China Plastics Recycling Association of CRRA show that in 2021, China recycled about 19 million tons of plastic waste, a year-on-year increase of 19% (about 3 million tons) from the 16 million tons in 2020.

Thanks to rising prices and increased recycling volume, China's plastic waste recycling output reached approximately 105 billion yuan in 2021, a year-on-year increase of 33% from the 79 billion yuan in 2020.

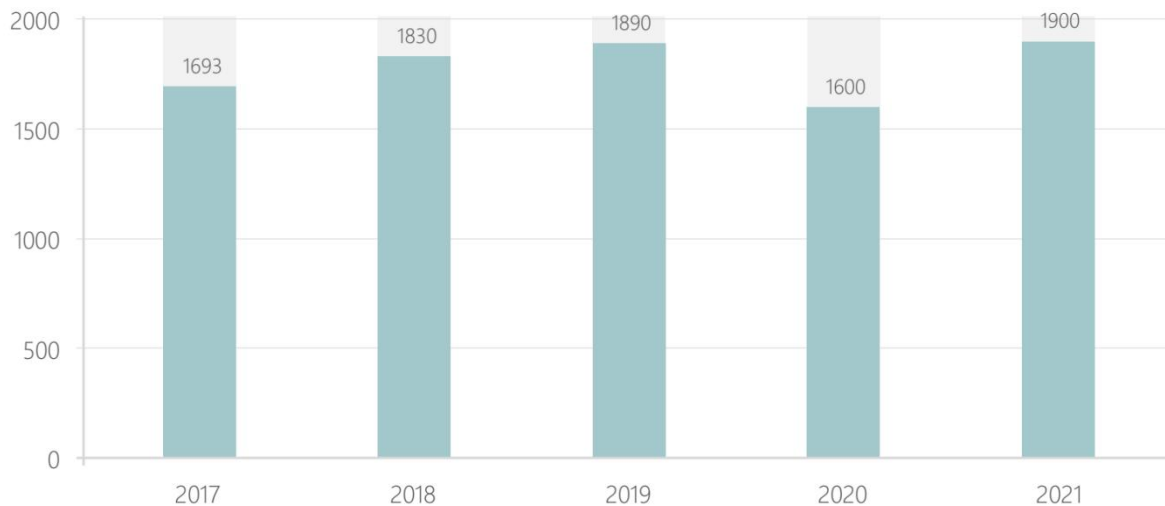


Figure 2-6. Volume of Recycling of Plastic Waste in China in 2017-2021 (Unit: 10⁴ tons)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); circulation data from Ministry of Commerce, P.R.C

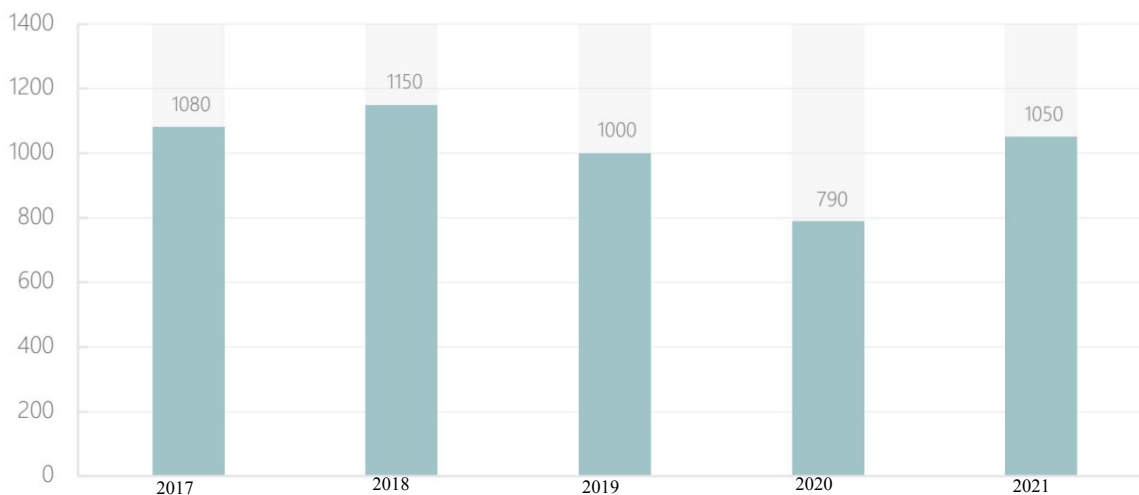


Figure 2-7. Value of Recycling of Plastic Waste in China in 2017-2021 (Unit: 10⁸ yuan)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); circulation data from Ministry of Commerce, P.R.C

II. Plastic Industry and Plastic Waste Recycling in China

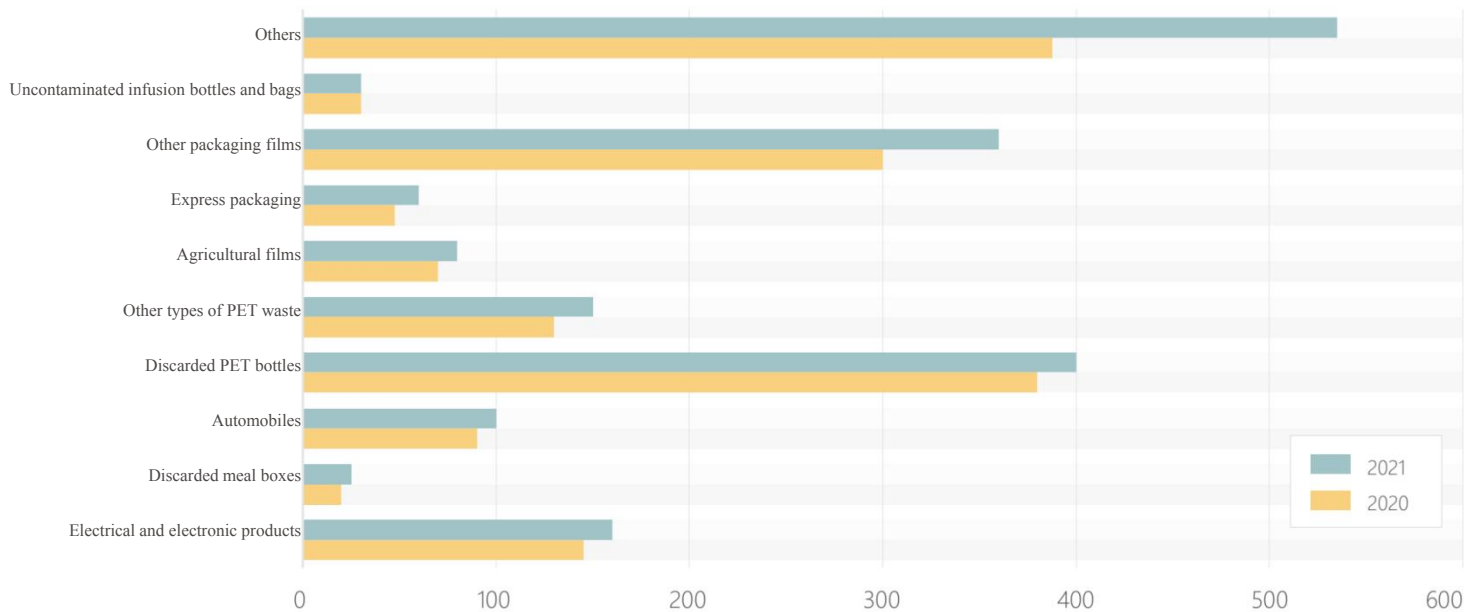


Figure 2-8. Plastic Waste Generated from Various Sectors in China in 2020-2021 (Unit: 10⁴ tons)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA)

According to statistics and calculations of plastic waste recycling in 2021, plastic waste recycled from electrical and electronic products was 1.6 million tons, accounting for 9%; from discarded meal boxes was 250,000 tons, accounting for 1%; from automobiles was 1 million tons, accounting for 5%; from PET waste was 5.5 million tons, in which 4 million tons were from discarded PET bottles, accounting for 21%, and 1.5 million tons were from other types of PET waste, accounting for 8%; from agricultural films was 800,000 tons, accounting for 4%; from express packaging was 600,000 tons, accounting for 3%; from discarded packaging films (excluding express packaging) was 3.6 million tons, accounting for 19%; from infusion bottles (bags) was 300,000 tons, accounting for 2%; and from other unidentified sources was 5.35 million tons, accounting for 28%.

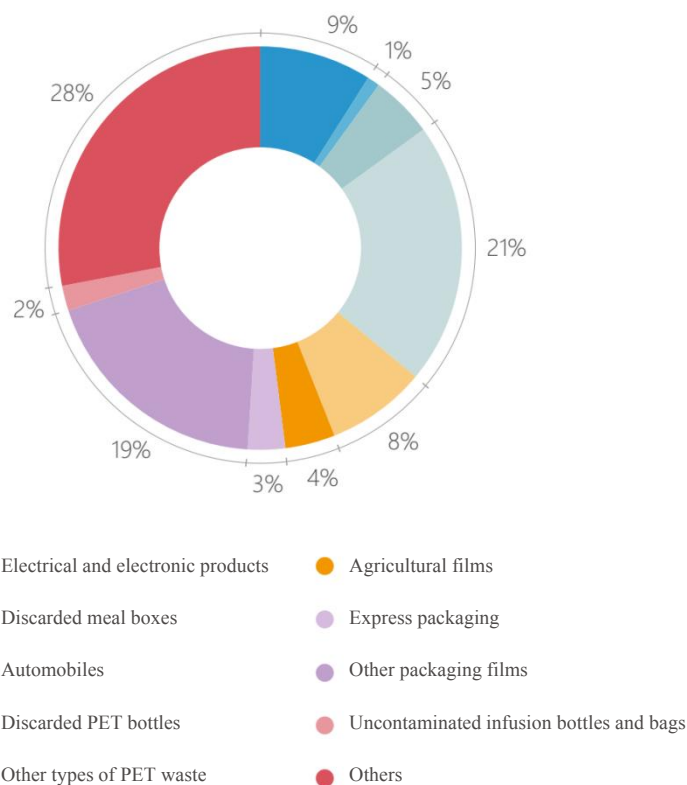


Figure 2-9. Proportions of Plastic Waste Recycled from Various Sectors in China in 2021
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA)

(2) Imports of plastic waste in China

GACC data show that total Chinese imports of plastic waste dropped to 5.83 million tons in 2017, to 51,900 tons in 2018, and became basically negligible in 2019. From 2020 to 2021, Chinese import of plastic waste was zero. In the next 3-5 years, it is expected that China's imports of plastic waste and scrap will continue to be zero, but imports of recycled pellets will remain at a certain level. According to research, China imported about 3.6 million tons of recycled plastic pellets in 2021.

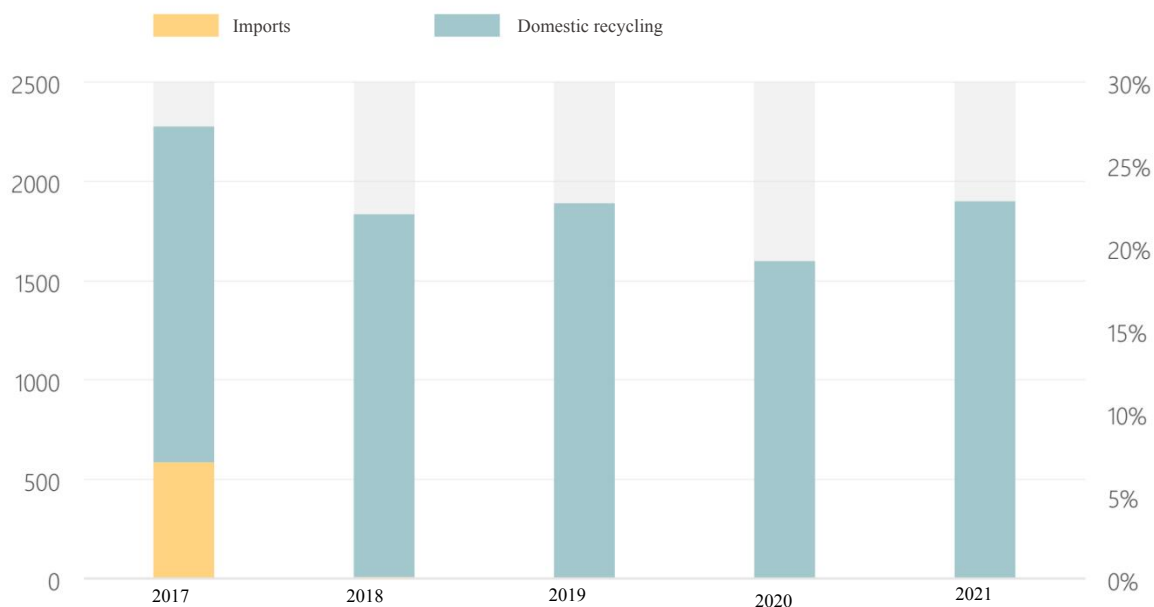


Figure 2-10. Imports of Plastic Waste in China in 2017-2021 (Unit: 10⁴ tons)
Source: Customs data

(3) Processing and utilization of plastic waste in China

China's production of recycled plastics currently ranks first in the world. At present, recycled plastics processing companies are concentrated in northern, eastern and southern China. Meanwhile, influenced by environmental protection policies, cost issues and the establishment of plastic waste recycling system, processing companies will spread to inland areas such as central, northwestern, northeastern, and southwestern China. In recent years, large-scale recycled plastics processing companies are more inclined to establish branch factories in central China.

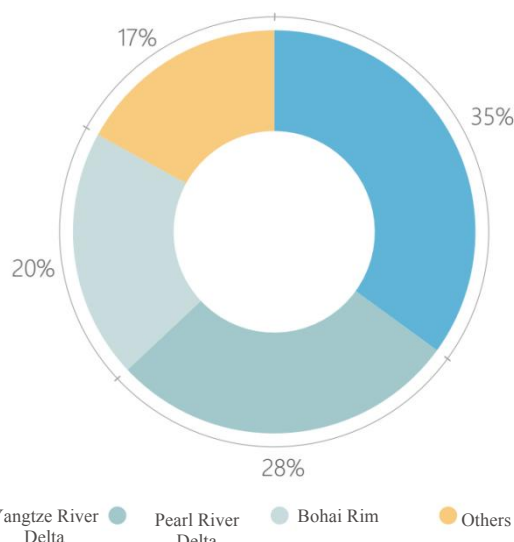


Figure 2-11. Geographical Distribution of Processing Capacity in Recycled Plastics in China in 2021
Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); publicly available data on the Internet

II. Plastic Industry and Plastic Waste Recycling in China

In 2021, the supply of recycled plastic pellets increased as a result of rising raw material prices and the receding impact of Covid-19 epidemic. According to statistics and calculations from China Plastics Recycling Association of CRRA, China's domestic production of recycled plastics was about 16.5 million tons in 2021, an increase of about 2.73 million tons from the 13.77 million tons in 2020, up by 19.8%.

According to statistics and calculations of the recycling of main plastic waste products in 2021, the production of recycled PET was 4.8 million tons, accounting for 29%, which was the main product in recycled plastics processing in China. The production of recycled PE pellets was 3.3 million tons, accounting for 20%; that of recycled PP pellets was 3.3 million tons, accounting for 20%; recycled polyolefin pellets accounted for 40%; the production of recycled PVC pellets was 1.35 million tons, accounting for 8%; that of recycled ABS pellets was 850,000 tons, accounting for 5%; that of recycled PS pellets was 800,000 tons, accounting for 5%; that of recycled PC pellets was 450,000 tons, accounting for 3%; that of recycled PA pellets was 500,000 tons, accounting for 3%; and that of other recycled plastic pellets was 1.15 million tons, accounting for 7%.

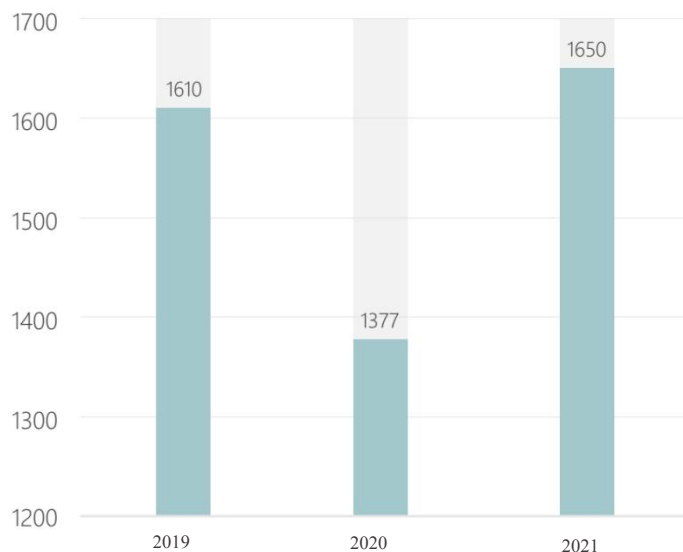


Figure 2-12. Recycled Plastic Pellets Processing in China in 2019-2021 (Unit: 10⁴ tons)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); publicly available data on the Internet

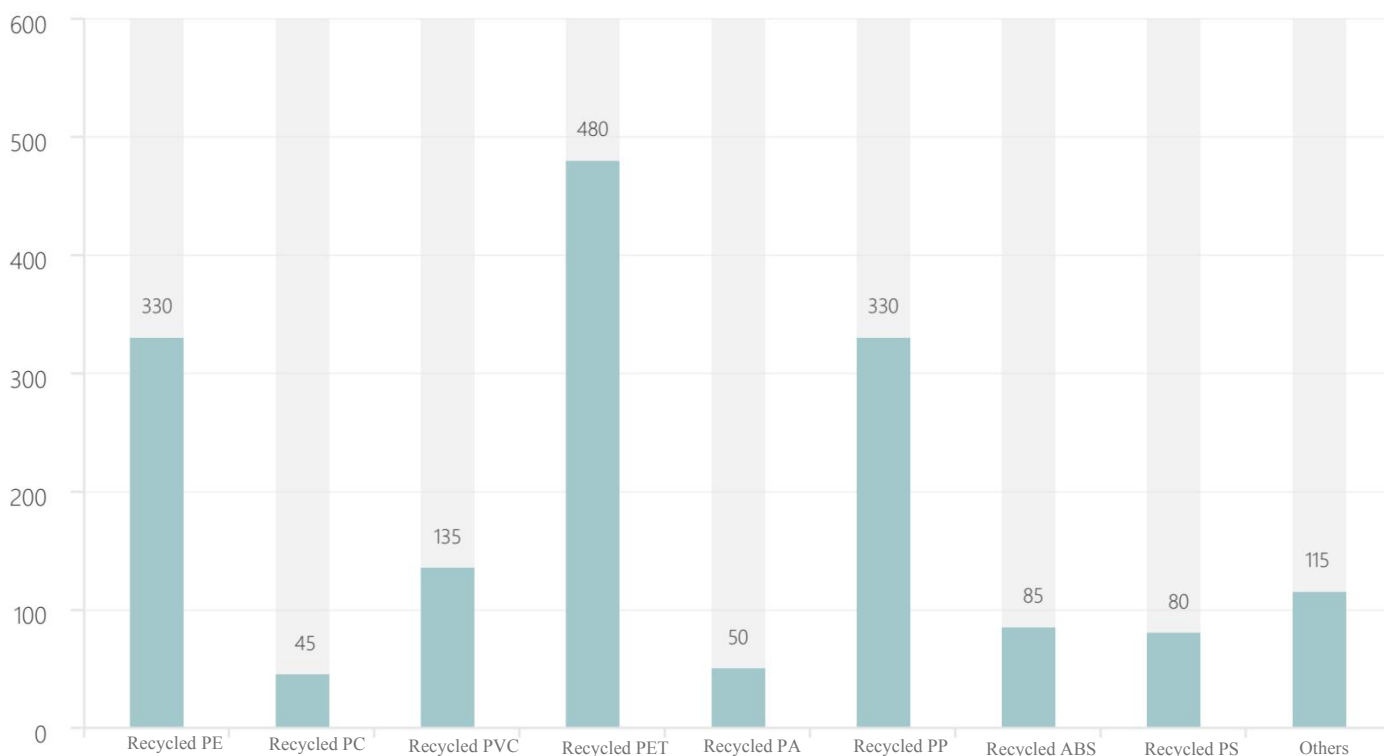


Figure 2-13. Processing of Main Recycled Plastic Products in China in 2021 (Unit: 10⁴ tons)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); publicly available data on the Internet

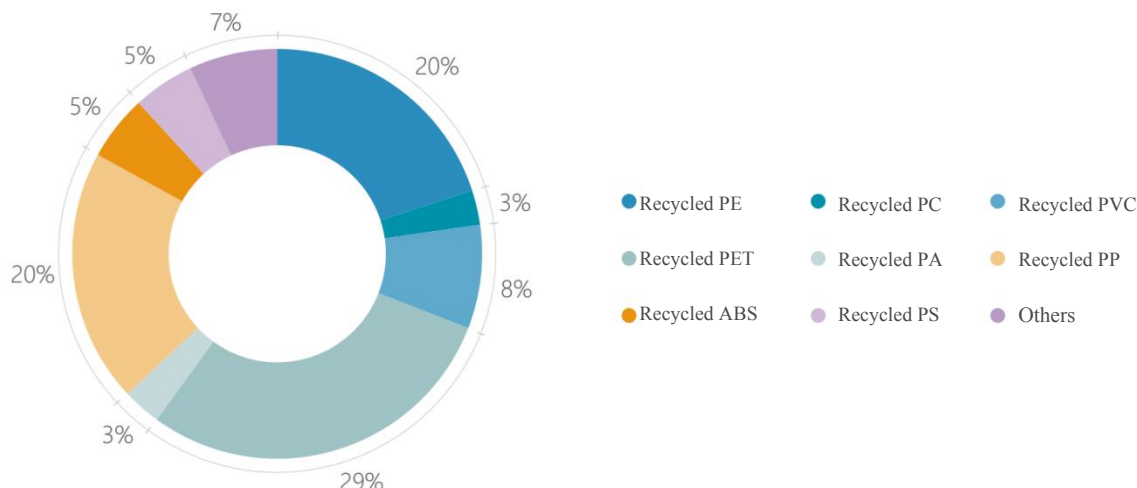


Figure 2-14. Proportions of Main Recycled Plastic Pellets in China in 2021
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); publicly available data on the Internet

(4) Main areas of application of recycled plastics in China in 2021

The downstream uses of recycled plastics in China are generally similar to those of virgin plastics (except for food-related use). At present, recycled plastics have been widely used in textiles, automobiles, packaging, consumer electronics, agriculture, construction and building materials, etc. Recycled general-purpose plastics are most widely used in the areas of films and injection molding, accounting for 36% and 28% respectively. Their application in blow molding and pipes has reached 12%. Recycled engineering plastics have been increasingly used in textiles, automobiles, packaging, consumer electronics, etc. For example, recycled PC is commonly used in home appliances, automobiles, plates, and modification (including alloy) industries; recycled PA is more used in automobile manufacturing, electronic appliances, medical equipment, and textile industries.

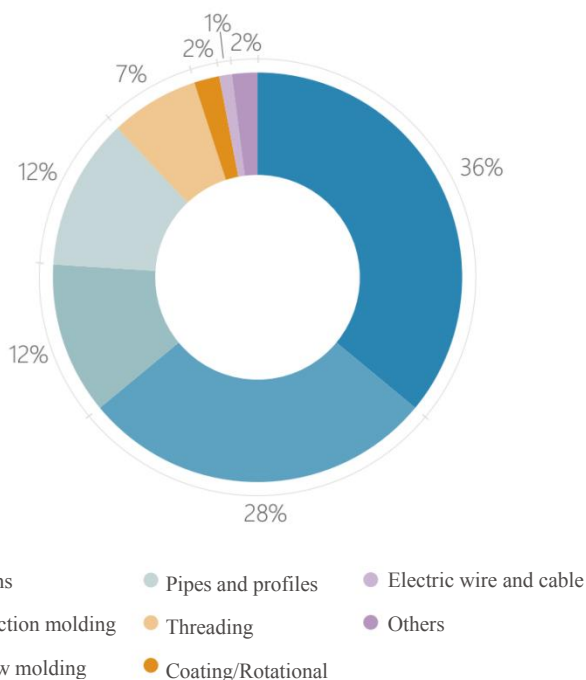


Figure 2-15. Downstream Application of Recycled General-Purpose Plastics in 2021 (Excluding Recycled PET)
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); partially publicly available data

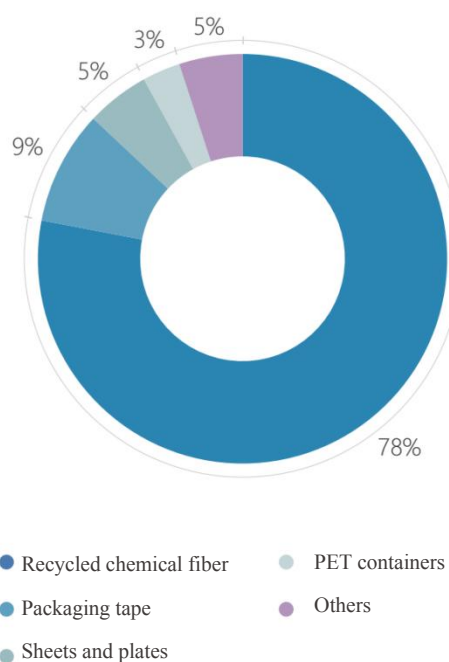


Figure 2-16. Downstream Application of Recycled PET in 2021
 Source: China Plastics Recycling Association of China National Resources Recycling Association (CPRA); partially publicly available data

(5) Development history of recycled plastics industry in China

Understanding and start of recycling (1984-1994): Before 1984, only a few state-owned enterprises and collectively-owned enterprises were engaged in recycling. After 1984, with the rapid development of self-employed businesses, China faced a growing demand for plastic resources and an increasing volume of discarded plastics, hence the gradual development of plastic waste recycling and processing industry.

Development and improvement (1994-2004): This stage is a "golden period" for the recycling of plastic waste, as tens of thousands of "family workshops" entered this industry. Recycling rate grew from less than 22.6% to 30% and even higher (recycling rates of some products reached 60%-80%).

Maturity and competition (2005-2007): During this stage, competition in the industry became fierce. Large-scale companies emerged, and problems gradually stood out. Meanwhile, local plastic waste resources could barely meet domestic market demand, and the supply of imported plastic waste continued to grow during this period.

Adjustment and plateauing (2008-2013): After 2008, environmental protection-oriented rectification became normalized, and for a long time, many recycled plastics processing markets in China were under rectification or shutdown. In 2013, rectification of recycled plastics industry covered the entire China. At this time, a consensus was reached on structural upgrading such as industry technology upgrade and environment-friendly development, and China's recycled plastics industry officially entered a stage of transformation and upgrading.

Transformation and upgrading (2014-2017): After the "Operation Green Fence" to combat smuggling of overseas waste in 2013, the shutdown or rectification of recycled plastics distribution centers became normalized in China. At this stage, stimulated by environmental concerns, Chinese companies stopped operations and began to go through transformation and upgrading, or to move abroad, marking the start of a comprehensive transformation and upgrading of the industry.

Green development (2018 - into the future, a new era of environmental protection): China officially introduced the "ban on waste" in July 2017, and further upgraded its policy in 2018, hence a significant drop in imports of plastic waste. At the same time, China actively guided local recycling, and China's plastic waste recycling companies came back to their function of disposing of solid plastic waste with an obvious environmental focus, starting a new chapter in recycled plastics industry.

As China's recycled plastics industry officially entered a new stage of green development and has been marching forward under the guidance of a number of policies, how to better balance environmental protection and industry development, and how to better solve the existing environmental problems such as plastic pollution and piled garbage surrounding cities, have become a major challenge for the recycled plastics industry in China.

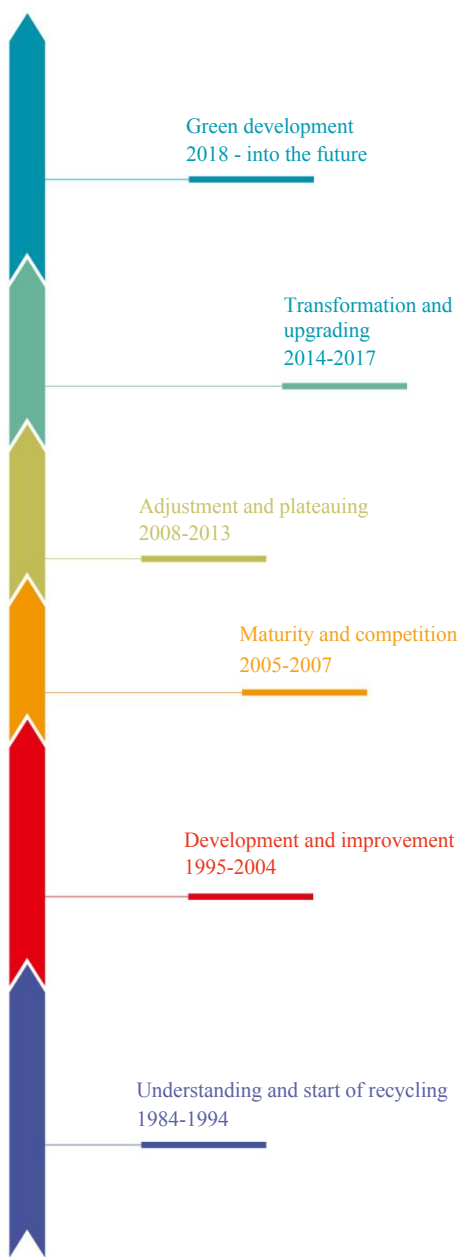


Figure 2-17. Development History of Recycled Plastics Industry in China

III

Overview of Plastic Pollution Prevention and Control in Chinese Cities

Improperly disposed of, all discarded plastic products can cause pollution. In cities, the consumption of plastics is massive and concentrated, so is the discarding of the plastics. This requires cities to enhance their waste disposal capacity. Plastic wastes in cities are mainly from domestic sources, but they can also include wastes from commercial institutions (e.g., supermarkets) and wastes from industrial sources. Among them, packaging plastics in film form are most common. In addition, most of the express packaging and meal boxes used in the express and takeaway industries are scrapped in communities, and plastic wastes from discarded household appliances, automobiles, and building materials are basically disposed of through recycling system instead of environmental health system because of easy classification.





As previously mentioned, recycling, landfilling, and incineration for power generation are, up to today, the main methods to dispose of plastic waste and solve plastic pollution problems in urban areas.

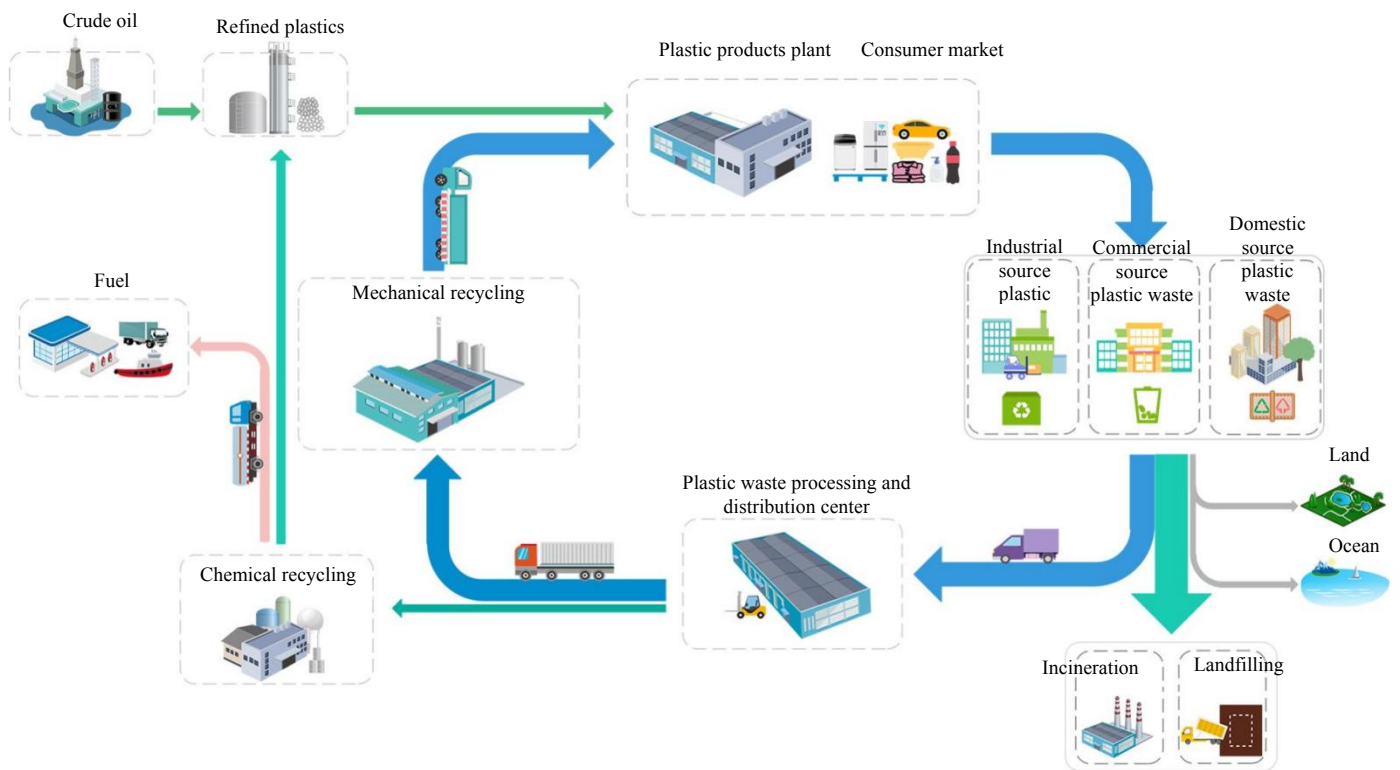
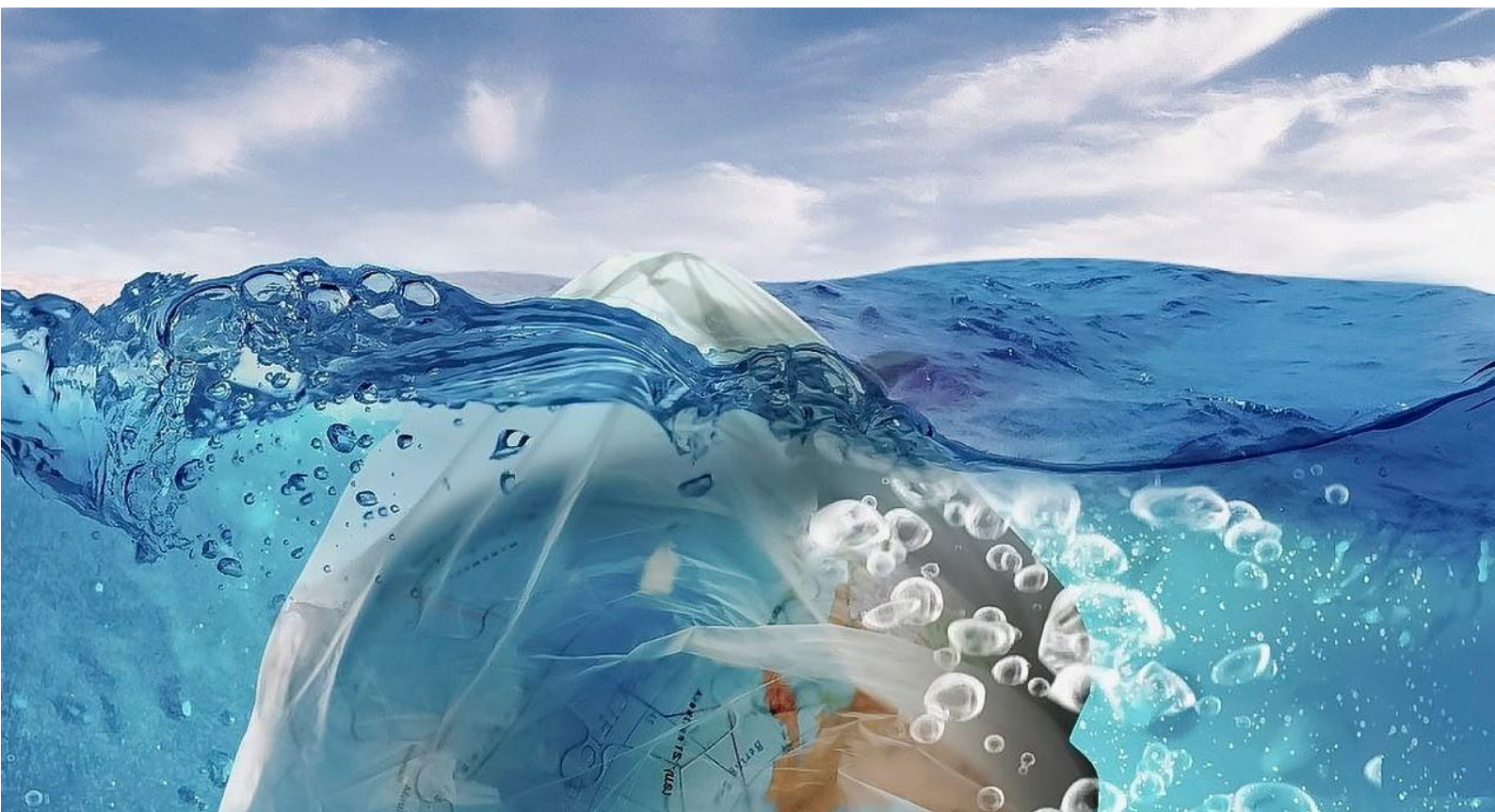


Figure 3-1. Plastic Waste Recycling Chain in China



(i) Overview of Plastic Pollution in Cities

1. Nature of plastic pollution

Once leaked into the natural environment, plastic waste will need hundreds or even thousands of years to completely degrade naturally, which will have long-term adverse effects on the global soil environment, water ecology and environment, climate change, biodiversity, etc. As an important basic material in contemporary society, plastic brings great convenience to people's daily lives. It is not a pollutant in itself, and the nature of plastic pollution is environmental leakage caused by poor management of plastic waste. The serious plastic pollution today is a result of long-term accumulation in history.

2. Main manifestations of plastic pollution

Visual pollution: Visual pollution by plastics refers to damage to urban appearance and natural landscapes, caused by plastic waste scattered in the environment. Some light and thin plastic products and packaging, such as plastic bags, plastic films, and waste agricultural films, are easily blown up by the wind, floating in the air or hanging on tree branches. They appear in some tourist attractions and on both sides of the road, forming "white pollution."

Water pollution: Water pollution by plastics refers to the phenomenon that plastic waste enters rivers, lakes, and oceans through various channels due to poor management and affects water ecology and environment. Water pollution by plastics mainly includes land-based pollution and sea-based pollution. Land-based pollution is mainly caused by plastic waste entering various types of water bodies either directly or as microplastics; sea-based pollution is caused when fishing gears from fishery and mariculture, marine equipment and garbage from shipping and offshore operations, as well as various plastic products carried by tourists, are discarded into the sea. Plastic pollution in water bodies is more hidden than plastic pollution in soil, and its impacts are more widespread.

Soil pollution: Compared with visual pollution, plastic pollution in soil is much more hidden. Soil pollution by plastics occurs when plastics are mixed into the soil in the form of plastic fragments or microplastics, causing changes to the soil in terms of its original properties and conditions, such as worsened soil permeability and reduced fertility. Plastic pollution in soil mainly comes from plastic waste, tire wear particles in road runoffs, and randomly discarded agricultural materials such as agricultural mulch films and pesticide packaging. In addition, the use of livestock and poultry manure and sludge containing microplastics for composting, and the use of sewage containing microplastics for irrigation will also bring microplastics into the soil.

Microplastic pollution: Microplastic pollution not only causes serious damage to our ecology and environment, but may also threaten human health. Microplastics leaked into the environment are easily absorbed by plants, and are accidentally eaten by fish and small animals, thus entering the food chain. They are passed through the food chain and gradually concentrate at all levels till they enter the human body. In addition, plastic microbeads are widely used in daily toiletries such as toothpaste and shower gel, and some microplastics can be directly ingested by the human body. Some studies even believe that ingested microplastics will enter the human body's circulatory system and reach specific tissues, possibly causing oxidative stress, inflammatory reaction, metabolic disorders, etc., and even affecting the expression and inheritance of DNA information.

Increased greenhouse gas emissions: Plastic products are converted from chemicals and fossil fuels, which means greenhouse gases will be generated in their entire life cycle, including production, circulation, consumption, disposal and utilization. During plastics production, carbon from fossil fuels is transferred into the plastics. If these plastics are degraded, landfilled or even incinerated after being discarded, they will be slowly released in the form of greenhouse gases such as carbon dioxide and methane, adding pressure to the reduction of greenhouse gas emissions.





(ii) Urban Plastic Pollution Prevention and Control System and Mechanism

Prevention and control of plastic pollution in cities requires a systematic operating mechanism. Operating mechanism refers to laws, regulations and business models developed for environmental health department and recycling industry, the main actors in preventing and controlling plastic pollution.

1. Implementation of garbage classification system

Garbage classification is a policy that directly serves garbage removal and recycling. It refers to a series of activities that classify, store, dump and transport garbage according to certain rules or standards, thereby transforming the garbage into public resources.

Garbage is classified for two purposes: to reduce environmental pollution and avoid environmental health problems; to increase the resource value and economic value of garbage for optimal utilization.

Many countries in the world, especially Japan, had implemented garbage classification system before China did. China piloted garbage classification first in Shanghai and gradually promoted it in major Chinese cities. In March 2017, the General Office of the State Council forwarded the *Implementation Plan for Domestic Waste Classification System* issued by the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development, in a bid to deploy and promote domestic waste classification. In June 2019, nine departments including the Ministry of Housing and Urban-Rural Development issued

the *Notice on Comprehensively Carrying out Domestic Waste Classification in Cities at Prefecture Level and Above*, planning that beginning from 2019, such cities nationwide will fully start domestic waste classification, that by the end of 2020, 46 key cities will have basically completed garbage classification and disposal system, and that by the end of 2025, such cities nationwide will have basically established garbage classification and disposal system.

2. Operating model of plastic waste recycling in cities

Recycling is the most economical and reasonable disposal method to solve the problem of plastic pollution. Plastics recycling can reduce environmental carbon footprint while keeping carbon coming from petrochemical resources in the circular system. Cities in China have a relatively sound recycling system. Plastic is a very important component in the recycling system. Based on procedures, China's plastics recycling can be divided into front-end collection and back-end processing, with sorting as the dividing line. Front-end collection is completed within urban areas and can be roughly divided into three models, which are (1) market-driven, spontaneous and decentralized collection; (2) company-led centralized collection; (3) government-business collaborated collection.

(1) Market-driven, spontaneous and decentralized collection

Market-driven, spontaneous and decentralized collection is usually done by professional scavengers, cleaners, community waste station operators, middlemen, private transfer stations, packaging station operators, and unlicensed waste processors. This model is spontaneous and driven by economic benefits. It is commonly seen in various regions of China and has long been coexisting with other collection models.

According to statistics, across China, about 800,000 individuals are involved in plastics collection. In places where garbage classification is not implemented, individual collection is one of the main forces in plastic waste collection. In places with garbage classification, market share occupied by individual collection is usually related to the implementation method and extent of the local garbage classification system. Even in places with very strict garbage classification system, individual collection still takes up a considerable market share.

Individual collection does not need to be based on a garbage classification system. This model will continue to exist as long as front-end collectors can get demand from back-end processors, as long as the local concentration level of plastic waste is high enough, and as long as the profit margin is sufficient to sustain commercial operation.

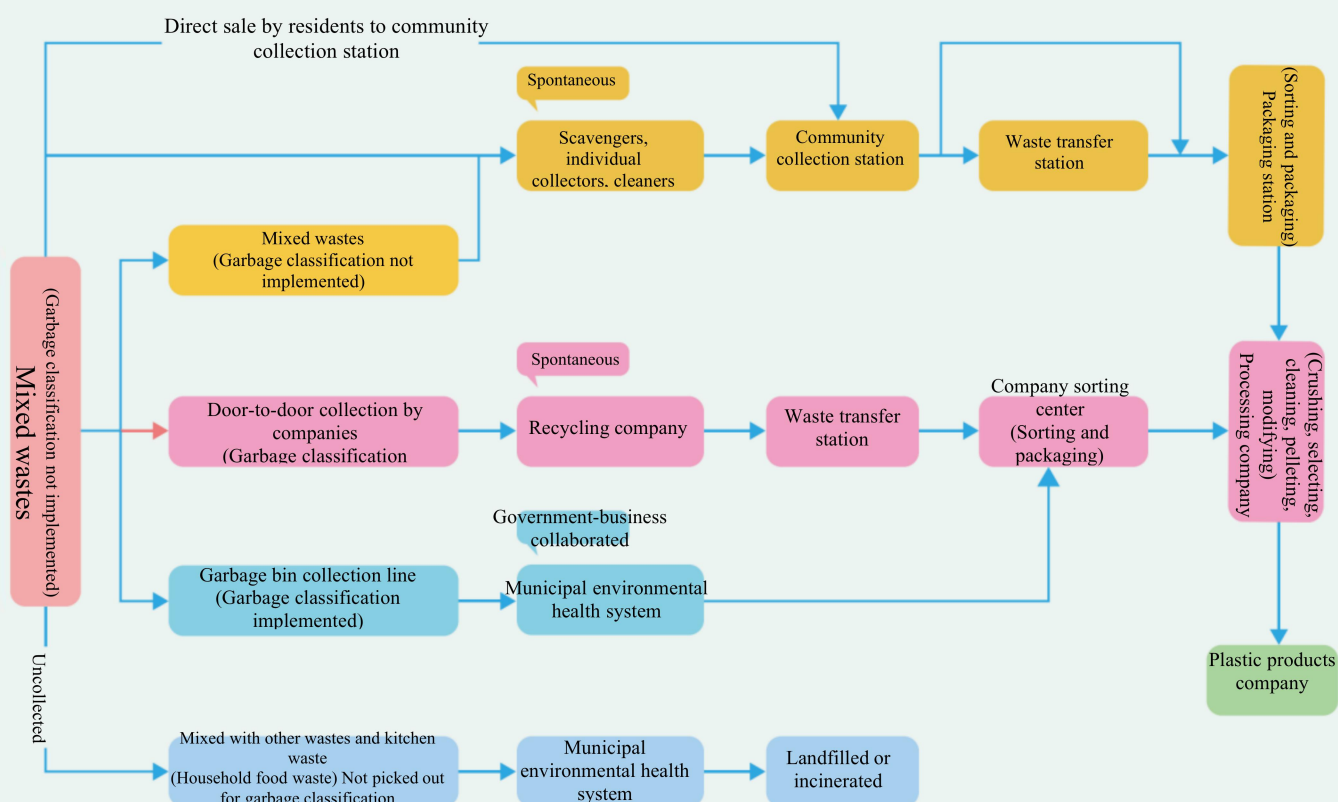


Figure 3-2. Recycling System in Chinese Cities

(2) Company-led centralized collection

Company-led centralized collection is a derivative model based on individual spontaneous collection. It is the result of the integration of front-end collectors by recycling companies. The in-depth participation of companies promotes the construction of urban recycling infrastructure. For example, the recycling infrastructure for takeaway boxes includes classified trash bins (for low-value recyclables), community stations (transfer stations), packaging stations, regional sorting centers, etc. In addition, market-based operation has greatly promoted the diversification and digitization of recycling services. For example, companies may provide door-to-door collection services, or use automated equipment to provide services. Big data management centers are built to record logistics data of various procedures such as front-end collection, transfer station, and sorting center, with waste removal and transportation capacity ready to be deployed at any time, achieving traceability of collected materials and transparent transaction throughout the process.

(3) Government-business collaborated collection

Government-business collaborated collection is a model in which urban environmental health system works with companies to share front-end collection network. This model can save companies the cost of building and operating infrastructure for front-end collection, and also saves environmental health system a certain amount of cost in disposing of solid waste. It is a win-win model. This model is driven by local policies. Like spontaneous collection by companies, collaborated collection also relies heavily on a successful and effective garbage classification system. Residents need to correctly classify their garbage before dumping. If a large volume of other types of garbage are mixed with recyclables, the following sorting will be very difficult.

Since the implementation of garbage classification, many cities in China have begun to pay attention to the recycling of low-value recyclables and have been developing dedicated recycling channel for low-value recyclables by promoting cooperation between government and companies. This practice has appeared in cities such as Shanghai and Hangzhou, and has a very obvious impact on the public although it is not yet large-scale operation.

3. Building Zero Waste Cities

"Zero Waste City" is an urban development model that is guided by the new concepts of innovation, coordination, green development, opening up and sharing. It aims to minimize the environmental impacts of solid waste by promoting green development and green lifestyle, continuing to reduce and recycle solid waste, and minimizing landfilling. It is also an advanced urban management concept. Zero Waste Cities have the following tasks. First, they shall strengthen top-level guiding design and give play to the government's macro-guidance function. Second, they shall implement industrial green production, and strive for zero growth in the total volume of storage and disposal of bulk industrial solid wastes. Third, they shall promote agricultural green production and full reuse of major agricultural wastes. Fourth, they shall practice a green lifestyle and promote the reduction and recycling of domestic wastes. Fifth, they shall improve risk prevention and control capabilities and strengthen comprehensive safety management of hazardous wastes. Sixth, they shall incentivize the vitality of market entities and foster new models of industrial development.

On December 29, 2018, the General Office of the State Council issued the *Work Plan for Building Pilot Zero Waste Cities*. On April 30, 2019, the Ministry of Ecology and Environment of China announced 11 cities and 5 special districts as pilot areas of Zero Waste Cities. On December 10, 2021, the Ministry of Ecology and Environment, together with 17 departments and units, including the National Development and Reform Commission, the Ministry of Industry and Information Technology, and the Ministry of Finance, issued the *Work Plan for Building Zero Waste Cities during the 14th Five-Year Plan Period*. The *Plan* clearly states that during the 14th Five-Year Plan period, efforts will be made to drive about 100 cities at prefecture level and above to build themselves into Zero Waste Cities. It also states that by 2025, the generation of solid waste in Zero Waste Cities will rapidly decrease in intensity, the comprehensive utilization level will be significantly improved, safe disposal capacity will be effectively guaranteed, synergistic reduction of pollution and carbon emissions will fully work out, solid waste management information will be basically integrated, the concept of "zero waste" will be widely accepted, and solid waste management system and capabilities will be significantly improved. On April 24, 2022, the Ministry of Ecology and Environment announced the list for building Zero Waste Cities during the 14th Five-Year Plan period.



IV

Public Engagement in Plastic Pollution Control and Sustainable Consumption in China

Guiding the public towards a reasonable consumer behavior is a key part of plastic pollution control. Consumer behavior is the most difficult to regulate, and irrational consumption has the greatest impact on plastic pollution. China has always attached great importance to controlling plastic pollution by guiding consumer behavior. At a government level, China sets carbon peaking and carbon neutrality-oriented economy as a national strategy and has formulated relevant laws and regulations. It has revised the *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste*, and issued the *Implementation Plan for Promoting Green Consumption* and other regulations and policies to constrain consumer behavior and manage consumption results. At a social level, social organizations have developed industry norms and labels to provide guidelines for sustainable consumer behavior; non-governmental organizations, publicity and education centers, and various public welfare activities are mobilized to improve public awareness of the hazards of plastic pollution through publicity, education, and demonstration, so that the public will reduce unnecessary consumption of plastics and actively participate in garbage classification and plastics recycling.





(i) Awareness of Sustainable Consumption

Sustainable consumption means consumers have the awareness and action not to consume resources or energy in an unrestrained manner; it takes place when consumers reduce the consumption of single-use and non-recyclable goods and materials; it is environment-friendly and safe; it can contribute to low carbon emissions and quantifiable carbon emissions in the production process; it is consumption that is moderately restrained.

Awareness of sustainable consumption can be manifested at four levels.

1. Moderately restrained consumption

The purpose is to reduce the generation of non-recyclable wastes. Moderately restrained consumption includes reducing repeated consumption and refraining from unnecessary consumption.

It means living within your means and consuming in moderation. On the one hand, consumer spending should be compatible with their own income, which includes the current income level and future income expectations. Consumers need to consider the dynamic factor of money-making capability; on the other hand, active and reasonable consumption within one's own financial capacity should be promoted instead of being restrained.

Consumers need to avoid following others blindly and buy rationally. They should try not to be influenced by unhealthy consumer psychology, and stick to rational buying based on their actual needs.

Green consumption should be promoted to protect the environment. Green consumption refers to various consumer behaviors that are aimed at protecting consumer health and saving resources and comply with human health and environmental protection standards. The core is sustainable consumption.

Consumers should uphold the spirit of diligence, thrift, and hard work. Diligence, thrift, and hard work are the traditional virtues of the Chinese nation. They are a national spirit rather than a specific consumer behavior, and this spirit never goes out of style.

2. Low-carbon consumption

Lots of young people are aware of the fact that carbon emissions cause global warming, but as consumers, they are not so aware of low-carbon consumption or sustainable consumption. Low-carbon consumption means guiding consumers to adopt a low-carbon lifestyle in food, clothing, housing and transportation. When it comes to plastics, it means consumers should reuse packaging, use simple plastic packaging, and use recycled plastic products.

Residents are end users of products and services, and both their direct and indirect consumption can have an important impact on carbon emissions. The improvement of residents' living standard is directly related to the total energy and material consumption. Decoupling living quality improvement from the increase in carbon emissions is currently one of the keys to address climate change. Whether the public have a low-carbon value orientation and consumption preference will largely affect the formation of green production-end operations and supply chains. Therefore, improving low-carbon consumption capabilities on the demand side will contribute to low-carbon development on the supply side.

(1) Low-carbon consumption can directly reduce carbon emissions.

Over the past 40 years of reform and opening up, with the acceleration of China's industrialization and urbanization, tremendous changes have taken place in consumption. Total consumption has continued to expand, becoming the first driving force for economic growth. As China's per capita carbon emissions and per capita residents consumption-caused carbon emissions continue to increase, effectively guiding residents towards low-carbon consumption and lifestyle has become an urgent issue in response to climate change and in promoting ecological progress. The *Paris Agreement* sets a target to keep the global average temperature rise to less than 2 degrees Celsius above pre-industrial levels, sending a clear signal for a global green and low-carbon transformation. China has led international cooperation on climate change and is an important participant, contributor, and leader in promoting ecological progress globally. Addressing climate change is an inherent requirement for China to promote ecological progress, and also a due responsibility for China as a responsible major country. Research shows that in 2017, carbon dioxide emissions directly caused by China's urban residents were 270 million tons, and that by China's rural residents were 289 million tons. It is predicted that carbon dioxide emissions directly caused by China's urban and rural residents will reach a peak of 673 million tons by 2037 and will then slowly decline, with direct carbon emissions still at 441 million tons by 2050. Transforming to low-carbon consumption will effectively reduce direct carbon emissions due to residents' lifestyles and make a direct contribution to China's intended nationally determined contributions (INDCs).

(2) Low-carbon consumption can effectively promote low-carbon production and green transformation of the society.

At present, consumption has become an important aspect restricting the overall green transformation of China's economy. Research shows that carbon dioxide emissions indirectly caused by urban and rural residents were about 4.15 billion tons in 2017, which will increase to about 5 billion tons in 2030 and will then gradually decline to 3.22 billion tons in 2050. Green and low-carbon consumption can force green transformation in production through price mechanisms, competition mechanisms, information transmission, and coexistence mechanisms. Changes in consumer values and behaviors will indirectly promote the green transformation of production, thus creating a huge driving force for the green transformation of the entire society.

(3) Low-carbon consumption helps enhance environmental literacy among residents.

Residents consumption in China is upgrading, characterized by consumption in housing and automobiles. The rapid improvement of people's living standard has led to a rapid increase in daily energy consumption. In the existing research on low-carbon development policies, there is increasing concern about carbon emissions from residents consumption. Carbon emissions from consumption have become a key area of policy and management innovation in reduction of greenhouse gas emissions. It is imperative to incorporate low-carbon consumption into government decision-making and formulate low-carbon consumption strategy and action plan in line with China's national conditions. Through innovation in consumption concepts and changes in consumption patterns, China can guide a transformation from incremental to high-quality consumption, and strive to meet people's growing demand for a better life with lower carbon emission levels.

3. Healthy and environment-friendly consumption

In healthy and environment-friendly consumption, waste classification and processing are encouraged, the environment is not damaged due to consumption, consumer products that do not produce harmful waste are used, and supply of natural and organic consumer products is increased.

Garbage classification is not a trivial matter. It not only relates to people's daily life, but also conforms to the concept of promoting ecological progress. In recent years, with economic and social development and significantly improved consumption levels, garbage generation in China has increased rapidly. This not only caused a waste of resources, but also made environmental hazards increasingly prominent. It has become a constraint on the sustainable and healthy development of the economy and society, and a strong concern among the people. Following the principles of waste reduction, recycling, and safe disposal, implementing waste classification and processing, and guiding people to follow green development and lifestyle can effectively improve the urban and rural environment, promote resource recycling, and is conducive to the enhancement of people's awareness and social progress.

Garbage classification is not an easy task. It requires stronger scientific management, long-term mechanism, and fostering of habit. In recent years, top-level design of garbage classification has been continuously improved and garbage classification has been pushed forward with increasing efforts. The promotion of this practice has rendered initial results. Starting this year, cities at prefecture level and above across the country have fully started domestic waste classification, achieving positive progress. However, it should be noted that in general, garbage classification still has a very limited coverage, separate collection, transportation and disposal facilities are still to be developed, and public understanding and awareness are still inadequate. To further advance garbage classification, China should follow the important instructions of President Xi Jinping to strengthen guidance, adapt measures to local conditions, and take concrete actions in a continued manner.

Garbage classification is not a one-person job. It requires everyone to work together to improve the living environment and contribute to green and sustainable development. It is a systematic project that involves government, businesses, communities, residents and other stakeholders. It includes multiple procedures such as dumping, collection, transportation, and disposal, and needs to be pushed forward jointly. To advance garbage classification, China needs to follow the important instructions of President Xi Jinping to carry out extensive campaigns to educate and guide the public to understand the importance and necessity of garbage classification, and prompt more people to take action and foster the good habit through effective supervision and guidance.

Just like a journey of a thousand miles begins with a single step, promoting the formation of green development and lifestyle is a profound revolution to development concepts.



4. Circular consumption

This approach puts special emphasis on not using disposable products and reducing the consumption of plastic products, which means reducing endless demands for resources and energy.

(1) Green catering has become a trend

Takeaway platforms and catering companies actively promote green catering. Meituan Takeaway, online takeaway platform, has set "quantity of tableware" as a required item users have to fill in before placing orders. From July 2019 to July 2020, orders marked as "no tableware required" increased by 203% year on year. In addition, to help users order based on demand and with precision, Meituan Takeaway has rolled out diversified small-portion meals and standardized dish information descriptions. As of now, 74.64% of the dishes on sale on this platform have portion information, and 85.59% of online merchants have dishes with portion information indicated in their stores.

(2) Simple packaging has become a consensus

Nowadays, more and more consumers have realized that while enjoying takeaway and express services, they should also pay attention to and solve problems such as excessive packaging, increased garbage volume, and difficulty in classifying and recycling cartons, plastic bags, and fillers.

"The key to solve the problem of express waste recycling is to reduce the volume of express packaging from the source," said Ling Yunfei, deputy director of Suning Logistics Research Institute. Suning Logistics has rolled out a "Qingcheng Plan" to vigorously promote green packaging and to further reduce the wasting of and pollution by express packaging by reducing the width of tapes, popularizing electronic waybills, and using delivery boxes and insulation cases in a circular manner.

Sustainable consumption is in line with the 3R principles (i.e. reduction, reuse, recycling) and is a sustainable fashion. This means guiding consumers to pay more attention to the sustainable attributes of products, focus on choosing natural and innovative materials, and strike a balance between ethical requirements and their own needs.

In China, carbon peaking and carbon neutrality targets have become a national strategy, and sustainable consumption is the general trend. China's economy is changing towards high-quality development. The concept of sustainable consumption is consistent with high-quality development of industries, especially in terms of circular, recyclable, and environmentally sound consumption. China strives to peak carbon emissions before 2030 and achieve carbon neutrality before 2060.

Sustainable consumption will have a significant impact on people's daily lives, such as food, clothing, consumption, and transportation. At the same time, it can also bring new business opportunities to merchants dealing in consumer products such as food and beverages, personal care, and household cleaners, as well as packaging and logistics in their value chain.



(ii) Green Procurement

"Green procurement" means companies promote green and low-carbon concepts in procurement activities. They would fully consider environmental protection, resource conservation, safety, health, low-carbon circular development and recycling, and give priority to the purchase and use of energy-saving, water-saving, material-saving raw materials, products and services that can help protect the environment.

"Green procurement" in government departments is an important part of public finance. Public finance aims at and focuses on meeting public needs, and energy conservation, consumption reduction, and environmental protection are such public needs that can reflect the overall interests of the entire society. Therefore, supporting environmental protection and purchasing energy-saving and consumption-reducing products are important functions of public finance.

On November 16, 2021, the National Government Offices Administration, the National Development and Reform Commission, the Ministry of Finance, and the Ministry of Ecology and Environment jointly issued the *Implementation Plan for Deepening Green and Low-Carbon Actions by Public Institutions to Promote Carbon Peaking*. According to the *Plan*, by 2025, the total annual energy consumption of public institutions nationwide will be controlled within 189 million tons of standard coal equivalent, and the total carbon dioxide emissions will be controlled within 400 million tons; on the basis of 2020, the energy consumption per unit building area will decrease by 5%, and the carbon emissions will decrease by 7%; before 2025, public institutions in regions with corresponding capabilities will peak carbon emissions, and before 2030, public institutions nationwide will peak carbon emissions as early as possible.

More than 80% of public institutions at county level and above will strive to meet the requirements for conservation-minded institutions, 2,000 conservation-minded public institutions will become demonstration units, 200 public institutions will be selected as energy efficiency leaders, and 300 public institutions will become green and low-carbon demonstration units.

To this end, the *Plan* proposes five major measures, which include accelerating green and low-carbon transformation of energy use, improving green and low-carbon operation of buildings, promoting use of products with green and low-carbon technologies, carrying out green and low-carbon demonstration projects and related publicity, and strengthening management capacity building for green and low-carbon development.

According to *China Public Procurement Development Report (2021)*, green procurement received more attention. In recent years, green procurement and sustainable development have continued to draw attention, and China has been continuously implementing green procurement through concrete actions. First, public institutions and state-owned enterprises vigorously promote green and low-carbon concepts in procurement activities, fully consider environmental protection, resource conservation, low-carbon circular development and recycling, and give priority to the purchase and use of energy-saving, water-saving, material-saving raw materials, products and services that can help protect the environment. Second, electronic procurement platforms are utilized to achieve a green and low-carbon procurement process through paperless operation and remote tender opening and evaluation. Third, the concept of green supply chain is highlighted. Government procurement standards are formulated for commodity packaging and express packaging, and in engineering procurement, environment-friendly and convenient prefabricated buildings are vigorously promoted to achieve low carbon emissions in the entire process of procurement, production, transportation, storage, use, and scrapping.

(iii) Green Labels

Green labels are specific marks issued by government departments, public or industry organizations to relevant parties in accordance with certain environmental standards. They are printed on the certified products to prove to consumers that the products comply with green standards and sustainable development concepts from their research and development to production, transportation, sale, use, and recycling.

1. Green product certification and labelling

On November 22, 2016, the General Office of the State Council issued the *Opinions on Establishing a Unified Green Product Standard, Certification, and Labelling System* (hereinafter referred to as the *Opinions*), opening a new chapter in the evaluation and certification system for green products. The *Opinions* states that "establishing a unified green product standard, certification, and labelling system is a must to promote green and low-carbon circular development and build a green market; it is an important measure to strengthen supply-side structural reform and improve the quality and efficiency of green product supply; it is an urgent task in guiding industrial transformation and upgrading and improving the competitiveness of China's manufacturing; it is an effective approach to lead green consumption, protect and improve people's livelihood, and is required to actually fulfill China's international emission reduction commitments and enhance the country's institutional voice in global governance."

Green products refer to products that meet environmental requirements throughout their life cycle. They are harmless or less harmful to the ecological environment and human health, consume less resources and energy, and are of high quality.

The basic label for green products is "CGP", standing for "China Green Product", based on which derived the full-green and half-green labels.

2. Product certification by China Environmental Labelling

Environmental labels are put on a product or its packaging. It is a "certification trademark" of the product. It indicates that this product has passed quality inspection and also have environmental advantages compared to similar products, as they comply with specific environmental requirements during production, use, and disposal and are therefore less harmful and more resource-saving.

The implementation of environmental labelling is essentially a full life-cycle (also known as "from cradle to cradle") control of the environmental behavior of the products during their design, production, use, discarding, disposal, and recycling. Such certification is conducted by state-designated institutions or non-governmental organizations in accordance with environmental standard of products (also known as technical requirements) and relevant regulations. It assesses the environmental performance and production process of the products, and uses logos and patterns to show to consumers which products meet environmental requirements and are more beneficial to the ecological environment.

The pattern of China Environmental Labelling has mountain, water and the sun at the center to represent the environment that human beings depend on, as well as ten linked circles in the surrounding space to represent public participation and joint protection of the environment. It means that "all people are united to jointly protect the environment on which mankind depends for survival." This certification has clear technical requirements for products and clear rules on various product indicators and testing methods.



Figure 4-1. Green Product Certification and Labelling



Figure 4-2. Product Certification by China Environmental Labelling

3. Plastics recycling labelling

(1) Recycling labels for plastic packaging products

Plastics recycling labels are special marks that directly tell consumers whether plastic products and packaging can be recycled.

China has implemented the marks for plastic materials as required in its national standard GB/T 16288 "Marking for plastic packing products recycling" as early as 1996.

The plastic products recycling labels were developed in 1988 by the Society of the Plastics Industry (now renamed Plastics Industry Association) of the United States. This set of labels with plastic material identification codes (from 1 to 7) are put on containers or packaging, saving the public the trouble to learn the similarities and differences of various plastic materials and making recycling an easy task. Usually on its bottom, each plastic container has a small identifier - a triangular mark. Inside the triangle are numbers 1 to 7, with each number representing a type of plastic container. These plastic containers are made of different materials and are subject to different restrictions in use.

(2) Labels for plastic products that are easy-to-collect and easy-to-regenerate

Circular use of plastic waste starts with recycling. However, in order to meet public consumption needs and product innovation, designs of many plastic products are diverse and complicated in terms of materials, colors, labels and even shapes, which greatly affects recycling efficiency, quality, and recycling rate.

In order to further increase the recycling rate of plastic waste, in June 2020, initiated by China Petroleum and Chemical Industry Federation (CPCIF) and China National Resources Recycling Association (CRRA), 16 leading companies upstream and downstream of the plastics industry chain jointly established the Green Recycled Plastic Supply Chain Joint Working Group (GRPG). GRPG will focus on building a 3+1 standard system to guide the recycled plastics supply chain, in which the "Double E Design" standard (easy to collect and easy to regenerate) is an important component. GRPG has set up a standards working group to collect and sort out information related to plastics recycling industry at home and abroad, and to carry out the drafting work of the "Double E Design" standard. On January 18, 2021, GRPG released the *General Guidelines for the Evaluation of Plastic Products' Easy-to-Collect & Easy-to-Regenerate Design*. In July 2021, it released four rules including *the Implementation Rules for the Evaluation of Plastic Products' Easy-to-Collect & Easy-to-Regenerate Design - Single-use Plastic Packaging Containers for Takeaways (for Trial Implementation)*, *Implementation Rules for the Evaluation of Plastic Products' Easy-to-Collect & Easy-to-Regenerate Design - Dairy Packaging (for Trial Implementation)*, *Implementation Rules for the Evaluation of Plastic Products' Easy-to-Collect & Easy-to-Regenerate Design - Daily Chemical Products' Packaging (for Trial Implementation)*, and *Implementation Rules for the Evaluation of Plastic Products' Easy-to-Collect & Easy-to-Regenerate Design - Beverage Packaging Containers (for Trial Implementation)*. It also issued easy-to-collect and easy-to-regenerate labels (Double E Labels) for plastic products and carried out related certification work.

Products and packaging printed with these labels have been certified by Double E evaluation and meet the Double E standard.

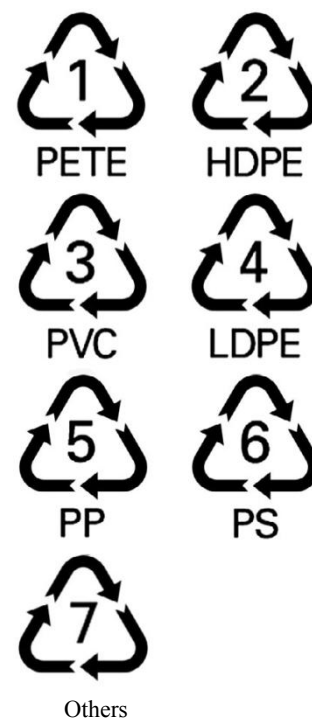


Figure 4-3. Plastics Recycling Labelling



Figure 4-4. Double E Labelling

V. Conclusion

Plastic is an excellent material. It is used in many areas to ensure food safety, promote grain production, manufacture logistics containers, reduce social operating costs, and make daily life more convenient, proven to be a widely applicable, highly reliable and affordable material. Per capita consumption of plastics also reflects the economic development level of a country. The huge consumption of plastics will generate a massive volume of plastic wastes, but not all plastic wastes will cause pollution. The root cause of plastic pollution lies not in the increase in plastic consumption or waste, but whether plastics have been properly recycled and disposed of after being discarded. Plastic pollution is caused by plastic waste leaking into the environment. Therefore, we should see plastic pollution scientifically and rationally, actively and effectively control environmental leakage, build a scientific and precise waste management system, properly manage and control plastic waste, and increase recycling rate. This will fundamentally solve the problem of plastic pollution, provide resources to meet the needs of the society, and reduce carbon emissions at the same time.



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