

Study on the Roadmap of Plastic Pollution Control for the Zero-Waste Cities in China



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FOREWORD

As a fundamentally essential material, plastics have brought about great convenience to production activities and people's daily lives. Lightweight, strong, corrosion resistant, and highly insulating, with diverse functions at a low production cost, plastics are widely used in industries, agriculture, service, transportation, information sectors, etc. They have spurred the robust industrial development, improved people's everyday life, and greatly facilitated scientific and technological progress. The application of plastic products is so ubiquitous that they can be found everywhere from industrial production to everyday life such as clothing, food, housing and transportation. Statistics show that global plastic production has soared from 2 million tons per year in 1950 to 348 million tons in 2017, and has grown into a global industry worth US\$522.6 billion.

While plastics improve people's lives, they have also transformed global consumption patterns and increased the demand for resources and production. As production and consumption of plastics continue growing, so does the amount of plastic waste, resulting in massive discharge of pollutants and a string of environmental concerns. As noted at the Fifth Session of the UN Environment Assembly (UNEA-5) in 2022, the impacts of plastic pollution on the triple planetary crisis of climate change, nature loss, and pollution are a catastrophe in the making: First, endocrine-disrupting chemicals (EDCs) contained in plastics may harm human health, potentially affecting fertility, hormonal, metabolic and neurological activity, and open burning of plastics contributes to air pollution. Second, by 2050 greenhouse gas (GHG) emissions associated with plastic production, use and disposal could account for 15% of the allowed emissions under the goal of limiting global warming to 1.5°C. Third, more than 800 marine and coastal species are affected by plastic pollution through ingestion, entanglement and other risks. Fourth, some 11 million tons of plastic waste flow annually into oceans and the figure may triple by 2040. Fifth, the shift to a circular economy can reduce the volume of plastics entering oceans by over 80% by 2040, reduce virgin plastic production by 55%, save governments US\$70 billion by 2040, and reduce GHG emissions by 25%.

The nature of plastic pollution is the leakage of plastic waste into the environment, which must be addressed through joint efforts at global, national, municipal, business and individual levels. A holistic approach to control plastic pollution throughout the plastic value chain should be adopted, addressing all the processes, including design, material selection, production and processing, consumption and circulation, collection and recycling and disposal, to promote

the transition to greener, circular, and low-carbon plastic value chain.

With the support of the SWITCH-Asia Programme — Regional Policy Advocacy Component Implemented by UNEP, a study on the roadmap of plastic pollution control for the zero-waste cities was carried out by the Solid Wastes and Chemicals Management and Technology Centre of the Ministry of Ecology and Environment (MEESCC), to strengthen research and international exchanges in this regard. By reviewing laws and policies, enforcement and implementation, achievements, gained experience and proven models in China, this study puts forward effective pathways for zero-waste cities in China to control plastic pollution. This study is designed to provide implementation guidance and best practices for Chinese cities that joined the zero-waste cities initiative and others as well, and to present valuable solutions and suggestions to government departments. This study aims to facilitate and support the development of zero-waste cities in China during the 14th Five-Year Plan period (2021-2025), and the achievement of China's "dual carbon" goals (i.e. peaking its carbon emissions by 2030 and carbon neutrality by 2060).

ABBREVIATIONS

CPRRA	China Plastics Reuse and Recycling Association
CRRA	China National Resources Recycling Association
EPR	Extended Producer Responsibility
EU	European Union
GHG	Green house gas
GRPG	Green and Recycled Plastic Supply Chain Group
MEE	Ministry of Ecology and Environment
MEESCC	Solid Waste and Chemicals Management Center, MEE
MIIT	Ministry of Industry and Information Technology
MOC	Ministry of Commerce
NDRC	National Development and Reform Commission
SAC	Standardization Administration of China
SWITCH-Asia	SWITCH-Asia Regional Policy Advocacy Component
RPAC	
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
WWF	World Wide Fund for Nature
3R	Reduce, Reuse and Recycle



1. POLICIES FOR PLASTIC POLLUTION CONTROL AND IMPLEMENTATION STATUS

1.1 Policy-making for plastic pollution control

1.1.1 The concept of circular economy throughout top-level design

In alignment with a circular economy based on the “3R” principle (Reduce, Reuse and Recycle), China adopted the whole life-cycle approach to plastic pollution control in 2018. In this new era of development, the State Council issued the *Guiding Opinions on Accelerating the Establishment and Improvement of Green and Low-Carbon Circular Economic System*, further clarifying the necessity of building a green supply chain. It encourages enterprises to achieve green product life-cycle by adopting green design, materials, procurement, manufacturing processes, packaging and transportation, and waste recycling and disposal. The Guiding Opinions highlighted the acceleration of establishing a system for recycling waste and scrap materials, including improving the collecting and recycling of waste paper, plastics, tires, scrap metals, glass and other recyclables, to increase the resource productivity and recycling rate. In addition, the *Opinions on Further Strengthening the Control of Plastic Pollution*, issued by the National Development and Reform Commission (NDRC) and the Ministry of Ecology and Environment (MEE) in January 2020, outlines China’s plastic strategy and its paths to and main tasks in plastic pollution management.

At the beginning of the 14th Five-Year Plan period, China issued a number of strategic plans which set out the objectives, tasks, paths and measures for plastic pollution control in different terms.

In the *14th Five-Year Plan on the Development of A Circular Economy*, a special campaign for industrial chain-wide plastic pollution control is listed as one of the key projects and actions. The main objectives of the special campaign by 2025 include a) universal adoption of green design, b) improved network of waste and scrap materials recycling, and c) a higher replacement ratio of recycled resources to primary ones.

The *Action Plan for Plastic Pollution Control in the 14th Five-Year Plan Period* stresses that all stakeholders should shoulder their responsibilities in earnest, and focus on the key links, industries, and areas in plastic pollution control. The goals by 2025 include: a) more effective mechanisms for plastic pollution control, b) real accountability in local governments, sectors, and enterprises, c) significant progress in whole-chain pollution control involving plastic production, distribution, consumption, recycling, and final disposal, and

d) effective containment of plastic pollution.

The *14th Five-year Plan on the Green Development of Industry* encourages high-quality reutilization and chemical recycling of plastic waste, and aims to build a dual-track (domestic and international), online-and-offline parallel recycled resources supply chain by using the Internet, block chain, big data, and other information technologies.

The *Action Plan for Carbon Dioxide (CO₂) Emission Peaking Before 2030* sets out main objectives, e.g., a higher share of non-fossil energy consumption, improved energy efficiency, and lower carbon emission intensity. The Action Plan stipulates that the goal to peak carbon dioxide emissions should permeate the whole process and every aspect of economic and social development. It also put particular focus on the implementation of ten major actions to peak CO₂ emission, including the action for green and low-carbon energy transition, and the action for energy saving, carbon emission mitigation and efficiency improvement, among others.

1.1.2 Management and phase-out of single-use plastic products

At the end of 2007, the State Council issued the *Notice on Restricting the Production and Sale of Plastic Shopping Bags* which banned all supermarkets and stores from providing single-use plastic bags for free.

In October 2019, the Standardization Administration of China and the State Administration for Market Regulation issued the *National Standard on Biodegradable Plastic Shopping Bags (GB/T 38082-2019)*, in which biodegradable plastic shopping bags were defined as bags made from biodegradable resin as the main raw material and, with a structure for carrying, used for packing and carrying goods in places of sale and service. In addition, the Standard specified requirements for the labeling, thickness and size deviation, sensory attributes, physical and mechanical properties, and biodegradability of biodegradable plastic bags.

In early 2020, the NDRC and the MEE jointly issued the *Opinions on Further Strengthening the Control of Plastic Pollution* to phase out the production and sale of ultra-thin plastic shopping bags, Polyethylene (PE) agricultural mulch film with a thickness of less than 0.01 mm, disposable foam tableware, disposable plastic stick cotton swabs, and daily chemical products containing plastic microbeads. It also set to phase out or limit the use of non-degradable plastic bags, disposable plastic tableware, disposable plastic hotel supplies, and plastic packaging in logistics.

In June 2020, the NDRC, in collaboration with other departments, released the *Notice on Carrying out Plastic Pollution Control with Solid Progress*, pressing ahead with the control over plastic products through stronger supervision and management, which showed the country's determination to contain plastic

pollution.

1.1.3 Strengthened collecting and recycling system of plastic waste

In 2007, the then State Environmental Protection Administration issued the *Technical Specifications for Pollution Control of Waste Plastic Collecting and Recycling* which specified environmental requirements for the collection, storage, transportation, pretreatment and recycling of plastic waste.

In August 2012, the then Ministry of Environmental Protection¹, the NDRC and the Ministry of Commerce jointly laid down the *Regulations on the Prevention and Control of Pollution from Waste Plastic Processing and Utilization*, to strengthen the prevention and control of pollution caused by the processing and recycling of plastic waste in order to better implement the State Council's previous *Notice on Restricting the Production and Sale of Plastic Shopping Bags* and *Opinions on Establishing a Complete and Advanced Collecting and Recycling System for Waste Products*.

In December 2020, the MEE, MOC, NDRC, and the General Administration of Customs jointly issued the *Announcement on Matters Concerning the All-out Ban on the Import of Solid Waste* which announced that any import of solid waste, including plastic waste, would be banned as of January 1, 2021 to protect people's health and environmental safety in earnest and promote sound development of the circular economy.

The following measures are also underlined, to different extents, by the 14th five-year plans for different sectors: a) improving segregation, collecting, and recycling of plastic waste, b) encouraging the use of new-type, environmentally friendly functional materials, and the use of more up-to-standard quality recycled plastics for permitted purposes, c) supporting projects of plastic waste recycling, publishing lists of enterprises in compliance with the standards for comprehensive utilization of plastic waste, guiding relevant projects to cluster in parks and bases for resource recycling or for integrated utilization of industrial resources, and promoting large-scale, standardized and cleaner development of the plastic recycling industry.

1.1.4 Specified requirements and goals for plastic pollution control in key sectors

Since plastics are widely used for various purposes, the control of plastic waste pollution must take account of the distinctive features of each industry. To that end, China has formulated guiding opinions and implementation plans for plastic pollution control in key sectors such as agricultural film, packaging in express delivery, electronics and electrical appliances, automobiles, etc.

¹ The State Environmental Protection Administration and the Ministry of Environmental Protection were both predecessors of the Ministry of Ecology and Environment.

The Ministry of Agriculture and Rural Affairs issued the *Action Plan for Agricultural Film Recycling*, intending to improve resource recycling, urban and rural environment, and green development of agriculture by promoting household waste sorting and the collecting and recycling of agricultural film. The Ministry of Industry and Information Technology introduced the *Normality Conditions for Agricultural Film Industry (2017)* based on revisions of the previous *Access Conditions for Agricultural Film Industry*. The 2017 revision was designed to further strengthen the management of the industry, regulate production, operation and investment behaviors, and provide guidelines towards a resource-saving and environmentally friendly agricultural film industry.

The State Post Bureau and other nine government departments jointly issued the *Guiding Opinions on Collaborative Promotion of Green Packaging in Express Delivery Industry* in 2017. Following the principles of “government guidance combined with private sector participation, innovation-driven source control, and targeted guidance adjusted for specific circumstances”, the Guiding Opinions set out to optimize top-level design, promote source control of pollution, increase the supply of green express delivery services, improve resource efficiency of packaging, cut the consumption of packaging materials, and mitigate environmental pollution. In February 2021, the Ministry of Transport released the *Measures on the Management of Express Mail Packaging* which stipulated that delivery service providers should use environmentally friendly materials in line with relevant provisions for packaging, and prioritize the use of reusable and easily recyclable packaging. These measures aimed to optimize and cut the use of packaging for mails and express delivery and encourage its collection and recycling. Delivery service providers were encouraged to use alternative packaging that are reusable, easily recyclable, and degradable.

In July 2021, the NDRC issued the *Notice on Encouraging Household Appliance Manufacturers to Take Actions on Establishing an Accountability Mechanism for Recycling Targets* which proposed that the household appliances manufacturers should increase their procurement of recycled materials and create a list of green suppliers. The policy also encouraged the manufacturers to work with dismantling enterprises in establishing joint R&D platforms which concentrating on secondary raw materials, products with recycled content, and components and parts for recycling and reuse, to bring forth products that can be easily recycled and dismantled. The policy demanded continuous efforts for improving the quality and utilization efficiency of recyclables and unclogging the channels for waste recycling and reutilization.

1.2 Progress in policy implementation

1.2.1 Active implementation by local governments

Following the *Opinions on Further Strengthening the Control of Plastic Pollution* issued in January 2020, local governments made arrangements accordingly. All provinces (including autonomous regions, and municipalities directly under the administration of the Central Government) issued their own implementation plans for strengthening plastic pollution control. 5 municipalities specifically designated in the national economic and social development plan², 23 provincial capitals, and some prefecture-level cities also introduced corresponding measures. For example, Beijing Municipality launched a special campaign to limit the use of plastic bags while promoting household waste sorting. Hainan Province continued its province-wide pilot programs and set up an information management platform for plastic pollution control. In Fujian Province, plastic pollution control was integrated as a crucial part into the pilot program for promoting ecological progress. As different measures were phased in, the capacities for plastic waste collection and harmless disposal have been greatly improved.

In September 2021, the NDRC and the MEE jointly issued the *Action Plan for Plastic Pollution Control During the 14th Five-Year Plan Period* which highlighted the key links, fields, and regions in the work. The goals of the Action Plan included: a) source reduction of plastic production and consumption, and promotion of plastics alternatives in a scientific and sound manner, b) rapid standardization of plastic waste collecting and recycling, c) vigorous improvement in the final disposal of plastic waste, d) special campaigns to clean up plastic waste, e) significant reduction in the amount of plastic waste in landfill and its leakage in the environment, and e) remarkable progress in controlling the plastic pollution. Local authorities have also been working actively to achieve plastic pollution control targets set out for the 14th Five-Year Plan period. For example, Hebei and Hunan provinces have included the whole-chain control of plastic pollution into their 14th Five-Year Plan for environmental protection. Guizhou Province has specified its bans and limits on plastic products in the *Regulations of Guizhou Province on the Prevention and Control of Environmental Pollution by Solid Waste* which provided legal basis for relevant work. Henan Province has set up a grid management mechanism for plastic pollution control, and taken targeted measures to ban or limit different categories of plastics in different fields and stages.

² Namely, Dalian, Qingdao, Ningbo, Xiamen, and Shenzhen.

1.2.2 Significant results in plastic waste control

Statistics showed that, in 2021, China's supply of plastic raw materials in primary form reached 144.36 million tons (Mt), and output of plastics about 80.04 million tons. The same year, plastic waste in China stood at about 62 Mt, of which 15.4 Mt (25%) were landfilled, 27.6 Mt (44%) incinerated, and 19 Mt (31%) recycled, up by 3 Mt (19%) from 16 Mt in 2020. The output value of recycled plastic waste was about 105 billion yuan in 2021, rising 33% from 79 billion yuan in 2020. The recycling rate of plastic waste material reached 31%, about 1.74 times of the global average.

1.2.3 Progress in the current phase of curbing single-use plastic products

After China put curbs on the single-use plastic products, the year 2015 saw the annual consumption of plastic bags in major retail outlets across the country decrease by 2/3 from 2010, which represented a significant contribution to energy and resources saving, ecological protection, and an active response to global climate change. In recent years, especially since the 18th National Congress of the Communist Party of China (CPC) in 2012, China has greatly strengthened its capacity for plastic pollution control, especially for curbing single-use plastics, by improving its law-based pollution control system, vigorously advancing reforms in relevant fields, and implementing key projects, such as the import bans on plastic waste, the reform of the management system for solid waste import, extensive promotion of waste sorting, and the pilot program of building "zero-waste" cities.

2. PROGRESS IN PLASTIC POLLUTION CONTROL THROUGH THE DEVELOPMENT OF ZERO-WASTE CITIES

2.1 Comprehensive control of plastic pollution

In December 2018, the State Council issued the *Work Plan on "Zero-waste City" Pilot Program in China* and launched the pilot program in 11 cities (including Shenzhen) and 5 special areas (including Xiong'an New Area). Plastic waste is one of the solid waste targeted by the pilot program, coming from a wide range of sources, including industrial offcuts, dumped household plastics, discarded agricultural film, and packaging castoffs in logistics. The pilot sites have taken plastic pollution control as a vital task for building zero-waste cities, and have gained valuable experience and explored

successful models during the pilot program.

In December 2021, the MEE and other 17 departments jointly issued the *Work Plan on “Zero-waste Cities” During the 14th Five-Year Plan Period* to ensure steady progress in this regard. The Work Plan proposed to integrate about 100 cities at prefecture-level and above into the transition to zero-waste cities. These cities need to fulfill the following goals by 2025: a) generation of solid waste drops significantly; b) capacity for comprehensive utilization of solid waste is greatly improved; c) capacity for harmless disposal is guaranteed; d) synergy between pollution and carbon emissions control is given full play; e) all information of solid waste management are integrated into a network; f) zero-waste philosophy is widely acknowledged; g) the system of and capacity for solid waste governance are significantly improved. The Work Plan also outlined the following major tasks for plastic pollution control in terms of promoting green and low-carbon lifestyles and reducing and recycling household solid waste: a) pushing forward with the whole-chain governance of plastic pollution, including slashing the use of single-use plastics, promoting biodegradable alternatives, and strengthening the recycling of plastic waste; b) accelerating the green transformation of packaging for express delivery by promoting recyclable green packaging; and c) embarking on the cleanup and control of marine plastic waste.

The comprehensive development of zero-waste cities significantly helps promote source reduction, recycling and harmless disposal of plastic waste, facilitate the transition to greener cities, and improve the ecological environment and livability of cities, in the following ways.

First, the development of zero-waste cities contributes to the control of urban plastic pollution and, through environmental improvement, induces a stronger sense of gain in citizens. To transition to zero-waste cities, the program is going to encourage all segments of society to reduce plastic waste, build up urban solid waste management, speed up the tackling of plastic pollution, and improve urban ecological environment and people’s well-being.

Second, the development of zero-waste cities is conducive to furthering the reform of the plastic waste management system in the attempt to establish effective long-term management systems and mechanisms. Since 2012, the CPC and the Central Government of China have prioritized the control of solid waste pollution in the development of ecological civilization. The transition to zero-waste cities is a crucial step to further reform the comprehensive management of plastic waste at city level.

Third, the development of zero-waste cities accelerates the transition to a greener plastic industry. This program facilitates the integration of better plastic waste management into urban management, and sets the plastic industry on a path to circular development that saves resources and protects the environment.

2.2 Main measures for plastic pollution control

As an important part in the transition to zero-waste cities, prevention and control of plastic pollution involves many fields, such as industries, agriculture, and people's daily lives. Plastic pollution control within the framework of zero-waste cities centers on policymaking of the bans and curbs on plastics, reduction of and alternatives to single-use plastics, waste sorting, plastic waste collecting and utilization, recycling and disposal of agricultural film and plastic pesticide containers, and public information and education. Moreover, in some coastal cities, plastic pollution control also entails eco-friendly upgrade of plastic products such as buoys and fishing nets. All the pilot cities have made active exploration in plastic pollution control in accordance with their respective local conditions, and achieved significant results, especially in reduction of single-use plastics in cities, source reduction of plastic waste, and recycling of agricultural film. The specific measures taken by these cities are listed as follows.

2.2.1 Strengthening the top-level design for plastic pollution control

Following the national requirements, the pilot cities have made for plastic pollution control one of the top tasks for their transition to zero-waste cities. They strengthened top-level design by introducing work plans for plastic pollution control, and local regulations and standards that restrict the production, sale and use of non-degradable single-use plastics. They also surveyed and investigated the manufacturers of non-degradable single-use plastics. Access to the production of these plastics had been restricted and their production processes phased out. Stronger policy support was provided for industries related to alternative products through policymaking and implementation which encouraged manufacturers to develop alternatives. In a word, the pilot cities took the lead in plastic pollution control in China.

Table 2-1 Plastic Pollution Control Policies in Pilot Cities

No.	City	Document	Key measures
1	Shenzhen	<i>Implementation Plan on Further Strengthening Plastic Pollution Control of Shenzhen City</i>	Strictly restrict the project approval for prohibited plastics; Investigate the production capacity of manufacturers of obsolete plastics; Drive industrial transformation and technological upgrading, and phase out obsolete low-end plastic manufacturing.
2	Weihai	<i>Implementation Plan on Further Strengthening Plastic Pollution Control of Weihai City</i>	Prohibit or restrict the production, sale and use of certain plastics in certain fields, with clearly defined categories of prohibition and phased goals
3	Shaoxing	<i>Notice on Limiting Single-use Consumer Goods;</i> <i>Notice on Encouraging the Use of Biodegradable Garbage Bags</i>	Limit the use of single-use consumer goods in all star-rated hotels to reduce the use of plastics at the source; Encourage the CPC and government departments, public institutions, state-owned enterprises, markets, and communities to use biodegradable garbage bags

4	Sanya	<p><i>Implementation Plan on Comprehensive Prohibition of Production, Sale and Use of Non-Degradable Single-use Plastics of Sanya City;</i></p> <p><i>Task Division Plan of the Pilot Program on Banning the Production, Sale and Use of Non-Degradable Single-use Plastic Products of Sanya City;</i></p> <p><i>Key Tasks of Comprehensive Prohibition of Production, Sale and Use of Non-Degradable Single-use Plastics in 2020;</i></p> <p><i>Work Plan on the River Chief System of Sanya City;</i></p> <p><i>Implementation Plan on Promoting the Marine Sanitation Work of Sanya City</i></p>	<p>Define the scope, tasks, timetable and roadmap of the ban on plastics to provide guidelines for follow-up work;</p> <p>Refine the division of tasks, strengthen the performance of responsibilities, and establish a guarantee system for banning plastics;</p> <p>Specify annual key tasks and refine annual targets;</p> <p>Implement the river/lake/bay chief systems, and establish regular monitoring over pollution control of sea-bound rivers;</p> <p>Implement a marine sanitation system to strengthen marine waste control, and establish a mechanism for connecting land and sea sanitation.</p>
5	Baotou	<p><i>Implementation Plan on Further Strengthening the Regulation of the Recycling and Utilization Industries of E-Waste, Waste Tires, Waste Plastics, Used Clothes, and Household Appliances Dismantling</i></p>	<p>Survey the enterprises dealing with the five types of waste, clean up the illegal recycling enterprises and processing plants that cause serious pollution;</p> <p>Clamp down on the illegal recycling enterprises in accordance with laws.</p>
6	Chongqing	<p><i>Opinions on Further Strengthening the Plastics Control</i></p>	<p>Prohibit or limit the production, sale, and use of certain plastics in an orderly manner, and closely monitor the production and sale of substandard plastics in the city;</p> <p>Standardize the recycling of plastic waste, establish and improve the management system of each link;</p> <p>Accelerate innovation and upgrade in recycling technologies;</p> <p>Promote alternatives that are recyclable, easily recoverable, and degradable to increase the supply of green products.</p>

Source:Material collected from the Internet

2.2.2 Promoting source reduction and replacement

The pilot cities have been actively promoting the reduction and replacement of single-use plastic products at the source. A number of measures were adopted in key areas, such as green lifestyles, green packaging, and green agriculture. Green manufacturing was reinforced as a driving force for source reduction and replacement. Departments responsible were held accountable for plastic pollution control. Law enforcement and supervision over the production and use of single-use plastics were strengthened. In terms of green production, the production of blacklisted non-degradable single-use plastics was banned while the construction of manufacturing plants for fully biodegradable plastics was promoted. In express delivery and logistics, green packaging was promoted to reduce single-use plastic packaging and tapes at the source. Electronic waybills were popularized and more recycled transfer bags or boxes were used. In agriculture, the production, sale, and use of polyethylene (PE) agricultural mulch film with a thickness less than 0.01 mm were prohibited and fully biodegradable alternatives vigorously promoted. Green prevention and control technologies were advocated to reduce plastic packaging and containers of pesticides and fertilizers.

2.2.3 Regulating and standardizing plastic waste recycling

The pilot cities actively promoted the integration of urban sanitation with recycling networks to improve their recycling and utilization system. New modes and types of business were fostered. The market for plastic waste recycling was regulated and recycling operations improved. To promote household waste sorting, collecting containers or bins for more detailed categories of recyclables were put into use in suitable residential quarters. The recycling system was formalized and standardized in terms of collection sites, sorting centers, information platforms, and uniform vehicles for recycling use only. Through cooperation and division of labor between subdistrict offices (*jiedao*), committees of neighborhood communities (*shequ*), and property management companies, an effective statistical system for recycling was established, where individual waste pickers were designated to specific areas for more regulated recycling and the amount of recovered plastic waste and other recyclables was regularly reported to waste collection stations. City-wide collection and disposal systems for plastic waste and other recyclables were set up by tapping into policy guidance and market forces while relying on major enterprises. Management standards were established for recycling sites and their layout optimized. Drop-off sites and transfer stations with capacities for both sorting and recycling were put in place. Non-recyclable plastic waste was collected and transported, following the standards for household waste, to treatment plants for harmless disposal. Incentivized by government subsidies, recycling enterprises and supply and marketing cooperatives worked together to set up a sound recycling system with higher recycling rate of waste agricultural film .

2.2.4 Advocating green lifestyles

Guidance on green lifestyles were published to encourage citizens to start small and make simple, moderate, and low-carbon lifestyle choices in their everyday activities, such as giving preference to green hotels, tourist attractions, and shopping malls. The CPC-related and government departments, along with other public institutions transitioned towards paperless offices. A list of green office supplies was set for government procurement. Application of biodegradable plastics was expanded and use of disposable plastic bags cut, driven by demonstrations such as customized choices of take-out boxes, less plastic packaging in supermarket chains, and centralized purchase and sale of plastic bags in farmer's market. These measures helped limit the use of single-use plastic bags and tableware in large supermarket chains, star-rated restaurants, large catering enterprises and large farmer's markets. Publicity campaigns for the bans and limits on plastics were launched to disseminate information and knowledge about environmental protection and single-use plastics in primary and secondary schools where

students were encouraged to help mobilize wider public participation for reducing single-use plastics. Schools were encouraged to give preference to reusable office supplies, and to guide their students to green behaviors, such as not using plastic wrappers for their books and joining in swap meets. The certification and market access for green products was improved to facilitate the transition to lifestyles and consumption behaviors that were economic, moderate, low-carbon, civilized, and healthy.

2.3 Progress made in plastic pollution control

The pilot cities have been proactive in making bold experiments and innovations for plastic pollution control. In particular, their reforms and experience in institutional construction, source reduction, recycling and replacement, and recycling of agricultural film have proved effective for plastic pollution control.

Regarding the governance system of plastic pollution, the pilot cities have established management mechanisms for plastic pollution control and corresponding implementation plans to introduce phased curbs on different categories of plastics to different industries. For instance, the City of Weihai has broken down key tasks of plastic pollution control and set up monthly schedules to ensure smooth progress. The City of Sanya has created connection mechanisms between land and sea sanitation. Sanya also prevented land-based waste from entering the sea through cleanup actions of waterways, coastal wetlands, and seacoasts, which has strengthened the source control of marine debris.

Regarding source reduction of plastic waste, the pilot cities have tapped into their potential and led by examples of green manufacturing, such as promoting standardized recyclable delivery packaging on a large scale and significantly cutting down on the secondary packaging of e-commerce goods during delivery. For instance, Beijing Economic-Technological Development Area has combined the zero-waste transition with green manufacturing: it has both promoted source reduction of plastic waste and constantly improved green manufacturing system by providing supporting infrastructure as well as recycling and reducing packaging. In the case of the City of Shaoxing, recyclable express delivery packaging was promoted by reducing packaging at all stages including packing, distribution, and collection, and by building a mechanism of shared recycling and utilization of delivery packaging. In Shaoxing, 99% of express delivery clients now use electronic waybills. About 60% of e-commerce parcels are free from secondary packaging. 80% of delivery distribution centers use recyclable transfer bags, and 417 standardized collecting devices for waste packaging are put into use in delivery service outlets.

Regarding the alternatives to plastics, the pilot cities have been stepping up R&D and application of key technologies of biodegradable plastics and actively advocating for and popularizing reusable alternatives. The City of Baotou developed alternative logistics pallets made of coal fly ash with added polymer materials and rare earth elements, which reduced the use of plastics while promoting the large-scale and high-value utilization of fly ash. The City of Xuchang encouraged large supermarkets and shopping malls to use reward points and other incentives to promote customers' use of non-plastic products and degradable alternatives, such as eco-friendly cloth bags and paper bags.

Measures regarding recycling and comprehensive utilization of residual agricultural film were twofold: on one hand, taking advantage of the recycling network to address agricultural film recycling in a coordinated way; on the other hand, stepping up technological R&D for comprehensive utilization of residual film. The Municipality of Chongqing built a multi-purpose recycling system which integrated the recycling of both agricultural film and pesticide containers, and streamlined the processes of storage and transportation. As a result, the recycling cost was significantly reduced and the recycling rate of waste agricultural film reached 91.85% in 2020. Xiong'an New Area in Hebei Province strengthened the R&D of alternatives to plastic mulch film and other agricultural film, using easily degradable, eco-friendly new materials. It adopted a deposit system for plastic mulch film recovering to improve the recovery rate. Farming system was optimized with crop rotation to reduce the average coverage of plastic mulch film per unit area. Public information and guidance was strengthened to disseminate the knowledge among farmers about the harm of waste plastic mulch and other agricultural film to soil and thus motivated them to engage in recycling. The proportion of degradable plastic mulch film were gradually increased to reduce soil and water pollution from waste film.

Regarding plastic pollution control and mitigation, departments responsible strengthened the environmental surveillance and routine inspections of plastic manufacturers. The City of Baotou issued the *Implementation Plan on Plastic Pollution Control* which addressed comprehensively the production, sales, use, recycling, and disposal of plastic products to be banned or limited. It continuously strengthened the market supervision and management of key fields and emerging industries, such as supermarkets, marketplaces, catering, and food delivery and takeout. The city also furthered the recycling of residual plastic mulch film on farmlands and the cleanup of informal waste drop-off locations. The City of Weihai took the lead nationwide in launching the "Campaign on Eco-friendly Marine Floats". The foam or inferior plastic floats for inshore raft culture and cage culture were easily breakable with low recycling value. The campaign replaced them with 5 million eco-friendly floats that were less breakable, more durable, and easily recyclable, which was expected to prevent about 10,000 tons of plastic debris from entering the

ocean.

Regarding public information and education, information dissemination and guidance for the public on plastic pollution control was enhanced in various channels and forms. Weihai intensified its efforts in the publicity for marine environmental protection, for example, through a number of programs on marine conservation and plastic waste control on the Ocean Channel of Weihai Television Station. Information dissemination and education activities for seafarers were boosted, with strict management of plastic discharge from ships in Weihai waters. Chongqing built up the publicity of plastic pollution control and advocated vigorously for green lifestyles and consumption behaviors, including encouraging citizens to use baskets and cloth bags for groceries, reducing the use of single-use plastics, and avoiding excessive packaging. Newspapers, radio and television, new media and other channels were employed to publicize the success stories and best practices of plastic pollution control.

3. EXPERIENCE AND MODES OF PLASTIC POLLUTION CONTROL: ZERO-WASTE CITIES OF CHINA AND CITIES OF EUROPE

3.1 Shenzhen: “Source reduction with sorting and collection + separated transportation and recycling” for household waste

The City of Shenzhen adhered to a dual-track strategy of leveraging the private sector while highlighting specialization. It set up the strategic guidelines of “reduction at the source, separation and sorting at the front, and comprehensive utilization at the end”. By establishing four systems for waste sorting, including separation and sorting, publicity and supervision, accountability, and technical standards, the city promoted the whole-process governance of household waste.

3.1.1 Reducing household waste at the source and encouraging greener lifestyles

Shenzhen stepped up its efforts in establishing a system of green actions, including advocating for green, moderate, low-carbon, civilized, and healthy lifestyles to cultivate a social climate in favor of green choices. The city has launched several projects targeting the “cells” or basic unit of zero-waste cities, including governmental agencies, schools, hotels, shopping malls, and

families. Five sets of standards and detailed rules were developed for evaluation of these projects, which provided a system of clear evaluation indicators for building zero-waste urban cells. Shenzhen took the lead nationwide in creating a carbon currency service platform where registered users were rewarded with “carbon currency” or points for their low-carbon and other desirable behaviors, such as sorting household waste, recycling plastic waste, volunteering in supervision of waste sorting, and participating in knowledge contests on zero-waste cities. The carbon currency could be used for electronic coupons for daily, sporting and cultural goods, tickets to sports venues, mobile phone credits, etc. It motivated and incentivized the general public to take part in the development of a zero-waste city.



Figure 3-1 Shenzhen Carbon Currency Service Platform for Ecological Civilization

Source: *Report on Experience and Models of Developing Zero-waste City in Shenzhen*

Shenzhen upgraded its actions to control plastic pollution. The city issued the *Implementation Plan on Further Strengthening the Control of Plastic Pollution* which included strict restrictions on project approval for banned plastics industries, production capacity investigation of the manufacturers of obsolete plastics, overall industrial transformation and technological upgrading, and the phase-out of obsolete low-end plastic manufacturing. Ear-marked funds for circular economy, energy conservation, and emission reduction were set aside to support degradable plastic manufacturers in applying for green manufacturing certification. Shenzhen held 2020 Forum on Plastic Alternatives in Shenzhen: Fully Biodegradable Plastics-related Technologies to encourage enterprises to tap into the market potential of biodegradable plastics. The same year, the city organized promotional activities to introduce alternatives to plastic shopping bags in shopping malls, supermarkets, farmer’s markets, and catering businesses as a step to ban or limit the sale and use of plastics. The High-level Forum on Zero-Waste Cities was held to discuss the whole-chain governance of plastic pollution control that involves source reduction, substitution, collecting, recycling, and terminal disposal, from the perspectives of policy, technology, industry, and public awareness.



Figure 3-2 2022 Forum on Plastic Alternatives in Shenzhen: Fully Biodegradable Plastics-related Technologies

Source: *Report on Experience and Models of Developing Zero-waste City in Shenzhen*

To promote green and recyclable express packaging, Shenzhen made the following attempts. First, it published green packaging management guidelines and recyclable packaging operation guidelines for intra-city express delivery services, which laid down standards and specifications for local express delivery industry to reduce packaging and pursue green and circular development. Second, the city supported the R&D of Feng Box recyclable packaging box, KDB shared packaging box, JD logistics green packaging box, and recyclable transfer bags. It also promoted electronic waybills and created a recovery network for delivery packaging. Third, to raise public awareness, the concept of green express delivery was publicized through local television stations and newspapers and a number of delivery companies launched the green delivery initiative jointly.



Figure 3-3 Feng Box Recyclable Packaging

Source: *Report on Experience and Models of Developing Zero-waste City in Shenzhen*

3.1.2 Establishing a publicity and supervision system for waste sorting to raise efficiency at the source

Taking waste sorting as a part of a civilized city, Shenzhen highlighted behavioral guidance by strengthening publicity, enhancing basic education in schools, innovating public education, and connecting publicity and supervision

systems at municipal and district levels, thereby creating a favorable social climate for public participation. With priority given to public education and guidance for citizens, the city achieved initial progress in building a publicity and supervision system that integrated public education, public information, school education, family guidance, and on-site supervision.

Shenzhen introduced the strictest administrative punishment measures for household waste sorting in the country: any individual that violates the sorting regulations may be subject to a fine up to 200 yuan; the fine for entities may be up to 500,000 yuan. Individuals in violation of the regulations may be exempted by attending training sessions of waste sorting or regular supervision activities in residential quarters. Incentives were introduced for household waste sorting, which involved public commendation accompanied by cash allowances for outstanding organizations, communities, families, and individuals.

3.1.3 Establishing a governance system of waste sorting to improve recycling capacity

In strict accordance with the requirements of separated drop-off, collection, transportation, and disposal, Shenzhen strived to promote the whole-process governance of household waste sorting. In terms of initial sorting, household waste was divided into four categories in line with the national standard, i.e., recyclables, kitchen waste, hazardous waste, and other waste. Catering waste, fruit and vegetable scraps, and garden waste, usually generated in large amounts by concentrated sources, were first to be separated from other waste. After that, more detailed sorting was carried out to separate kitchen waste, glass, metals, plastics, paper, furniture, fabrics, flowers and potted plants, and hazardous waste. Regarding collection, transportation, and disposal, different recycling companies were commissioned to handle different types of waste to ensure separated transportation and disposal and thus prevent the sorted waste from being mixed again at later stages.

3.1.4 Establishing a whole-process supervision system

To strengthen overall supervision over waste collection, transportation, and disposal, Shenzhen established a comprehensive, whole-process, and multi-level supervision system for the collection, transportation, and disposal of household waste. First, the responsibilities of urban management departments at both city and district levels were clearly divided and exercised in earnest. A city-level supervision center was set up to urge and guide all districts to fulfil their supervising obligations. District-level urban management departments were responsible for routine supervision. Dispatched supervision groups or third-party specialized institutions may be commissioned to ensure all sanitation facilities were under supervision. Second, a smart urban management platform was built to conduct whole-process supervision over the

generation, transportation, and disposal of waste, and to address problems in a timely manner, by using technologies such as the Internet of Things (IoT) and big data. This ensured standardized and well-organized waste collection, transportation, and disposal .

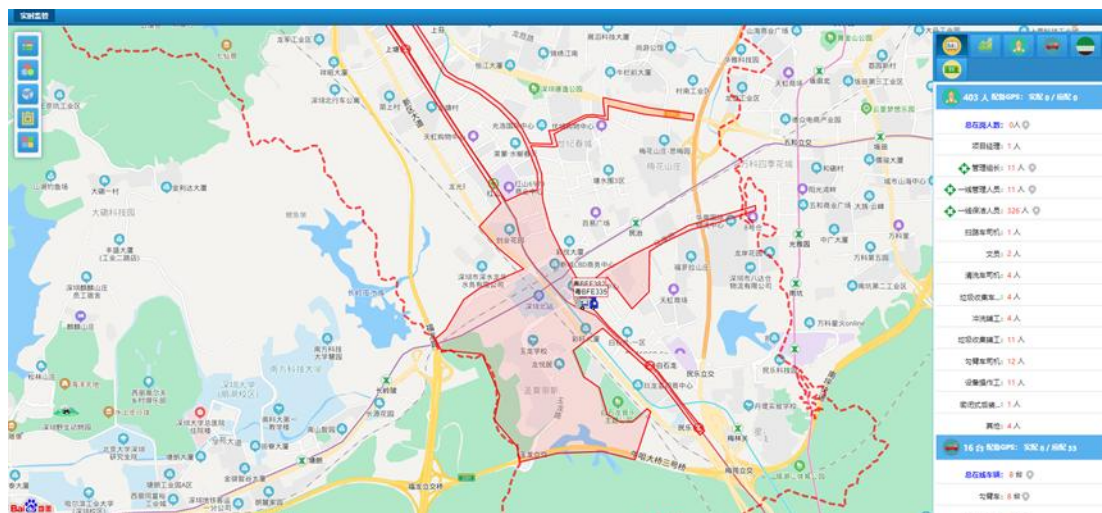


Figure 3-4 Smart city management platform

Source: Report on Experience and Models of Developing Zero-waste City in Shenzhen

3.2 Sanya: A comprehensive management mode of “institutional drive + source reduction + land-sea coordination”

3.2.1 Innovating the institution for comprehensive control of plastic pollution

In terms of institutional improvement, the City of Sanya strived to build a comprehensive governance system featuring “source prohibition, process control, and final disposal” to provide an all-encompassing institutional guarantee for plastic pollution control. First, Sanya imposed an overall ban on single-use plastics to strengthen the top-level policy and institutional improvement. For example, the city issued the *Implementation Plan on Comprehensive Prohibition of Production, Sale and Use of Non-degradable Single-use Plastics of Sanya City*. Second, in line with the *Work Plan on the River Chief System of Sanya City*, the city implemented the river/lake/bay chief system, and established a regular monitoring system for pollution control of sea-bound rivers. The *Work Priorities of River/Lake Chief System of Sanya City 2020* was released to promote the crack-down on the waterway offences such as illegal moorings, unauthorized floating mats and construction, waterway blockage, and littering. It also strengthened the daily management of river sanitation and ensured the timely cleanup of waterways. Third, the city implemented a marine sanitation system and strengthened marine waste

control by introducing the *Implementation Plan on Promoting the Marine Sanitation Work of Sanya City*. Fourth, the city established a guarantee system for plastic recycling by issuing the *Implementation Plan on the Collection and Utilization System for the Recyclables of Sanya City*, which advanced the construction of outlets and projects related to the collection and utilization of recyclables, and promoted the recycling of plastics.

3.2.2 Taking multiple measures for source reduction of single-use plastics in various fields

For everyday life and household consumption, Sanya fully prohibited the sale and use of non-degradable single-use plastic bags, tableware and other plastics blacklisted by Hainan Province. In addition, the city encouraged the use of reusable alternatives by launching projects to build “zero-waste urban cells”, including projects of green shopping malls, schools, and communities, and zero-waste government agencies, airports, tourist attractions, and islands. Moreover, Sanya promoted green packaging in the postal and express delivery industry and thereby reduced the single-use plastic delivery packaging and tapes at the source.

For agriculture, the production, sale, and use of PE agricultural mulch film with a thickness of less than 0.01 mm were prohibited. Priorities were given to promoting fully biodegradable agricultural film and adopting green prevention and control technologies to reduce the generation of waste packaging and containers of pesticides and fertilizers.

For production, Sanya imposed a ban on the production of non-degradable single-use plastics blacklisted by Hainan Province. It also supported the construction of the manufacturing plants of fully biodegradable plastics to secure the supply of alternatives and thus guaranteed effective source reduction. Moreover, by relying on the provincial management information platform for plastics bans in Hainan, Sanya explored the whole-process traceability management of the production, sale, and use of biodegradable plastics.



Figure 3-5 Supply of alternatives after the ban on non-degradable single-use plastics

Source: *Report on Experience and Models of Developing Zero-waste City in Sanya*

3.2.3 Developing a comprehensive management mode of land-sea coordination to promote multi-dimensional control of plastic waste pollution

To control land-based plastic waste and prevent its entry into the sea, Sanya took the following measures. First, combined with its campaigns to “build a civilized city and reinforce urban sanitation” and towards beautiful countryside, Sanya strengthened urban and rural sanitation to mitigate the risk of plastic waste entering the natural environment. Second, in combination with the Clean Countryside campaign, Sanya engaged in the control of agricultural plastic waste through the whole-process management of agricultural inputs, and standardized the recycling of waste agricultural film and pesticide packaging. Third, the recycling of plastic waste was enhanced. Based on waste recycling outlets and sorting centers, the city established a plastic waste recycling network featuring market-based operation. Fourth, Sanya promoted standardized collection and harmless disposal of plastic waste. Built on the integrated collection and transportation system for urban and rural household waste, the city achieved timely collection, transportation, and harmless disposal of the household waste, including non-recyclable plastic waste. Fifth, Sanya consolidated its safeguards against land-based sea-bound waste by introducing the river/lake chief system. Regular patrols of sea-bound rivers and cleanup of waterways were carried out to prevent waste from entering the sea.

Regarding the control of marine plastic pollution, Sanya first conducted a study on the characteristics of waste entering the sea to provide scientific and data basis for decision-making and cleanup actions. Second, the comprehensive marine sanitary work was launched to build an integrate system for collection, salvage, transportation, and disposal that covers all coastal and inshore waste. The land-sea sanitation was coordinated and arranged by the municipal authorities for housing and urban-rural development. After being collected and sorted, the non-recyclables in marine waste were first transported to the nearest transfer stations and then, along with other non-recyclables from land-based waste, to the household waste incineration plants for disposal, while the recyclables of marine waste entered the recycling system of each district. Third, Sanya developed the *Measures for the Prevention and Control of Environmental Pollution by Water Vessels* to supervise and control environmental pollution from watercrafts and their related activities and prevent waste from entering the sea.



Figure 3-6 Sanitary work at sea

Source: *Report on Experience and Models of Developing Zero-waste City in Sanya*

3.2.4 Strengthening public information and guidance to enhance public awareness on Plastic Smart Cities

First, a series of publicity and education activities were held to ban plastic bags and protect the marine environment on Earth Day, World Environment Day, World Oceans Day, and International Coastal Cleanup Day. Second, the initiative of Plastic Smart Cities was incorporated as a part of the regular public information and education on environmental protection. Teams for public information dissemination were organized to carry out publicity and education activities on plastic pollution control in key locations such as communities, schools, hospitals, farmer's markets, supermarkets, hotels, and scenic spots. Moreover, coastal cleanup activities were regularly organized to engage citizens, students, and tourists, together with incentives to motivate the general public to join in plastic waste management. Third, information and education bases were set up in popular tourist attractions, such as Wuzhizhou Island, Meilian Village, West Island, and Dadong Sea, to serve as permanent public platforms for science popularization on marine environmental protection. Fourth, a series of themed activities called "zero-waste tours" were held for tourists to popularize the zero-waste philosophy and help tourists come to understand Plastic Smart Cities while enjoying themselves. Besides, during zero-waste urban cell projects, such as zero-waste hotels, zero-waste tourist attractions, and green shopping malls, publicity activities on plastic reduction and Plastic Smart Cities were carried out in areas where tourists flocked to raise their awareness. Fifth, volunteer teams for environmental protection were built to engage in regular public information and education activities.

3.2.5 Strengthening international cooperation and exchanges to draw on experience of environmental governance

Sanya was active in engaging in international exchanges and cooperation. It

became the first city in China to take part in the World Wildlife Fund (WWF) initiative of Plastic Smart Cities and launched a pilot program to engage the government, enterprises, the public, research institutions, and other stakeholders in search of the solutions to plastic pollution. It also strengthened cooperation and exchanges with the Basel Convention Regional Centre for Asia and the Pacific, and joined international experience sharing on Plastic Smart Cities. Upon signing the *China-Norway Memorandum of Cooperation on Capacity Building of Marine Plastics and Microplastics Management*, Sanya set off to become an exemplar of plastic smart cities under the framework of China-Norway cooperation, enhancing its management capacity of marine plastics and microplastics, and raise its international profile for the prevention and control of plastic pollution.



Figure 3-7 Publicity and education on plastic smart cities

Source: Report on Experience and Models of Developing Zero-waste City in Sanya

3.3 Xining: Institutional innovation for the recycling of residual agricultural film

Xining, the capital city of Qinghai province, lies in the northeast of the Qinghai-Tibet Plateau. With a cold climate and abundant sunshine, the city is ideal for high-quality broad bean, oilseed rape, potato, Tibetan sheep, yaks, and other specialty agricultural products. With the increasing use of agricultural mulch film, recycling became a bottleneck for comprehensive utilization of residual film. Since joining the pilot program of zero-waste cities, Xining has been making efforts in source reduction, recycling and utilization, and guarantee and support. It built a recycling and utilization system which involved collection by households, recovering by film suppliers, and utilization

by film recyclers. In a word, Xining created a closed-loop mechanism with recycling by enterprises, farmers' participation, government supervision, and market-based operation.

3.3.1 Taking multiple measures for source reduction

Advanced technologies and materials were promoted. First, in line with the provincial *Standards on Polyethylene Blow Molded Agricultural Mulch Film* of Qinghai, Xining set the bar high for manufacturers in terms of the thickness of agricultural mulch film. In the promotion of the full-covering plastic mulching technologies, all plastic mulch films used were thicker than 0.01 mm to reduce the residue in farmland and facilitate the manual or mechanized film collection. Second, Xining was active in developing and promoting alternatives to plastic film to gradually reduce the use of the latter. Third, the city explored the use of biodegradable agricultural mulch film through pilot projects.

Supervision and management was strengthened. Xining gave full play to governmental departments in governance, supervision, and market management. Agricultural mulch film manufacturers that failed to meet the quality standards were brought to face legal consequences such as investigation and punishment, which helped standardize the production at the source. Any substandard product was not allowed in markets, for which market inspection was intensified to crack down on the substandard, fake or shoddy products. The supervision helped optimize the market of agricultural supplies and lay a solid foundation for agricultural film recycling.

3.3.2 Establishing and improving the recycling system

All stakeholders took their responsibilities. Government subsidies were fully utilized as leverage and guarantee. Local agricultural technology centers were given full play in popularizing full-covering plastic mulching technologies and arranging the recycling of residual mulch film. An operation mode was established with film suppliers in charge of recovering, users collecting, and collectors transportation.

Suppliers for recovering: The agricultural technology centers, in collaboration with film producers, were responsible for recovering the residual mulch film collected by the users (e.g. farmers, cooperatives, or large growers) for further utilization by leading local enterprises. The residual film generated by sources other than the promotion project of full-covering plastic mulching technologies was recovered by project implementors in construction, hydraulic engineering, transportation, etc. and subject to local management. Local authorities enhanced their collaboration with the project implementors responsible with clearly defined responsibilities to ensure smooth recycling.

Uses for collecting: If the agricultural mulch film was used by ordinary

farmers, the township authorities would assign the collecting work to each village where the village cadre was responsible for organizing villagers to collect the residual film. If the film is used by major cooperatives or large growers, a recycling commitment letter with specific collection tasks would be signed by the users and an amount of guarantee deposit paid to the local agricultural technology center to ensure the users carry out their collecting responsibilities.

Collectors for transportation:The cooperatives or large growers which collected the residual film were responsible for transporting it to the designated locations where the local agricultural technology center, together with the recycling enterprises, performed acceptance inspection and then paid the subsidies for transportation and collection to the cooperatives or large growers.

Residual film was collected and recycled in three steps:

Step 1: When distributing agricultural mulch film to users, the agricultural technology center determined the recycling rate. Farmers, cooperatives or large growers later collected the residual film by mechanical and manual means. The purchase of film collecting machines was also subsidized.

Step 2: The cooperatives or large growers who collected the residual film were obliged to transport it to the designated locations. After the acceptance check was done by the agricultural technology center and recycling enterprises, the subsidies for transportation and collection were paid to the cooperatives or large growers.

Step 3: The film suppliers transported the collected residual film to the leading local enterprises for comprehensive utilization of agricultural mulch film.

For cooperatives or large growers, some agricultural technology centers collected a guarantee deposit equivalent to 25% of the value of the designated film coverage. After the collecting task of the year was completed and passed the acceptance check by the agricultural and rural bureau, township governmental authorities, and specialized cooperatives, the deposit was refunded and a subsidy for collection was paid at 1.5 yuan/kg of residual film.

On the premise of respecting the principles of market economy, the government played a guiding role in subsidizing the use of agricultural mulch film, the purchase of film collecting machines, and the collection and transportation of residual film, which guaranteed the quality of agricultural mulch film, the utilization rate of collecting machines, and the recycling rate of residual film.

3.3.3 Supporting leading enterprises for full utilization

First, Xining supported the existing agricultural mulch film manufacturers to build lines for recycling and utilization of residual film through interest subsidies

and reduction or exemption of corporate income tax. As a result, the recycling capacity reached 20,000 tons/year, which not only guaranteed the full utilization of residual film in Xining, but also helped other agricultural areas across Qinghai Province to achieve the comprehensive utilization. Second, the city subsidized the operation of agricultural film recycling enterprises at 1-1.5 yuan/kg to incentivize them for utilization and production. Third, Xining facilitated long-term cooperation between enterprises and farmers. It also actively explored the new-for-old scheme and the sale-based recycling mode for the agricultural mulch film industry to match production and sale with recycling and utilization, and film promotion and consumption with recycling and disposal.

For manufacturing wood-plastic composite products, Xining purchased 23 pieces or sets of equipment, including plastic extruders, granulators, grinders, 500-ton oil presses, residual film cleaning lines, and transport vehicles. Residual plastic mulch film was used as the main raw material, mixed with wood flour and other auxiliary materials, such as stabilizer, aging agent, wetting agent, and strengthening agent, as per the prescribed proportion. The output value of the wood-plastic composite products reached 22.1 million yuan. Promoting scientific innovation for the recycling and processing of residual film, Xining took great efforts to develop new technologies and new product varieties, and launched several projects, such as the technological demonstration for comprehensive utilization of agricultural residual film, the research on technologies for comprehensive utilization of agricultural residual film, and wood-plastic composite products lines made from recycled agricultural film. These projects were highly acclaimed in Qinghai Province for their leading technologies and results.



Figure 3-8 Products made from recycled residual agricultural film

Source: *Report on Experience and Models of Developing Zero-waste City in Xining*

3.4 Experience and modes of European cities

3.4.1 Plastic waste reduction, collection and recycling in Espoo

In Finland, cities bear the responsibility to organize the collection of household waste and waste generated by municipal service properties. The City of Espoo, the second largest in Finland, encourages its citizens to sort plastic waste at drop-off sites by building a large number of infrastructure. In 2021, plastic packaging accounted for 14% of urban waste with a recycling rate of 27%. To achieve sustainable development, Espoo puts forward the goal of reaching carbon neutrality by 2030 by reducing the generation of plastic waste through maximal reuse. Therefore, the recycling of plastics became crucial to reduce the use of raw materials and production at the source.

Since the 1950s, Finland has established a deposit system for beverage bottles to stimulate the public willingness to recycle through deposit and convenient recycling channels. As a result, the recycling rate of beverage packaging in Finland is the highest in the world. For a long time, the recycling rate of glass bottles has been maintained between 90%-99% and that of PET plastic bottles at 90%. Under the leadership of Helsinki Metropolitan Smart & Clean Foundation, Espoo carried out cooperation on the Closed Plastic Circle project, which aimed to improve the recycling and utilization of plastic waste, with a focus on the sorting and collection of plastic waste by families and small and medium-sized enterprises, and the enhancement of recycling capacity.

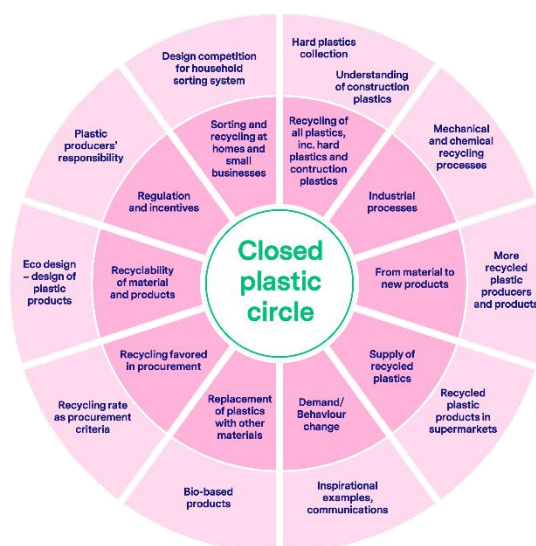


Figure 3-9 The closed plastic circle

Source: *Plastic pollution control at city level in Europe – reducing, reusing and recycling plastic in Espoo* (conference presentation by Ms. Mia Johansson, Circular Economy Specialist, City of Espoo, Finland on 12th April 2022)

3.4.2 A circular economy for plastics in Copenhagen

In January 2018, the European Union published the European Strategy for Plastics in a Circular Economy, aiming to help reduce the global pollution of plastic waste. The City of Copenhagen in Denmark is committed to plastic pollution control. Since 2000, the focus has gradually shifted from the incineration of plastic waste to sorting, recycling, and utilization. Copenhagen aims to become the world's first carbon neutral capital in 2025, for which plastic pollution control is a key area.



Figure 3-10 Waste bins for sorting

Source: *Plastic waste management in Copenhagen - An introduction to Copenhagen's efforts to create a circular economy for plastics* (conference presentation by Mr. Jonas ÅboMortensen, Urban Technology, Development, Waste and Resources Consultant for the City of Copenhagen on 12th April 2022)

Since Copenhagen launched its sorting and recycling program in 2012, the amount of recycled plastic waste has increased significantly. As stated by the Copenhagen City Council, the recycling of resources create more employment and economic value than landfills and incineration. Urban waste is divided into 9 categories, including food, paper, paperboard, metal, glass, plastics, beverage carton, hazardous waste, and residual waste. Textile waste will also be included by 2023. At present, the waste recycling rate in Copenhagen is 45% and is expected to increase to 70% by 2024. Copenhagen has formulated and implemented the charging policy for the disposal of urban household waste, which stipulates that residents must pay an amount of annual waste management fee to be collected together with the property tax. On average, each household pays about 225 euros per year. The total annual waste management budget of the city is about 80 million euros.

4. ROADMAP OF PLASTIC POLLUTION CONTROL FOR THE ZERO-WASTE CITIES

The roadmap of plastic pollution control for zero-waste cities involves the dimensions of institution, technology, market, and supervision, with a focus on plastic pollution which is of both domestic and international concern. The roadmap is designed to help build a plastic pollution control system through efforts in top-level design, capacity building, supervision and management, and publicity and education. Guided by the idea of plastic pollution control throughout the entire industrial chain for green, low-carbon and circular development, the roadmap of whole-chain plastic pollution control is designed for zero-waste cities in China to support them by providing instructive and practical implementation guidelines for plastic pollution control.

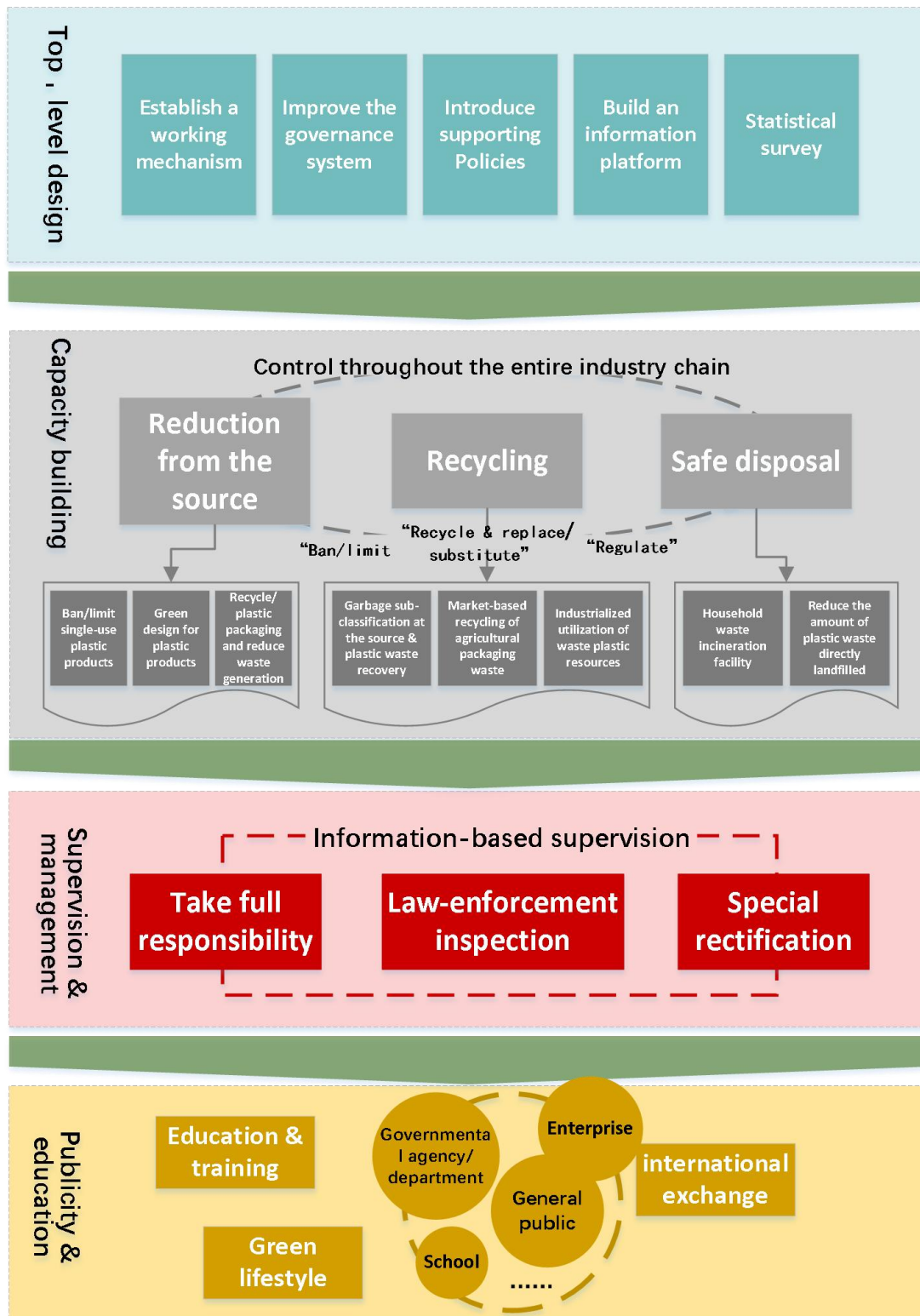


Figure 4-1 Plastic pollution control system in the development of zero-waste cities

Source: MEESCC

4.1 Whole-chain plastic pollution control

Guided by the idea of plastic pollution control throughout the entire industry chain for green, low-carbon and circular development, the roadmap focuses on key links, sectors, and regions, and prioritizes green transformation of socio-economic development. It aims to reduce plastic waste at its source by cutting back on the production and use of single-use plastic products and popularize the alternatives in a scientific and sound manner. It promotes green transformation of the plastic industry, standardization of plastic waste recycling, and significant reduction of plastics in landfills and its leakage in the environment. By doing this, it aims to press ahead with the coordinated plastic pollution control in the development of zero-waste cities.

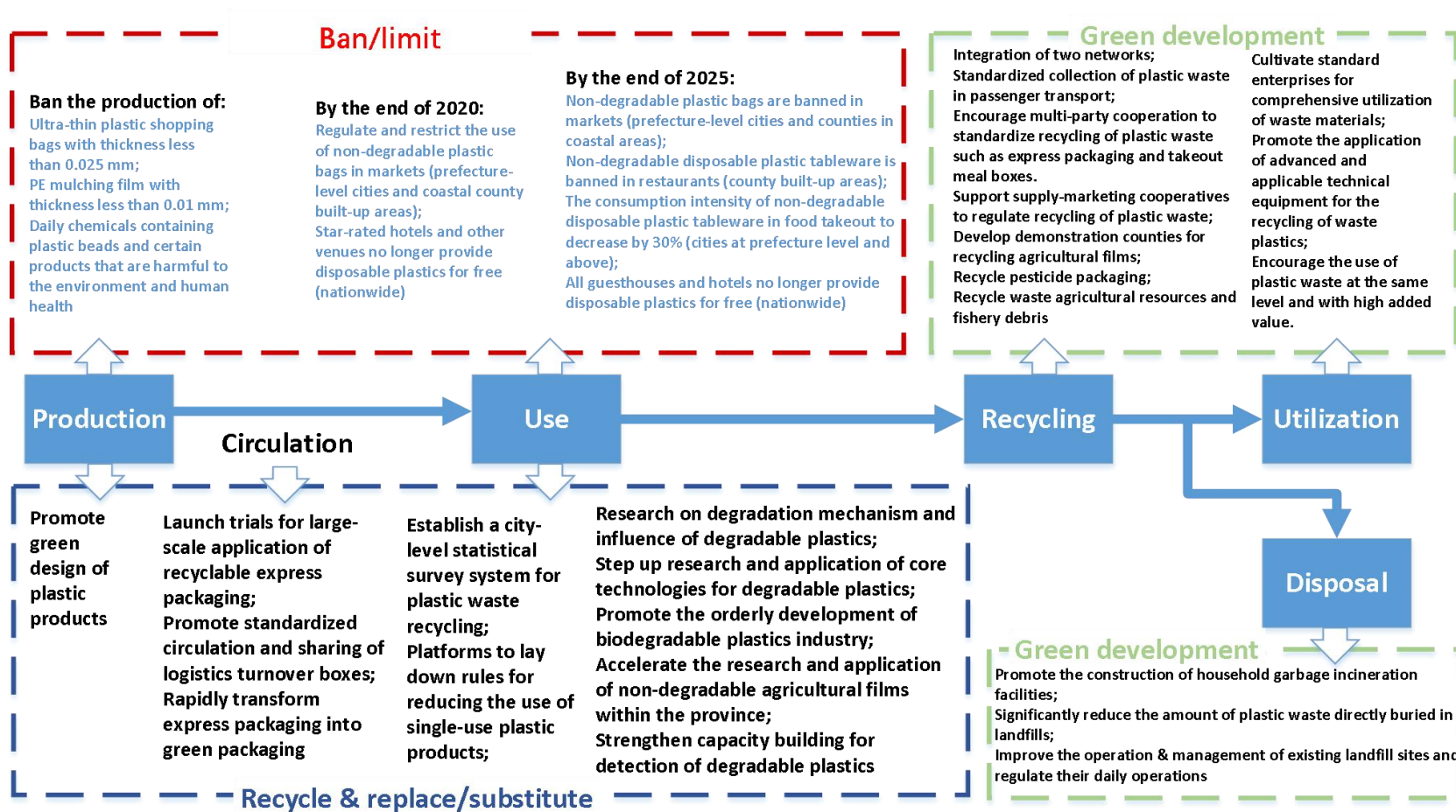


Figure 4-2 Plastic pollution control throughout the entire industrial chain for zero-waste cities

Source: MEESCC

4.1.1 Imposing bans and curbs to reduce single-use plastics at the source

In August 2020, the MOC issued the *Notice on Further Strengthening the Control of Plastic Pollution in Commercial Activities*, focused on key fields such as shopping malls, supermarkets, farmer's markets, catering, hotels, exhibitions, and e-commerce, and imposing specific requirements for banning or limiting plastics in different fields with different timetables.

In September 2021, the NDRC and the MEE issued the *Action Plan for Plastic Pollution Control during the 14th Five-Year Plan Period* which prohibited the production of certain products harmful to the environment and human health, including ultra-thin plastic shopping bags with a thickness of less than 0.025 mm, PE agricultural mulch film with a thickness of less than 0.01 mm, and household chemicals containing plastic microbeads. It also set the goals for source reduction of plastics by 2025, including a significant reduction in the unnecessary use of single-use plastics in key areas such as commodity retailing, e-commerce, food delivery and takeout, express delivery, and accommodation, general elimination of secondary packaging in express delivery for e-commerce, and the use of 10 million recyclable delivery packaging. These relevant provisions for banning or limiting the sale and use of certain plastics help continue reducing the production and use of single-use plastics.

4.1.2 Promoting recyclable alternatives to benefit regeneration and sustainable development

In the distribution sector, efforts were made to accelerate the green transformation of packaging in express delivery industry. In November 2020, the State Council forwarded the *Opinions on Accelerating the Green Transformation of Express Packaging* from the NDRC along with other departments, proposing that, by 2025, secondary packaging in e-commerce express delivery should be largely eliminated and the number of recyclable delivery packaging in use should reach 10 million. Other goals included major progress in developing new models and types of business for packaging reduction and green recycling, and overall success in the green transformation of express delivery packaging. In the development of zero-waste cities, efforts should be made in the following dimensions. Full coverage of electronic waybills in express delivery services should be realized. The application of recyclable and foldable express packaging, circular delivery boxes, and reusable refrigerated delivery boxes should be promoted for intra-city delivery of perishables and bulk cargo distribution of supermarket chains. The use of single-use foamed plastic boxes should be reduced. Pilot programs of large-scale recyclable delivery packaging should be implemented to foster new models and strengthen infrastructure construction in this regard.

For biodegradable plastic packaging products, the focus is the research on the whole-life cycle ecological design and evaluation methods, improvement of standards for product quality and food safety, and optimization of the green design for plastic packaging. Technological breakthroughs and their application should be actively sought for key and core technologies such as biodegradable plastics and applied to improve product quality and performance while reducing application cost. Efforts should be made to promote the sound development of biodegradable plastics industry and guide it towards a reasonable industry structure to avoid blind expansion of production capacity. Scientific research and promotion of fully biodegradable agricultural film should be vigorously supported through large-scale application of biodegradable mulch film combined with appropriate agronomic measures in key areas. The public should be encouraged to choose green lifestyles and participate in plastic reduction and replacement. Non-plastic alternatives such as environmentally friendly cloth bags or degradable bags should be promoted in shopping malls, supermarkets, pharmacies, bookstores, etc. More smart vending machines of the alternatives should be installed to make it more convenient for people to go green in everyday life.

4.1.3 Standardizing the recycling, collection, and disposal of plastic waste to promote green and low-carbon industrial development

The networks of the collecting and recycling sites for urban recyclable waste should be better integrated with the existing sites for household waste sorting. On one hand, reasonable locations should be chosen for collecting and sorting facilities and devices for household waste. On the other, efficiency of collecting and transporting plastic waste should be improved. A sound system for plastic waste collection, transportation, and disposal should be built with measures to recover pesticide packaging. Large farmers and growers, agricultural service providers, and recycling enterprises should be supported and guided in recovering and recycling used agricultural and fishery equipment and tools, such as irrigation equipment, fishing gears, nets, seeding trays, etc. The new form of business of “Internet + Recycling” should be encouraged. Multi-stakeholder cooperation should be fostered between e-commerce platforms (food delivery and takeout platforms included), express delivery enterprises, sanitation businesses, and recycling enterprises, to standardize the recycling of plastic waste, such as delivery express packaging and takeout meal boxes, for greener development.

Plastic waste recycling and utilization projects should be supported and guided to cluster in industrial parks and bases for resource recycling or comprehensive utilization. Enterprises in compliance with the standards for comprehensive utilization of plastic waste should be supported to promote the standardization, centralization, and industrialization of plastic waste recycling.

The application of advanced and appropriate technologies and equipment should be further promoted to facilitate high value-added and same-grade utilization of plastic waste, and to effectively shape a circular development model of the industry.

Construction of incineration facilities for urban household waste should be supported to boost the waste incineration capacity for a higher level of recycling and utilization and a significantly less amount of plastic waste in landfills. Besides, the comprehensive governance of the existing landfills should be strengthened to improve the operations management, standardize daily operations, prohibit random dumping or stockpile of household waste, and prevent the leakage of buried plastics into the environment. Synergy between pollution and carbon emissions control in the industry should be encouraged for green and high-quality local development.

4.2 Implementation roadmap

4.2.1 Top-level design

A working mechanism for overall planning and coordination of plastic pollution control should be established. The objectives and tasks for zero-waste cities and the plastic pollution control should be integrated into the municipal mid-term and long-term planning. Plastic pollution control should also be organically integrated and promoted in synergy with the all-out battle against pollution, key national strategies for carbon peak and carbon neutrality, and high-quality urban development. A working mechanism for the development of zero-waste cities should be established, where a leading group and facilitating offices are set up to provide overarching plan and guidance for coordinated plastic pollution control. The municipal bureau of ecology and environment, related departments, and counties or districts within the municipal jurisdiction should perform their respective responsibilities and collaborate with each other to faithfully carry out all tasks for plastic pollution control. Lists of goals, responsibilities, and tasks should be created, together with practical policies and feasible measures, to guarantee the accomplishment of goals and tasks.

Institutions for plastic pollution control should be further improved. The management system of plastic pollution control for key fields and links should be formulated and improved in light of the characteristics of production, living, and consumption of each city. Taking account of the actual conditions in different regions and sectors, appropriate implementation paths should be determined respectively, and plastic control measures further specified. The system of extended producer responsibility (EPR) should be put into effect, where incentives and restraints with clear responsibilities, sound standards,

and strong supervision are applied throughout different stages in plastic product life cycle, including product design, production, circulation, consumption, recycling, utilization, and disposal, to achieve robust and effective plastic pollution control. An information disclosure mechanism should be developed for the production and sale of both plastic raw materials and finished products. Mechanisms on commitment of business entities and punishment for the breach thereof should be explored by incorporating illegal production, sale, and use of plastics into the social credit system. A regular statistical system should be established to get a clearer picture of the baseline data in the production, use, recycling, utilization, and disposal of plastics.

Supporting policies for control plastic pollution should be further enhanced. Fiscal and tax supporting policies at the national and provincial levels should be implemented while increasing government procurement of green products that meet standards. Government agencies, enterprises, and public institutions should choose environmentally friendly products, equipment, and facilities to reduce the use of the single-use office supplies. Public institutions should take the lead in refusing non-degradable single-use plastics. Pilot or demonstration projects should be launched to develop new green supply chains and recycle waste agricultural film. Local conditions permitting, qualified enterprises should be selected to pilot new products and models, such as the large-scale application of recyclable packaging. Installation of specialized and smart recycling facilities should be supported by removing management barriers for these facilities to enter public spaces such as residential quarters, subway stations, railway and bus stations, office buildings, etc. Local governments are encouraged to use economic incentives to promote the reduction and replacement of single-use plastics. The allocation of urban land quotas should be coordinated to support more plastic waste recycling projects. Tax measures for promoting standardized recycling of plastic waste should also be explored. Expenditure on plastic pollution control should be covered by government departmental budgets to ensure smooth policy implementation.

An information platform should be built to improve effectiveness evaluation. Information technologies should be used to serve governance by tracking and evaluating the progress and effectiveness of plastic pollution control. Relying on the information platform for zero-waste cities, plastic pollution control should be incorporated into the indicator system of the development of zero-waste cities. Evaluation mechanisms for plastic pollution control should be established and improved with a set of recognizable and measurable departmental responsibilities. The breakdown and accomplishment of responsibilities, tasks, and projects of plastic pollution control should be defined and implemented with quantitative data indicators, which helps the cities to perform their responsibilities for plastic pollution control and evaluate their performance. The incorporation of the results in

plastic pollution control as a part of local government performance appraisal will be promoted. A system of departmental responsibilities for plastic pollution control should be established with clearly defined roles, responsibilities, and objectives.

A statistical survey system should be set up for the recycling data of plastic waste. Combined with the reporting system for the use and recycling of single-use plastics in the commercial and postal sectors, a city-level statistical survey system for the recycling data of plastic waste should be established to reveal the directions in which plastics circulate and to identify the areas where major environmental leakage happen and what the responsive control measures are.

4.2.2 Capacity building

In terms of capacity building, plastic pollution control throughout the entire industry chain, or whole-chain plastic pollution control, should be promoted. Efforts should be made in terms of strengthening both basic and applied research on plastic pollution control, attracting and fostering high-tech talents, bringing about breakthroughs in and application of key and core technologies of recyclable and degradable materials, promoting alternative materials and products, and facilitating the commercialization and application of scientific and technological achievements.

Source reduction of the production and use of single-use plastics should be actively promoted. National and provincial regulations on banning or restricting the sale and use of certain plastics should be implemented to achieve a significant reduction in the use of single-use plastics. Green design of plastics should be promoted. To be specific, environmentally friendly technologies should be developed in product design stage to make decomposition and recycling easier. It is also necessary to promote the use of biodegradable alternatives. Source reduction of the amount of packaging materials for express delivery should be boosted by reducing the secondary packaging of e-commerce goods, accelerating the green transformation of delivery packaging, promoting the use of recyclable green packaging, and fostering a new model of recyclable delivery packaging. Municipal government departments should strengthen infrastructure construction for recyclable delivery packaging in combination with the development of smart cities and smart communities, including planning for and building a number of delivery distribution terminals and recycling facilities for recyclable packaging in residential quarters, universities and colleges, business centers, etc.

Standardized collection and recycling of plastic waste should be accelerated. On one hand, the standardized plastics collection and recycling should be strengthened by building the system for source sorting and recycling in combination with household waste sorting. For plastic waste generated by

urban areas, e-waste, and certain industries, a separated recycling system needs to be established with strictly separated drop-off, collection, transportation, and disposal for different types of plastic waste. To promote the market-based recycling system for agricultural film and plastic packaging of pesticides and fertilizers, the actual conditions of the cities must be taken into account in the coordination and construction of three-tier facilities and services at county, township and village levels and in the selection of modes for waste collection, transportation, and disposal. Urban plastic waste recycling infrastructure should be optimized by encouraging large enterprises to participate in building the plastic waste recycling system. Coordination and cooperation between upstream and downstream enterprises should contribute to improve source design in the production of plastics and more intensive sorting and recycling. Appropriate guidance for plastic recycling should be provided to achieve maximal recycling. The collection and transportation efficiency, recycling rate, and supply of recycled plastic waste should be increased for to bring about more standardized recycling and a circular economy of plastics in the cities.

On the other hand, the technological level of recycling and utilization should be improved. Large plastic waste recycling enterprises should standardize their operations by further dividing the recovered plastic waste into more detailed categories. They should also develop and apply advanced and appropriate technologies and equipment for recycling and utilization to gradually expand application and improve recycling, which will increase the added value of recycled plastics. The large-scale, standardized and green development of the recycled plastic industry should be facilitated. Efforts should also be made to step up R&D of new recycling technologies such as chemical recycling. While chemical recycling and other efficient, high-value and environmentally friendly recycling technologies are being explored, technological bottlenecks in recycling low-value and mixed plastics should also be tackled to improve the recycling rate. The synthesis, processing, application, and disposal of plastics by both upstream and downstream industries should all be subject to comprehensive whole-chain recycling, so as to build up the recycling capacity of each industry.

Harmless disposal of plastic waste should be significantly improved. Reasonable locations for household waste incineration facilities should be chosen carefully. Cities at prefectural level and above and counties with incineration treatment capacity or construction conditions thereof shall no longer plan nor build any landfill for untreated waste. For sparsely populated areas with a small amount of waste generation and a lack of conditions for large-scale incineration facilities, they may turn to such facilities in other regions through cross-region collaboration and sharing; or, upon technical evaluation, pilot projects for decentralized and miniaturized incineration facilities may be built to reduce the amount of plastic waste going directly to

landfills. The existing landfills should be comprehensively reorganized to improve safe final disposal and operations management.

4.2.3 Supervision and management

An information system for supervision and management of solid waste data should be established to reveal the situation of corporate and municipal solid waste management and effectively strengthen the whole-process supervision of solid waste. Local governments, sectors, and enterprises should be urged to perform their respective responsibilities by strengthening routine management, supervision, and inspection and strictly implementing the bans and restrictions of the production, sale and use of certain plastics. Any illegal production and sale of plastics prohibited by the state should be cracked down and false or misleading labeling of plastics should be subject to rigorous investigation and punishment. Restrictions and standards of excessive packaging should be better implemented and publicized while law enforcement and supervision should be consolidated. Comprehensive law enforcement on ecological and environmental protection should be carried out, including strengthening the supervision of plastic waste recycling, utilization, and disposal and cracking down on illegal sewage discharge. The overhaul of the plastic waste processing industry should be continued with intensified measures to address small, scattered, and unregulated businesses and violations of laws and regulations. Enterprises that fail to meet the environmental standards for recycling and utilizing plastic waste should be shut down to avoid secondary pollution.

Special campaigns to control plastic pollution in key areas should be carried out. Efforts should be stepped up to clean up and control plastic waste in rivers, lakes, seas, tourist attractions, and rural areas. The urban river/lake chief system should be given full play as a platform for carrying out targeted cleanup of plastic waste in rivers, lakes, and reservoirs, and for establishing regular cleanup mechanisms. Special efforts will be made to collect plastic waste in bays, estuaries, shorelines, etc. and encourage coastal cities and counties to establish lasting mechanisms for marine cleanup, in order to keep key coastal areas free of any large amount of plastic waste. For urban tourist attractions, regular management mechanisms for household waste should be established and improved, including increasing household waste collection facilities in scenic spots, promoting integrated collection, transportation, and disposal of household waste from both tourist attractions and other urban or rural areas, and ensuring timely cleanup and collection of plastic waste in scenic spots. The requirements for plastic pollution control should be included in the evaluation and rating system for tourist attractions. Combined with the improvement of rural living environment, plastic waste should be included in village cleanup actions where villagers are organized to clean their surrounding environment, collect outdoor plastic waste scattered near houses,

rivers, ditches, fields, footpaths, and roads, and largely eliminate outdoor legacy plastic waste. The villagers' responsibilities should be specified in their commitments to good sanitation, landscaping, and public order around their houses (*menqian sanbao*) and other mechanisms. Local conditions permitting, villages may designate specific cleaning day and create welfare posts such as village cleaning chiefs and cleaners to promote institutionalized, normalized, and lasting village cleaning actions.

4.2.4 Publicity and education

Publicity for plastic pollution control as well as the education and training to foster a zero-waste culture should be strengthened. Plastic reduction in key places such as government offices, enterprises, public institutions, schools, etc. should be integrated into the projects of "zero-waste urban cells". It is necessary to guide the public to reduce the use of single-use plastics, participate in waste sorting, resist excessive packaging, and choose green lifestyles. Success stories and best practices for plastic pollution control should be widely publicized through newspapers, radio, television, new media, etc. Industry associations, commercial organizations, and public welfare organizations should be guided to carry out robust policy advocacy, specialized seminars and discussions, and volunteer activities. Plastic waste recycling facilities should be open to the public to increase the sense of public engagement. International exchanges and cooperation on plastic pollution control should be facilitated in the development of zero-waste cities to publicize the ideas and progress in building zero-waste cities in China and enhance the country's international profile in terms of plastic pollution control.

4.2.5 Goal setting for plastic pollution control

Short-term goals: By 2025, mechanisms for plastic pollution control become more efficient. Local governments, departments and enterprises perform their responsibilities more conscientiously. The whole-chain governance of plastic waste that covers its production, distribution, consumption, recycling, and final disposal is more effective and the white pollution of plastics is effectively curbed. In terms of source reduction, the unnecessary use of single-use plastics in key fields such as commodity retailing, e-commerce, food delivery and takeout, express delivery, and accommodation business decrease significantly. Express delivery of e-commerce goods largely gets rid of the secondary packaging and steps up the use of recyclable packaging. In terms of plastic recycling and disposal, systems for dropping off, sorting, collecting, transporting, and disposing household waste are established based on local conditions. Efficiency of collecting and transporting plastic waste is greatly improved. Incineration capacity for urban household waste reaches 800,000 tons or so per day while the amount of plastic waste directly buried in landfills is significantly reduced. The recycling rate of agricultural film reaches 85%

without any increase in the residual plastic mulch. In terms of waste cleanup, the outdoor legacy plastic waste left in key waters, tourist attractions, and rural areas is largely eliminated. The leakage of plastic waste into the natural environment is effectively controlled.

Long-term goals: By 2035, green industrial chains, green supply chains, and of product life cycle green management are implemented. Targeted whole-chain governance of plastic pollution is established. The internal driving force for green development is significantly strengthened with the size and scale of green industries reaching new heights. Energy and resources efficiency of key industries and key products is in the lead internationally. Green production and lifestyles are commonplace across the society to pave way for a beautiful China.

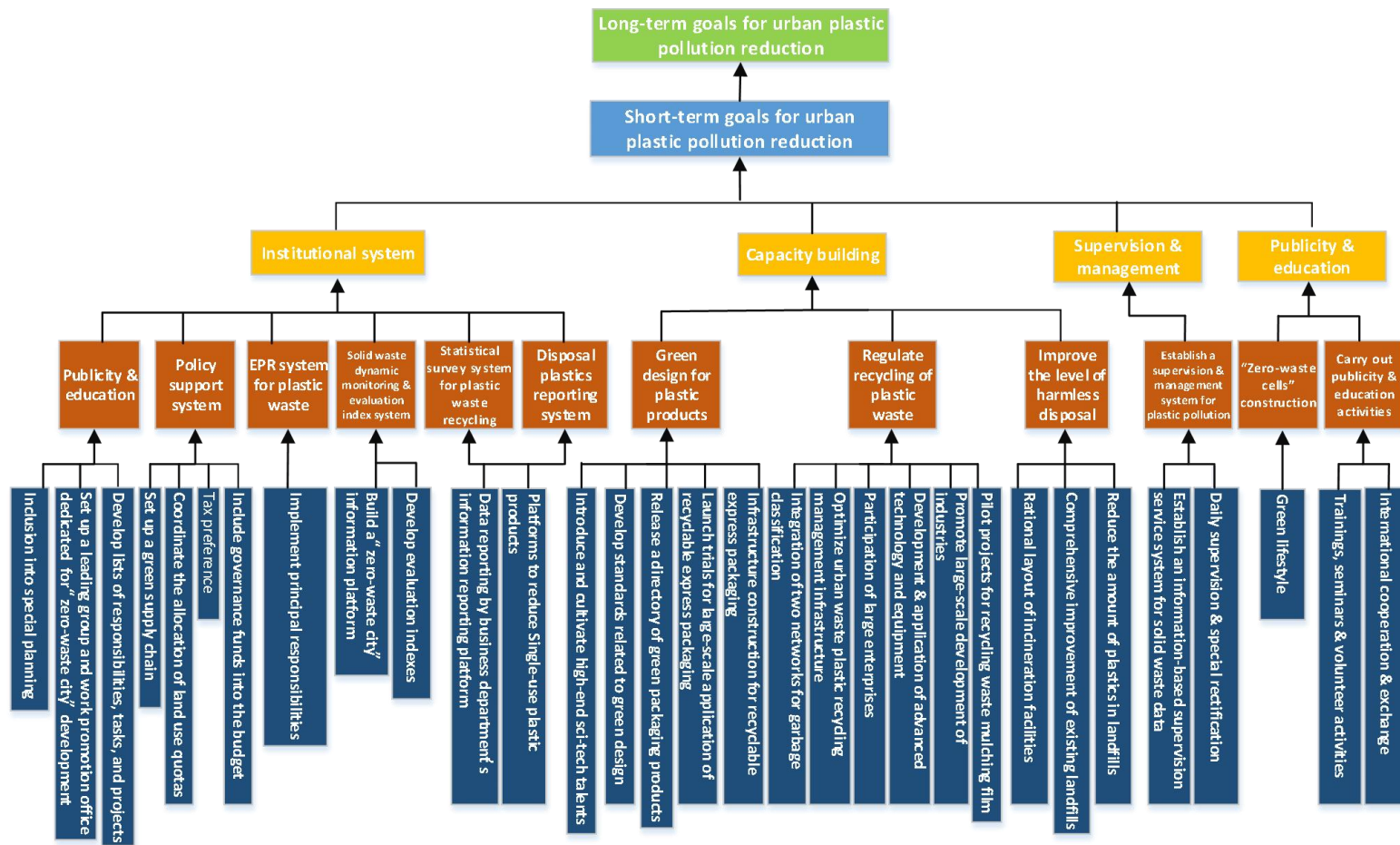


Figure 4-3 Roadmap of plastic pollution control for zero-waste cities

Source: MEESCC

4.3 Evaluation indicator system

The evaluation indicator system of plastic pollution control for zero-waste cities aims to promote significant reduction in plastic generation, boost recycling of plastic waste, minimize the amount of plastics in landfills, mitigate risks and hazards of plastic pollution, steadily improve the governance system and capacity for plastic pollution control, and ensure that the goals for plastic pollution control are attainable.

The evaluation indicator system consists of 6 Level I indicators and 15 Level II indicators (see Table 4-1). Level I indicators include 6 aspects, i.e. source reduction, recycling and utilization, harmless disposal, institutional system, supervision and management, and publicity and education. Level II indicators, as the breakdown and quantification of Level I ones, are divided into two categories: Category I of 11 mandatory indicators (marked by★ in Table 4-1) for plastic pollution control in all areas, and Category II of 4 optional indicators depending on the types, characteristics, and task arrangement of the cities. In addition, municipal governments may set customized indicators based on the distinctive development orientation, development stage, resource endowment, industrial structure, and economic and technological power of each city, giving full play to the synergy of pollution and carbon emission control.

Table 4-1 Evaluation indicators of plastic pollution control for zero-waste cities

Level I indicators	Level II indicators		Description
Source reduction	1	Annual amount of plastic packaging used per capita★	The amount of plastic packaging used per capita each year in the city Information/Data Source: Municipal Bureau of Commerce
	2	Market share of green products in products containing plastics (packaging excluded) ★	The proportion of products circulating within the city that conform to SAC's green product evaluation standards and MIIT's standards for product green design Information/Data Source: Municipal Bureau of Industry and Information Technology, Municipal Bureau of Commerce
	3	Number and proportion of enterprises engaged in ecodesign and/or circular design at the source	The number of registered enterprises that have launched or completed ecodesign and/or circular design at the source and their proportion in all registered enterprises in the city Information/Data Source: Municipal Bureau of Industry and Information Technology
	4	Decline rate of the use of single-use plastic products ★	The decrease in the amount of single-use plastic bags used per capita in the city from a baseline year Information/Data Source: Municipal Bureau of

			Commerce
	5	Coverage rate of household waste sorting	The proportion of residential quarters in urban areas and counties that carry out household waste sorting in collection and transportation Information/Data Source: Municipal Bureau of Housing and Urban-Rural Development, Municipal Development and Reform Commission, Municipal Urban Administration, Municipal Bureau of Landscaping & City Appearance Administration
Recycling and utilization	6	Collection rate of plastic waste ★	The proportion of the collected municipal plastic waste in total plastic waste generated (collected amount only and recycled amount excluded) Information/Data Source: Municipal Bureau of Commerce, Municipal Bureau of Housing and Urban-Rural Development, Municipal Urban Administration
	7	Recycling rate of plastic waste★	The proportion of plastic waste recycled and utilized in total plastic waste collected Information/Data Source: Municipal Development and Reform Commission, Municipal Bureau of Industry and Information Technology
Harmless disposal	8	Decline rate of plastic waste in landfills★	The reduction in the amount of plastic in landfills of current year from a baseline year Information/Data Source: Municipal Bureau of Housing and Urban-Rural Development, Municipal Bureau of Ecology and Environment
	9	Proportion of incinerated plastic waste for power generation★	The proportion of incinerated plastic waste for power generation to the total plastic waste incinerated in the current year Information/Data Source: Municipal Bureau of Ecology and Environment
Institutional system	10	Formulation of local regulations, policies, and plans for plastic pollution control ★	Local regulations, policies, and plans for plastic pollution control promulgated by the city Information/Data Source: municipal departments in charge of plastic pollution control
	11	Coordination mechanisms for plastic pollution control★	Organization and coordination mechanisms where the municipal CPC committee and the municipal government take the lead, municipal leaders bear the main responsibility, and all related departments play their roles, and other related taskforces and collaborative mechanisms Information/Data Source: municipal departments in charge of plastic pollution control
	12	Inclusion of plastic pollution control as a part of performance evaluation of the government	The progress in plastic pollution control is included in the performance assessment of municipal, county, and district governments and their departments Information/Data Source: Municipal Department of Human Resources and Organization, Municipal Department of Supervision

	13	Fiscal fund for plastic pollution control ★	Municipal ear-marked funds for household waste disposal or plastic pollution control with statistics by category (including collecting and recycling, landfill, incineration for power generation, general incineration) Information/Data Source: Municipal Bureau of Finance
Supervision and management	14	Proportion of filed criminal cases related to plastic pollution★	The proportion of filed criminal cases related to plastic pollution in the total number of clues of criminal cases related to solid waste pollution in the municipal jurisdiction Information/Data Source: Municipal Bureau of Public Security, Municipal Bureau of Ecology and Environment
Publicity and education	15	Penetration rate of publicity, education and training on plastic pollution control	Publicity, education, and training organized to enhance the public awareness and understanding of plastic pollution Information/Data Source: third-party investigation

★ refers to mandatory indicators

Source: MEESCC

4.4 Suggestions

4.4.1 Promoting source reduction of plastic waste

Source reduction should be promoted, which means reducing the generation of plastic waste. Green supply chains for recycled plastics should be introduced to make full use of recycled resources. Guidance should be provided to leading plastic manufacturers to contribute to green supply chains. Green procurement should be given full play to promote the recycling of plastic waste and shape a circular economy. Green ecodesign should be advocated for plastic products to increase the recyclability of plastics. More efforts should be made to tackle key technological challenges and promote the application of biodegradable plastics, which helps improve product quality and performance and cut application cost as soon as possible. Cities can also drive the source reduction of plastic waste by promoting green lifestyles.

4.4.2 Strengthening household waste sorting, collection, and transportation

Zero-waste cities should accelerate the integration of the waste sorting networks with the recycling networks and build a sound industrial chain that stretches from the initial sorting and collection to the final disposal of recyclables. To deal with urban household waste, cities should make an attempt to establish a measuring and charging system for household waste

sorting with reasonable fee schedules for waste sorting, transportation, and disposal. The disposal fee for unsorted household waste should be raised to urge required sorting at the source. For the ear-marked fund of household waste disposal fee, special management mechanisms should be established and explored. Cities are expected to promote waste-to-electricity and other utilization of waste as a source of energy. Bases for waste recycling and utilization should be established to promote various utilization, such as the reuse of recyclables, waste-to-energy plants, biodegradation, etc. In urban areas, an efficient operation model for sorting, collecting, transportation, utilization, and disposal should be built to boost utilization and harmless disposal. In rural areas, household waste sorting should include designated drop-off sites, collection by category, sorting and transportation, recycling and utilization, and bio-composting in line with local conditions. On-the-spot or local recycling and disposal and timely transportation and disposal should be advocated to facilitate local source reduction and utilization.

4.4.3 Consolidating the recycling system and technological innovation for plastic waste

Based on the development of zero-waste cities, attention should be paid to enhance the guidance from top-level design and the leading role of the governments. Cities should ensure reasonable locations of their collecting and recycling sites and networks in line with local conditions. Environmental protection-related enterprise clusters should be further regulated and integrated to consolidate the plastic recycling system and improve recycling capacity. Cities should increase economic, technical and other support for recycling enterprises to raise the recycling rate of plastic waste. Local management systems and supervision information platforms for plastic waste recycling should be established. Technological innovation in plastic recycling should be encouraged while introducing domestic or foreign advanced recycling equipment. Pilot and demonstration enterprises should be supported. Technological and management standards should be improved accordingly. Green product design and green supply chains should be promoted and optimized to bolster plastic pollution control through recycling.

4.4.4 Exploring and implementing the extended producer responsibility (EPR) system

The EPR system makes producers assume their responsibilities for resources and the environment throughout the life cycle of their products, so as to improve product recycling rate and accelerate green and circular development. Plastic production and processing industry is one with high capacity and the fastest growth, often with scattered enterprises. The recycling

and disposal also varies greatly from one type of plastics to another, with particularly poor recycling of low-value plastics. Zero-waste cities should explore the EPR system suitable for the current stage of their development for the recycling of express delivery packaging and agricultural film, which helps incentivize producers to improve production technologies and increase the recycling and utilization rate of plastic waste.

4.4.5 Supplementing the evaluation indicator system of plastic pollution control

The evaluation indicator system for zero-waste cities consists of three-tier indicators (Level I, Level II, and Level III) and three categories, i.e. mandatory, optional, and customized indicators. The indicators related to plastic pollution control include the proportion of green packaging used in express delivery, recycling rate of agricultural mulch film, and recycling rate of household waste. However, there is a lack of targeted indicator for plastic pollution control. Such indicators and standards should be set up in future to strengthen plastic pollution control for further development of zero-waste cities.

4.4.6 Improving the long-term mechanism for plastic pollution control

Based on the development of zero-waste cities, the long-term mechanism for urban plastic pollution control should be established and improved to reinforce departmental collaboration for comprehensive measures and concerted efforts. In key sectors and areas, departments responsible should jointly take cleanup actions to ensure timely collection, transportation, and disposal of plastic waste so as to effectively mitigate the risk of pollution. Measures on plastics control should be implemented with strengthened supervision of plastic production and integrated management of sorting and recycling. Smart monitoring platforms and management systems should be built to ensure whole-process intensive management and control of plastic waste. Favorable tax treatment and other conducive policies should be adopted to incentivize and support the recycling and utilization industry of plastic waste. Green government procurement should be expanded to encourage enterprises to phase in green procurement system. Subsidies and rewards should be used to motivate the public to buy green products.

4.4.7 Expanding public participation and international cooperation

With steady progress in developing zero-waste cities and popularizing the zero-waste philosophy, public awareness on environmental protection has been gradually enhanced with a more comprehensive grasp of plastic pollution. Nevertheless, public participation needs to be expanded. To fill the gap of public engagement, on one hand, more supporting measures for waste sorting should be adopted to facilitate public involvement, such as clarifying sorting standards, green product labelling and marks. On the other hand, long-term

incentives and restraints should be established and improved to build a social action system with universal participation and shape favorable public opinion on plastic pollution control. In the meantime, cities should carry out research projects through international cooperation and actively engage in forums and seminars on plastic pollution control at home and abroad. International exchanges and cooperation on policies, management, technologies, successful models, and lessons and experience should be enhanced for the prevention and control of plastic pollution to raise the international profile of China in this field.



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