[National Think Tank Report]

Investigation Report on Recycling and Utilization

of Low–value Recyclables in China

Institute of Economic Structure and Management, Macroeconomic Research Institute, National Development and Reform Commission

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Research Report on Collection and Recycling of Low-value Recyclables in China

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Executive summary:

The report to the 20th National Congress of the Communist Party of China proposes to implement a comprehensive conservation strategy, promote the conservation and intensive utilization of all kinds of resources, and accelerate the construction of the waste recycling system. At present it involves high cost and poor benefits to recycle paper-plastic composite packaging, flexible plastic packaging, waste plastic meal boxes, waste textiles, and other low-value recyclables, so the recycling rate of such things is low. It has thus become a weak link in the waste recycling system. It holds great significance for building a resource-saving and environmentally-friendly society to accelerate the exploration and establishment of a sound system for the collection and recycling of low-value recyclables, improve the operation mode, improve the long-term mechanism, and increase the collection and recycling rate. It is an important pillar for the construction of ecological civilization and the realization of the carbon peaking and carbon neutrality goals.

The so-called low-value recyclables mainly refer to the recyclables that are generated in the production and living process and have certain recycling value, but are hard to effectively recycle only by the spontaneous force of the market, such as low-value plastic packaging, waste glass, waste textiles, beverage paper-based composite packaging and other common types of waste.

Research findings:

1. In 2021, China generated about 95.77 million tons of low-value recyclables, including 50.21 million tons of low-value plastic packaging, 22.75 million tons of waste glass, 21.24 million tons of waste and used textiles, 1.32 million tons of mulching film, 640,000 tons of paper-based composite packaging for beverages, 125,600 tons of fertilizer packaging and 117,000 tons of pesticide packaging. Overall, there are considerable low-value recyclables.

2. In 2021, altogether 25.47 million tons of low-value recyclables were recycled in China, with a recycling rate of about 26.6%. Specifically, the recycling rate of the waste mulching film reached 60.6%; the recycling rates of pesticide packaging waste, beverage paper-based composite packaging, daily waste glass, waste textiles, and low-value plastic packaging respectively stood at 58.6%, 33.1%, 27.1%, 21%, and 19.5%.

3. By the end of June 2023, a total of 18 cities had issued special documents, management measures or specific catalogs on low-value recyclables. The low-value recyclables cover waste paper, waste plastics, waste flexible packaging, waste glass, waste ceramics, waste textiles and clothing, waste wood and waste miscellaneous iron. All localities have taken active actions.

Implementation summary:

4.In general, the policy side has yet to put in place a unified and sound policy system for the collection and recycling of low-value recyclables, and the waste classification and recycling system on the recycling side is not well developed. The classified placement of low-value recyclables at the source has poor effect; at the disposal end the sorting facilities in cities have yet to be improved and increased since the concentrated sorting ability is inadequate; at the utilization end enterprises have low enthusiasm for participation; the technology for utilizing the recyclables is at a low level, and the enterprises are small and scattered, which constitutes the major problem encountered by the industry.

5.According to the survey results, more than 80% of urban and rural residents do not know about low-value recyclables, and the proportion of diverse low-value recyclables directly discarded ranges from 30% to 89%. However, 94% of the residents have a positive attitude towards the recycling of low-value recyclables. At the same time, the self-employed represent the most important source of recycling the low-value recyclables since over 30% of such things are recycling from them.

6.The survey found that the recycling of low-value recyclables in China is still dominated by the spontaneous market behavior of enterprises. Relevant enterprises have carried out the recycling of low-value recyclables such as waste textiles, waste glass, waste pesticide and fertilizer packaging,

waste mulching film, waste beverage paper-based composite packaging and waste meal boxes. The well-developed recycling system of the region or the country has yet to be established, the whole-chain management concept is not well implemented and the packaging design needs to be more environment-friendly, and the long-term promotion mechanisms such as the deposit system and the extended producer responsibility system have a lot to be improved.

Suggestions:

The study proposes that given the actual development of the low-value recyclables industry in China and the characteristics of China's national conditions, the state and local governments should strengthen top-level design and system supply, issue catalogs and guidelines for recycling of low-value recyclables, accelerate the improvement of the licensing system, the deposit recovery system and the operation subsidy system for the recycling of low-value recyclables, encourage enterprises and residents to participate extensively, and take measures to promote the construction and improvement of the recycling system for low-value recyclables by the category:

1. For different categories of low-value recyclables, different recycling modes should be adopted based on their physical attributes and recycling channels. For waste glass and waste textiles, it is

Implementation summary:

advisable to adopt the mode of franchise operation and establish an independent collection, transportation, and disposal system.

For waste fertilizer and pesticide packaging and mulching film, it is advisable to take the extended producer responsibility system, establish a regional recycling alliance, and adopt deposit recovery and other modes for centralized disposal.

For bulky garbage, it is advisable to gradually introduce the paid treatment mechanism which shall be integrated with the urban sanitation system or the recyclables recovery system.

For non-returnable beer bottles, beverage bottles and other reusable packaging that can be reused, it is advisable to step up the deposit system implementation and develop a closed operation management system.

For other mixed low-value recyclables, it is advisable to build a low-value recyclables sorting center in the city for concentrated recycling, sorting, processing, and utilization.

2. The state should strengthen top-level design and institutional supply; incorporate the recycling and utilization of low-value recyclables into relevant laws, regulations, and strategic plans; develop and release a guide catalog for low-value recyclable; increase financial support and tax incentives; improve related standards and certification systems; launch demonstration pilot projects; and encourage and guide the participation of related associations and NGOs.

3. Local governments should develop and release local low-value recyclables catalogs and specific implementation rules,

explore the establishment of franchise systems, strengthen the guarantee of land, energy and other factors for the construction of recycling systems, strengthen information management, regulate enterprise production and operation behavior, and widely conduct promotional and guidance work, so as to enhance the recycling awareness of enterprises and residents.

4. Enterprises should continuously step up innovation, improve their industrial system, and explore sustainable business models for low-value recyclables by strengthening innovation in technology, equipment, and business modes for recycling low-value recyclables. Relevant manufacturing enterprises should be encouraged to enhance their utilization of renewable resources and carry out green supply chain management.

5. Consumers should consciously practice the concept of green living; readily return empty beer bottles, beverage bottles, etc. to designated locations; actively participate in the classification, recycling, and standardized delivery of low-value recyclables; and avoid mixed discharge and disposal of household waste.

If the recycling rate of low-value recyclables in China is raised from the current 26.6% to an average level of 50% through 3-5 years of efforts, 47.9 million tons of low-value recyclables can be collected and recycled every year. For the whole society, more than 45 million tons of renewable resources such as recycled plastics and recycled paper will be generated, which is equivalent to a reduction of 127.47 million tons of carbon dioxide emission a year.

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I. The connotations and classification of low-value recyclables

Low value mainly refers to relatively low economic value; "low-value recyclables" is a relative concept since the economic value of recyclables differs in different countries and regions or during different development periods of the same country and region. Therefore, it is necessary to systematically define and analyze the connotations, classification and characteristics of low-value recyclables.

(I) What are low-value recyclables

The term "recyclable" first appeared in the Classification and Evaluation Criteria of Urban Domestic Waste compiled by Guangzhou Municipal Appearance and Environment Health Bureau in 2004. The document indicates that recyclables belong to the category of domestic waste. It is pointed out that recyclables refer to waste paper, waste plastics, waste glass products, waste metal and waste fabric, which are suitable for recycling. Since then, the recycling policies released by different localities use the same wording for the same purpose. In 2021, the Catalogue of Low-value Recyclables of Shantou City issued by Shantou City pointed out that low-value recyclables refer to the solid domestic wastes that have certain recycling value and are easy to be mixed with other types of domestic wastes in the process of garbage placement. It is hard to effectively recycle and treat them by relying on market regulation as they can be reused only through large-scale recycling and centralized treatment.

Therefore, this research holds that low-value recyclables refer to the recyclables that are generated in the production and living process, have certain recycling value, and can be recycled by technological or economic means. Given the poor economic benefit generated in such recycling, it is difficult to effectively recycle the materials only by the spontaneous force of the market. Such materials are as follows: the waste glass, waste textiles, beverage paper-based composite packaging and other common types of waste.

Low-value recyclables represent a concept in contrast to that of the recyclables with high recycling value, such as scrapped cars, scrapped metal, and discarded electrical and electronic products. The low-value and high-value recyclables can be transformed into each other in different market environments and technological and economic conditions.

(II) Scope of low-value recyclables

China has yet to have a national document for the definition of low-value recyclables. Some cities have issued local guiding documents, such as the Guiding Catalogue of Recyclables in Shanghai (2019 Edition) issued by Shanghai Landscaping and City Appearance Administrative Bureau, the Guiding Catalogue of Low-value Recyclables issued by Xiamen Municipal Garbage Classification Office, etc. However, the scope of low-value recyclables differs from place to place due to the great difference in the urban economic development level and resource utilization. In general, the low-value recyclables in China basically consist of waste textiles, low-value plastic packaging, waste glass, beverage paper-based composite packaging, waste mulching film, waste fertilizer and pesticide bottles, and large pieces of garbage. See Figure 1-1 for details.

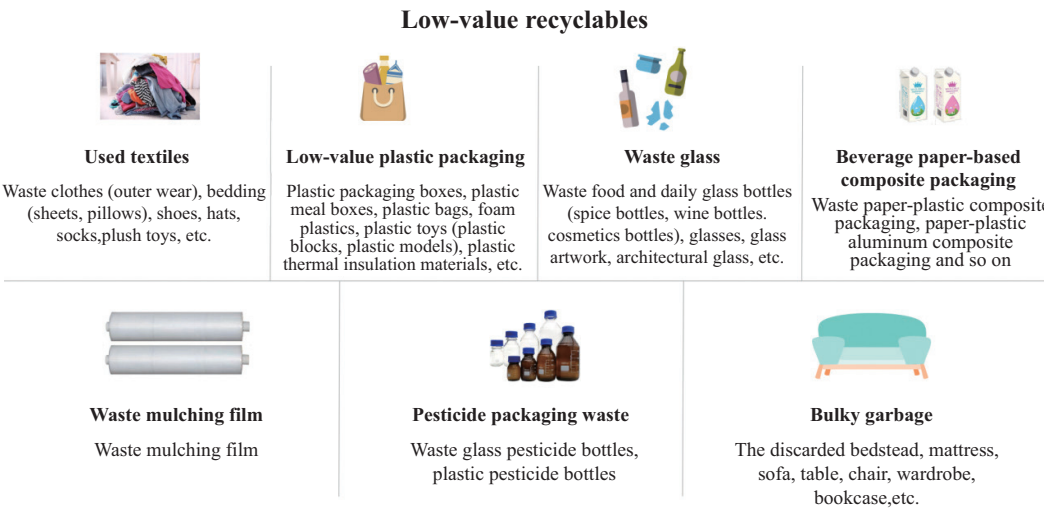

Figure 1-1 Classification of low-value recyclables

(III) Characteristics of low-value recyclables

Low-value recyclables as materials have the dual attributes of garbage and resources; they are scattered and diversified, as seen in their sources; and they are influenced by the economic development level, labor cost and other factors and show typical temporal and spatial differences. See Figure 1-2 for details.

1. Recyclable to some extent

The low-value recyclables have a certain recycling value from an economic point of view. Industrial raw materials such as recycled plastic, recycled glass products, recycled paper, recycled fibers and the like can be produced after recovering, sorting and processing the low-value recyclables, and can be reused for industrial production. Thus, the consumption of primary resources and the emission of carbon dioxide and other pollutants are reduced. Such activities have a typical positive externality, which is conducive to economic development and protection of the resources and environment.

2.Poor economic viability

In the process of front-end classified collection, the low-value recyclables are easy to be mixed with other domestic wastes, and can be recycled only after classified collection and centralized large-scale treatment. It is time-consuming and laborious, and involves a high cost to conduct classified collection and transportation. In the separation link, it is hard to adopt the centralized separation technology; the individual entities generally have low value, and the economic added value of recycled products is low, so recycling brings very limited profit. Therefore, enterprises have low enthusiasm for recycling, and it is difficult to effectively recycle only by relying on market forces, which leads to a large quantity of low-value recyclables being mixed with other wastes for incineration or landfill disposal.

3. Low-value recyclables scattered and hard to recycle

The low-value recyclables come in various types, different shapes and complex components, and many of them are composite materials. For example, paper-based composite packaging for beverages is a product made of paper, plastic, aluminum and other materials. In contrast to industrial waste and large-scale solid waste, the low-value recyclables are very scattered, like low-value plastic packaging, waste glass, waste textile, large garbage and the like. They are gradually generated along with people's daily lives, mostly in residential communities, streets and townships. Waste pesticide and fertilizer packages and mulching films are even more scattered in the fields, so it is difficult to collect, dispose of and utilize them in a centralized and large-scale way.

4. Recycling conditioned by time and space

The low-value recyclables are the phased products under the specific market economic conditions in the specific period. The "low-value" is a relative concept, representing a judgment of the economic value in the recovery and utilization of the low-value recyclables. Regarding the time dimension, as time goes on and the comprehensive social cost changes, some recyclables with a high value at present may become "unprofitable" due to the rise of comprehensive cost such as labor cost. Regarding the spatial dimension, low-value recyclables with economic value in China and other developing countries may be "garbage" with no economic value at all in Japan, EU and other developed countries and regions.

Figure 1-2 Characteristics of low-value recyclables

II. Current regulations and policies related to low-value recyclables

At present, China has yet to issue any special state management policies or documents on low-value recyclables. The recycling of low-value recyclables is

mentioned only in the regulatory documents related to the recycling of renewable resources. Locally, over recent years, some cities have successively issued special management policies or regulations on the collection and recycling of low-value recyclables to promote the establishment of the recycling system of low-value recyclables.

(I) Relevant state policies

1.Relevant state laws and regulations

Currently, there are no laws, regulations or policy documents at the national level that specifically address the collection and recycling of low-value recyclables; only relevant principle provisions are scattered in other laws, regulations or planning documents. The Circular Economy Promotion Law, promulgated in 2009, provides for the recycling of renewable resources including some low-value recyclables. The Environmental Protection Law of the People's Republic of China, revised in 2015, requires agricultural producers and operators to scientifically dispose of agricultural wastes such as mulching film. The Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste, which was revised and came into effect in 2020, clearly stipulates specific provisions on plastic pollution. It is proposed to promote the application of alternative products which are recyclable, easy to recyle and degradable, and to strengthen the collection and recycling of waste mulching film, pesticide packaging and other wastes. See Table 2-1 for details.

Table 2-1 Names of relevant laws

Name of the law	Time of promulgation	Contents
Circular Economy Promotion Law of the People's Republic of China	2008	Enterprises that produce products or packaging materials that have been included in the compulsory recycling list shall be responsible for recovering the waste products or packaging. The construction of the waste recovery system is encouraged and promoted. The people's governments at or above the county level shall make an overall plan for the construction of facilities for classified collection and recycling of urban and rural domestic waste, establish and improve the classified collection and recycling system, and increase the recycling rate of domestic waste.

Name of the law	Time of promulgation	Contents
Environmental Protection Law of the People's Republic of China	2015	The people's governments at various levels and the agricultural and other relevant departments and institutions thereof shall guide the agricultural producers and operators to conduct proper disposal of agricultural wastes such as mulching film so as to prevent agricultural non-point source pollution.
Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste	2020	The organizations and other producers and operators that produce agricultural solid waste such as waste mulching film and pesticide packaging waste should take recycling and other measures to prevent environmental pollution. The state encourages and guides the reduction in the use and the recycling of plastic bags and other disposable plastic products, and promotes the application of alternative products that are recyclable, easy to recover and degradable.

2.Relevant states administrative measures

In order to clarify the standards and technical specifications for the collection and recycling of low-value recyclables, different authorities have issued relevant management measures for the recycling of low-value recyclables. In 2007, the Ministry of Commerce, the National Development and Reform Commission, the Ministry of Public Security, the Ministry of Housing and Urban-Rural Development, the State Administration for Industry and Commerce, and the former State Environmental Protection Administration jointly issued the Administrative Measures for the Recovery of Renewable Resources, which provided explicit stipulations on recycling of renewable resources including the waste paper, the waste rubber, the waste plastic, the waste pesticide packaging, the waste glass and so on. Afterward, the State Post Bureau, the Ministry of Agriculture and Rural Affairs, the Ministry of Ecology and Environment, the Ministry of Commerce and other relevant departments have also issued a series of administrative measures for the recycling of low-value recyclables. See Table 2-2 for details.

Table 2-2 Relevant administrative measures

Administrative measures	Time of promulgation	Main contents
Administrative measures for the recovery of renewable resources	2007	It specifies the standards, technical policies and technical specifications to be observed for the collection, storage, transportation and treatment of waste paper, pesticide packaging, waste glass and other low-value recyclables in renewable resources.
Administrative measures for the recovery of express delivery packaging	2019	To standardize and promote the recycling and treatment of express delivery packaging wastes, it makes detailed provisions on the standards of express delivery packaging, the responsibility for recycling, the construction of recycling network and information disclosure. It has promoted the recycling of waste express delivery packaging and environmental protection.
Administrative measures on mulching film	2020	It poses specific requirements on the production, sale and use of mulching film, and requests that the mulching film recycling and utilization outlets should be set up so that a recycling and reuse system can be established.
Administrative measures for the recovery and utilization of mulching film	2020	It specifies the entities responsible for the mulching film recovery and utilization as well as the recycling process and requirements; puts in place the recycling system; clarifies the recycling standards and technical requirements; and stipulates the corresponding reward and punishment measures.
Administrative measures for the recovery and treatment of waste pesticide packaging	2020	It specifies the entities responsible for the pesticide packaging recovery and treatment as well as the recycling process and requirements; clarifies the recovery and treatment standards and technical requirements; puts in place the recovery supervision and administration mechanism; and stipulates the corresponding reward and punishment measures.
Implementation scheme of extended producer responsibility system for beverage paper-based composite packaging	2020	To increase the recycling rate of waste beverage paper-based composite packaging, the plan specifies the standard for recycling the waste paper-based composite packaging of beverages, supports the beverage paper-based composite packaging production enterprises to operate by the market principle, and encourages beverage paper-based composite packaging production (import) enterprises, according to the recovery quantity and utilization level, to provide technological and financial support for the weak links of the recovery chain.
Measures on the reporting of the use and recycling of disposable plastic products in the business field (Trial)	2020	To encourage and guide the reduction in the use and to push for the recycling of plastic bags and other disposable plastic products, we should establish a reporting system on the use and recycling of disposable plastic products, and require the nationwide units that run commodity retail outlets, e-commerce platform enterprises and take-away enterprises to report the use and recycling of disposable plastic products.

Administrative measures	Time of promulgation	Main contents
Administrative measures on express mail packaging	2021	The posting and delivering enterprises shall, in accordance with the relevant provisions, pack the express mails with environment-friendly materials, give priority to the use of reusable and recyclable packaging, improve the package of express mails, reduce the use of packaging and actively recycle packaging.

3.Relevant state policy documents

In recent years, in order to vigorously promote the development of a circular economy and accelerate the construction of a waste recycling system, the key state plans or policies all put forward requirements on the collection and recycling of low-value recyclables such as waste glass, waste plastics, waste textiles and waste paper. Among them, the 14th Five-Year Plan for the Development of Circular Economy proposes to build a recycling system for waste and old materials, implement standardized management of waste plastics, waste paper and other renewable resources recycling industries, and uplift the standardization level of the industries. The 14th Five-Year Plan for Controlling Plastic Pollution proposes to advance standardized recycling and disposal of plastic waste and reduce the production and use of plastics. In 2022, the Guiding Opinions of the National Development and Reform Commission and Other Departments on Accelerating the Construction of the Recycling and Utilizing System for Waste and Used Materials for the first time clearly put forward that local governments of the places where conditions permit are encouraged to formulate supporting policies for the collection and recycling of low value-added recyclables. See Table 2-3 for details.

Table 2-3 Relevant policy documents

Policy documents	Time of promulgation	Main contents
Value-added tax policies on comprehensive utilization of resources	2015	For the recycled plastic products produced by using waste plastics, the recycled plastic products produced by using waste mulching film, the recycled paper produced by using waste paper and the recycled glass produced by using waste glass, respectively 70%, 100%, 50% and 90% of the value-added tax is refundable.

Policy documents	Time of promulgation	Main contents
Opinions on further addressing plastic pollution	2020	It is forbidden to restrict the production, sale and use of plastic products such as non-degradable plastic bags, disposable plastic tableware, disposable plastic articles for hotels, and plastic packages for express delivery. We should step up efforts in classified collection and treatment of plastic wastes and other recyclables, set recycling facilities to recover express delivery packaging and take-away meal boxes in key areas, establish and improve the recycling system for waste mulching film, and standardize the recycling and disposal of waste fishing nets and gear.
The 14th five-year plan for circular economy	2021	We shall carry out the construction of a recycling system for urban waste and old materials, make overall plans for the construction of bases for the processing and utilization of renewable resources, and strengthen the classified utilization and centralized treatment of waste textiles, waste plastics, waste paper, waste glass and other low-value wastes.
The 14th five-year plan for controlling plastic pollution	2021	We shall increase the collection and transportation efficiency of plastic waste and enhance the standardization level of plastic waste recovery; carry out the mulching film recovery in a deep-going way and continue to build up the mulching film recovery demonstration county; and carry out the pesticide packaging recovery.
Income tax policies on comprehensive utilization of resources	2021	The income of the enterprises which use waste plastics, waste paper, waste glass and other resources specified in the Income Tax Policies on Comprehensive Utilization of Resources as their main raw materials to turn out products that are not restricted and prohibited by the state and conform to relevant national and industrial standards shall be counted at the reduced rate of 90%.
Implementation opinions on accelerating the recycling and utilization of waste textiles	2022	We shall reasonably set special recycling boxes or relevant facilities for used and waste textiles, properly design and build sorting centers and classified treatment centers, and promptly sort out and classify used and waste textiles.
Guiding opinions on accelerating the construction of recycling system of waste and used materials	2022	Local governments of the places where conditions permit are encouraged to formulate supporting policies for the recovery and utilization of low value-added recyclables, and implement and improve preferential tax policies for energy and water conservation and comprehensive utilization of resources according to law.

(II) Relevant local policies

1.Cities with explicit recycling policies for low-value recyclables

By the end of June 2023, a total of 18 cities had issued special documents, administrative measures or catalogs on the recycling of low-value recyclables, all of

which are concentrated in the central and eastern parts of China (See Figure 2-1 for details). In addition, of the 60 cities designated by the state as the pilot cities for the construction of waste and used materials recycling system, the cities that have issued relevant implementation plans have all clearly put forward relevant requirements for the collection and recycling of low-value recyclables in their respective plans for the construction of waste and used materials recycling system.

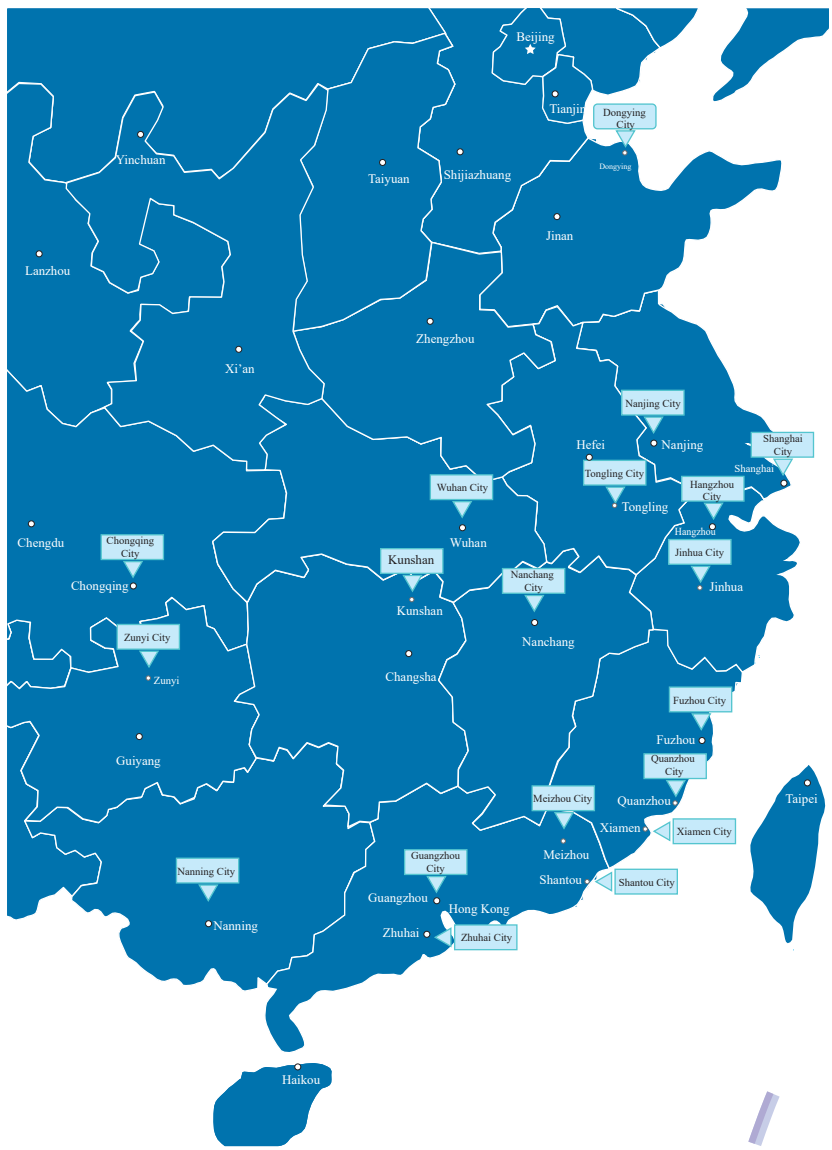

Figure 2-1 Cities with special policies regarding low-value recyclables

2. Administrative regulations on low-value recyclables in various places

At present, the administrative regulations on low-value recyclables issued by various cities are mainly local regulations formulated based on relevant state laws and regulations associated with the actual conditions of various places. Among them, Nanjing, Nanning, Guangzhou and Jiangmen have successively issued administrative measures to specify the types of low-value recyclables. They have all proposed to entrust professional companies to carry out the recycling of low-value recyclables by means of government purchase of services, and rolled out detailed provisions on the determination and pay of service fees. Thus, legal support is put in place for the construction of the recycling system of low-value recyclables.

Table 2-4 Administrative regulations on low-value recyclables in cities

Local policy documents	Time of promulgation	Contents
Interim measures of Nanjing Municipality on the recovery of low-value recyclables	2017	The urban administrative departments shall purchase the recovery and treatment services of the low-value recyclables from the enterprises through government procurement, and sign the service procurement contract. The municipal administrative department and the financial department shall work out the procurement guiding price based on the collection, transportation and disposal cost of the domestic waste.
Administrative measures of Guangzhou Municipality on purchase of recycling services for low-value recyclables	2021	The related municipal and district administrative departments shall be responsible for organizing and implementing the purchase of services for recovery and treatment of low-value recyclables; the municipal and district financial departments shall be responsible for raising funds and appropriating them in time; the commerce, supply and marketing cooperatives and other relevant departments shall perform their respective functions in the implementation of the measures; Guangzhou Municipal Domestic Waste Management Center shall be responsible for completing the accounting and payment formalities related to the service fees for the recovery and treatment of low-value recyclables.
Measures to promote the recovery of low-value recyclables in Jiangmen City	2022	The governments of counties (cities, districts) shall, in strict accordance with relevant procedures on government procurement, determine low-value recyclables recycling enterprises by means of government procurement service, and the recycling enterprises shall undertake the unified collection and transportation of low-value recyclables in the designated areas. The government procurement service expenses shall be raised and arranged by each county (city, district) government in light of the actual financial circumstances to promote the market-oriented operation of enterprises.

Local policy documents	Time of promulgation	Contents
Administrative measures of Meizhou Municipality on classified management of urban domestic waste	2022	The people's governments of cities and counties (cities and districts) shall formulate corresponding policies and adopt such measures as cooperation between the government and social capital and government purchase of services to encourage and guide social capital to participate in classified placement, collection, transportation, disposal and recovery of domestic waste. The municipal, county (municipal, district) people's governments shall formulate supporting policies for the recovery and utilization of recyclables with low added value, and guide and support social forces to recycle and utilize recyclables with low added value.

3. Catalogues of low-value recyclables in various places

At present, the Catalogs of Low-value Recyclables issued by various localities show they are different in the definition of the scope of low-value recyclables, as conditioned by local development. But basically they all cover waste paper, waste plastics, waste flexible packaging, waste glass, ceramics, waste textile clothing, waste wood, waste miscellaneous iron and so on. See Table 2-5 for details.

Table 2-5 Catalogs of low-value recyclables in different cities

Catalogue of low-value recyclables	Time	Low-value recyclables
Interim measures of Nanjing Municipality on the recovery of low-value recyclables	2017	Waste glass, waste wood, waste flexible packaging, waste plastics
Catalogue of low-value recyclables in Guangzhou	2018	Waste glass, waste plastics, waste wood, waste fabric, waste miscellaneous iron
Guiding catalogue for recycling recyclables in Shanghai (2019 Edition)	2019	Waste paper, waste plastics, waste glass products, waste fabrics, waste wood
Guiding catalogue for recycling recyclables with low added value from domestic waste in Xiamen	2020	Waste glass, ceramics, waste plastics, waste paper, waste textile clothing

Catalogue of low-value recyclables	Time	Low-value recyclables
Guiding catalogue for recycling recyclables in Zhuhai (2021 Edition)	2021	Paper, plastics, glass, fabric, wood
Catalogue of low-value recyclables in Shantou	2021	Waste paper, waste plastics, waste glass products, waste fabrics, waste wood
Catalogue of low-value recyclables in Dongying	2021	Waste glass, waste plastics (part), waste textile fabric, waste wood
Guiding catalogue for recycling recyclables in Meizhou (2022 Edition)	2022	Paper, plastics, glass, fabric, wood
Guiding catalogue for classification of domestic waste in Zunyi (2022 Edition)	2022	Paper, plastics, glass, fabric, wood
Catalogue for recycling low-value recyclables in Jiangmen	2023	Waste paper, waste plastics, waste glass products, waste fabric, waste wood

4.Subsidy policies on low-value recyclables in various places

As seen from local policies, local governments generally provide subsidies according to the total quantity of low-value recyclables recycled by related enterprises, or subsidize the enterprises in such links as classified recycling, centralized transportation and unified disposal of low-value recyclables, so as to ensure that participating enterprises can keep their principal, earn a slight profit and stay in normal operation. See Table 2-6 for details.

Table 2-6 Subsidy policies on low-value recyclables in various regions

Subsidy policies of different cities	Time of release	Main contents
Circular of Nanjing Municipality on interim measures for recovery of low-value recyclables	2017	We shall purchase the services for recovery and treatment of low-value recyclables from enterprises through government procurement, and sign the service purchase contract. The municipal and district urban administrative departments shall be responsible for the procurement of treatment services and recovery services respectively. The urban administrative departments shall, together with the financial departments, set the procurement guiding price based on the collection, transportation and treatment cost of domestic waste, and determine the unit price of recovery and treatment service through public bidding.
Subsidy measures on Jinhua urban garbage classification and recycling of low-value recyclables	2018	We conduct garbage classification and subsidize the recovery of recyclables to ensure the participating enterprises earn a slight profit in their door-to-door recovery process and remain in normal operation. The financial subsidy mainly covers two aspects: First, the subsidy goes for the purchase of special vehicles for recycling; second, the subsidy goes for operation and maintenance, to subsidize the cost for the operation and maintenance of the entities engaged in garbage classification and recycling of low-value recyclables.
Detailed implementation rules on subsidizing the recycling of low-value recyclables from domestic waste in Hongkou District, Shanghai	2018	The recovery of recyclable domestic waste with low added value in this zone shall be subsidized according to the total amount, with the subsidy going for supporting the garbage classification, recovery, transportation and disposal at the market price. The subsidy standard shall be 221 yuan per ton for solid waste disposal in Shanghai Municipality.
Administrative measures of Guangzhou Municipality on purchase of recovery services for low -value recyclables	2018	The district competent department of urban management shall purchase the recovery services for low-value recyclables from enterprises through government procurement. The Waste Management Center shall pay the recovery fee for low-value recyclables to the undertaking entity on a monthly basis according to relevant procedures of the settlement platform. The unit price of the low-value recyclables recovery in the current year shall be the comprehensive unit price of the domestic waste treatment in the previous year.
Measures of Quanzhou Municipality on subsidizing the classification, collection, transportation and disposal of low-value recyclables (Trial)	2018	We subsidize the enterprises engaged in pilot classified collection and transportation of low-value recyclables in the city. The subsidy for recovery of low-value recyclables is 186 yuan per ton.

Subsidy policies of different cities	Time of release	Main contents
Notice of the General Office of Tongan District People's Government in Xiamen City on issuing the key points of domestic waste classification in Tongan District in 2019	2019	The district finance subsidizes the recycling and utilization of low-value recyclables in the form of "award in place of subsidy".
Trial measures of Wuhan Municipality on subsidizing the classification of garbage and recycling of low-value recyclables (Exposure draft)	2020	The enterprises that undertake garbage classification and recovery of low-value recyclables in Wuhan, get listed in Wuhan Urban Mineral Resources Exchange to sell raw materials to production enterprises shall be subsidized according to the quantity of recovered and delivered supplies, as confirmed by the signed joint bill. The subsidy standard for low-value recyclables shall be set by referring to the comprehensive waste disposal cost standard of Wuhan City in the same year.
Implementation rules for subsidizing the recovery of recyclables with low added value in Minhang District, Shanghai	2020	The enterprise responsible for the operation of district-level two-network integrated distribution yard and the enterprises responsible for the operation of two-network integrated transfer station in the street and town (Xinzhuang industrial zone) shall be subsidized for the operation and disposal cost, with the subsidy standard being no more than 111.5 yuan per ton (the final bid price shall prevail).
Measures of Kunshan City on subsidizing the development of the low-value recyclables recovery industry	2022	For enterprises engaged in the recovery of low-value recyclables within districts and towns, the subsidy measures are implemented in five aspects, including offering incentives and guidance, fee reduction and exemption, employment support, epidemic prevention support, and other support.
Measures of Dongying City on subsidizing the recycling of low-value recyclables (Trial)	2021	Subsidies shall be granted to the enterprises determined by the counties and districts (development zones) through public bidding (authorized by the government) to undertake the recovery of low-value recyclables within their jurisdiction. The subsidy standard shall be set by referring to the weighted average value of financial subsidy unit price of the domestic waste incineration power plant in Dongying City in the current year.
Implementation rules on subsidizing the recycling of recyclables with low added value in Cixi City	2021	The subsidized are the enterprises that are determined by the Municipal Bureau of Commerce to undertake the recovery of recyclables with low added value from domestic waste in the city through comparison and selection, bidding and other ways. We subsidize the recycling of waste glass and waste fabric with low added value by key renewable resource recycling enterprises. The subsidy standard is 80% of Cixi municipal waste incineration disposal fee at 95 yuan per ton, namely, 76 yuan per ton. The maximum subsidy for recycling one type of recyclables with low added value shall not exceed 300,000 yuan per year.

Subsidy policies of different cities	Time of release	Main contents
Opinions on subsidizing the recovery of renewable resources in Fuyang District of Hangzhou City in 2021 (Trial)	2021	The recycling of low-value recyclables shall be subsidized by the standard of 300 yuan per ton.
Implementation rules of Tongling City on subsidizing the recovery of low-value recyclables (Trial)	2022	The recycling of low-value recyclables by enterprises within the municipal jurisdiction shall be subsidized according to the total recycled and transported value, and the subsidy goes for bridging the price difference in the recycling market and financing the links of garbage classification, recycling, transshipment and disposal.
Implementing rules on subsidizing the recovery of low-value recyclables in Huangpu District of Shanghai Municipality	2022	In principle, the enterprises that recycle recyclables in Huangpu District shall be subsidized by the standard set by referring to the domestic waste disposal fee. The exact subsidy shall be subject to the agreement in the contract. The subsidy mainly goes for subsidizing the market price and the input in such links as garbage classification, recovery, transshipment and disposal.
Application guide for projects of recycling low-value recyclables from domestic waste in Chongqing	2022	One to three districts and shall will be supported in recycling low-value recyclables, with each getting a subsidy of no more than one million yuan.
Trial measures of Nanchang City on subsidizing the recovery of recyclables with low added value	2023	The enterprises which undertake the recovery of recyclables with local added value determined by the counties (development zones) as well as the Wali Administrative Bureau through public bidding or other legal ways shall be subsidized by the standard set by referring to the weighted average value of the financial subsidy unit price for domestic waste incineration power plants in the city in the current year. The actual bid-winning price shall prevail (the actual bid-winning price shall not be higher than the weighted average value of the financial subsidy unit price of the domestic waste incineration power plant determined in the current year).
Implementation plan on offering incentives and subsidies for domestic waste classification in Songjiang District of Shanghai in 2023	2023	Recovery of low-value recyclables from domestic waste in this district shall be subsidized. The subsidy price shall be the actual bid price of the related enterprise, and the price shall be no higher than 221 yuan per ton. The subsidized amount hinges on the actually collected and transported amount, and it shall not exceed 50% of the collection and transportation index of the related enterprises in the local streets and towns in 2020.

III. Collection and Recycling of low-value recyclables in China

(I) The annual generation of low-value recyclables exceeds 95 million tons

It is calculated that in 2021 except for bulky garbage China generated about 95.77 million tons of low-value recyclables, of which low-value plastic packaging including plastic (other than PET) bottles, delivery packages, other packaging film, plastic packaging for various commodities, and meal boxes accounted for the largest amount, reaching 50.21 million tons① or 52.4% of the total; waste glass and waste textiles were 22.75 million tons② and 21.24 million tons③, accounting for 23.8% and 22.2% respectively; mulching film amounted to about 1.32 million tons④, accounting for 1.4%; the paper-based composite packaging of beverages amounted to 640,000 tons⑤, accounting for 0.7%; and the amount of waste fertilizer packaging and pesticide packaging was relatively small, 125,600 tons and 117,000 tons⑥ respectively, accounting for less than 0.2% of the total.

① The results come from the measurement group.
② Source: *China Renewable Resources Recycling Industry Development Report (2022).*
③ Source: *The 2020-2022 Report on Comprehensive Utilization and Development of Waste Textile in China, China Association of Circular Economy.*
④ Source: *China Rural Statistical Yearbook 2022.*
⑤ Source: Calculations based on the data from Nielsen.
⑥ Source: Extrapolated from pesticide use and fertilizer application rates, as detailed in the seventh part of this chapter.

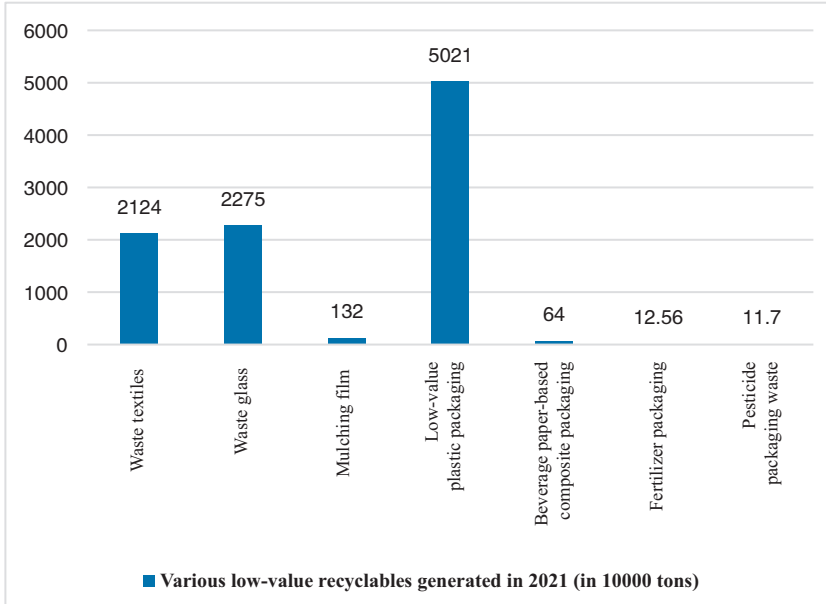

Figure 3-1 The low-value recyclables generated in China in 2021

In 2021, various low-value recyclables recycled in China totaled about 25.47 million tons, with a recycling rate of about 26.6%. Among them, the amount of recycled low-value plastic packaging was the largest, reaching 9.8 million tons; the recycled amount of waste textiles, waste glass and waste mulching film was also relatively high, respectively 4.66 million tons⑦, 10.05 million tons⑧ and 0.8 million tons⑨. In terms of recycling rate, the recycling rate of waste mulching film was the highest, reaching 60.6%, followed by a recycling rate of 58.6%⑩ for pesticide packaging waste. The recycling rates of paper-based beverage packaging, waste glass, waste textiles and low-

⑦ Source: The 2020-2022 Report on Comprehensive Utilization and Development of Waste Textile in China, China Association of Circular Economy.

⑧ Source: Glass magazine, Annually 12.7 million tons of waste glass wasted! Never let waste glass recycling become the marginal zone, August 8, 2023.

⑨ Source: China Recycled Plastics Industry Development Report, Plastic Recycling Association of China National Resources Recycling Association.

⑩ Source: Promotion Meeting on Typical Cases of Pesticide Packaging Waste Recycling Held in Beijing, Renewable Resources Information Network, September 23, 2022.

value plastic packaging were 33.1%, 27.1%, 21% and 19.5% respectively.

At present, the low-value recyclables that have not yet been recycled are mostly mixed with household waste for incineration or landfilling such that annually about 50 million tons of recyclable fail to be recycled and reused, which leads to a huge waste of resources. And the carbon dioxide emissions amount to 130 million tons, which is not conducive to the construction of waste-free cities and the achievement of the carbon neutrality and carbon peaking goals.

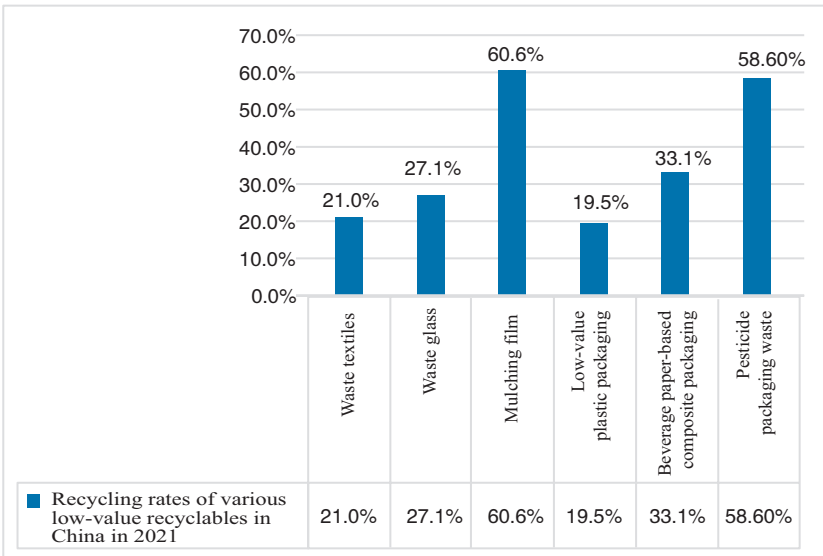

Figure 3-2 Recycling rates of various low-value recyclables in China in 2021[⑪]

(II) The collection and recycling level of waste textiles is relatively low

1. Level of recycling

There are two main sources of waste textiles: One is the leftover materials from the textile production process, and the other is the used and waste clothing and textiles from households.

According to the China Association of Circular Economy, in 2020 China generated

⑪ The recycled rate is calculated according to the use amount and the recycling amount (excluding the pesticide packaging waste).

22 million tons of waste textiles, including two million tons of waste textiles from production and 20 million tons of used and waste textiles which included about 11.5 million tons of waste garments and 8.5 million tons of waste household textiles. In 2021 China's waste textile output reached 21.24 million tons, and the recycled amount totaled 4.66 million tons, with a recycling rate of about 21%.[12]

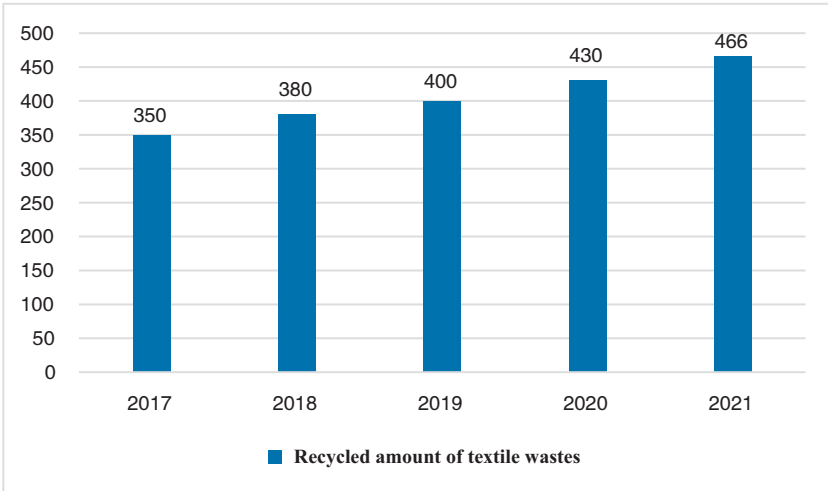

Figure 3-3 Recycling of waste textiles in China[13]

2. Recycling mode

Common textiles are usually made of fabrics such as cotton, hemp and chemical fibers. Except for cotton, hemp and other fabrics that can degrade in the natural environment, fabrics such as chemical fibers are not easy to degrade in the natural state; if they are incinerated or go to land fill as garbage, they will not only occupy resources, but also cause secondary pollution.

At present, there are two ways to recycle waste textiles: One is to renovate famous-brand garments with high value or second-hand garments that look good so

⑫ Source: The 2020-2022 Report on Comprehensive Utilization and Development of Waste Textile in China, China Association of Circular Economy.

⑬ Source: China Resources Recycling Industry Development Report 2022 from China National Resources Recycling Association; The 2020-2022 Report on Comprehensive Utilization and Development of Waste Textile in China from China Association of Circular Economy

they can go for export as second-hand clothes, charitable donations and domestic second-hand transactions; second, if they cannot be taken as second-hand clothes, they can be recycled through physical or chemical means. For example, they can be made into the interior materials of automobiles or building materials, the fillers of plush toys, raw materials of the paper industry, heat preservation quilts for vegetable greenhouses, rags, slippers, insoles, etc. According to China National Textile and Apparel Council, if all waste textiles in China are recycled, it is equivalent to saving 24 million tons of crude oil, reducing the emission of 80 million tons of carbon dioxide, and saving nearly one-third of cotton planting area every year.[⑭]

3. Outstanding problems

First, the recycling system of used and waste textiles is yet to be well-developed, and is basically in a state of spontaneous development by enterprises. The recycling channels are not unimpeded, making it difficult to ensure the effective collection and recycling of used and waste textiles. Second, given the wide variety of waste textiles and the great differences in material and quality, recycling is faced with certain technical problems; third, the industry has a low threshold for entry, and there are few competent enterprises in the industry. Some small workshops try to minimize costs by simplifying the input of facilities and equipment, avoiding labor health protection, evading taxes and fees, and even using inferior products for malignant competition.

(III) The recycling of waste glass is still at a relatively low level

1. Level of recycling

In China, waste glass mainly comes from three sources: First, it is the leftover material from the glass production process; second, it is the waste plate glass from construction waste and demolition waste; third, it is from discarded glass packaging bottles/ jars and other glass products.

In 2022, about 24.327 million tons of waste glass was generated in China, up

⑭ Source: *How to Make the Old Clothes Recycling Industry Healthier*, Economic Daily, August 23, 2023.

4.3% year on year. Among them, the waste plate glass and products amounted to 11.483 million tons, waste daily-use glass and products amounted to 10.724 million tons, and other waste glass and products amounted to 2.12 million tons. In 2022, the recycled waste glass in China totaled about 8.5 million tons, down 15.4% year on year, with the recycling rate standing at only 34.9%[15].

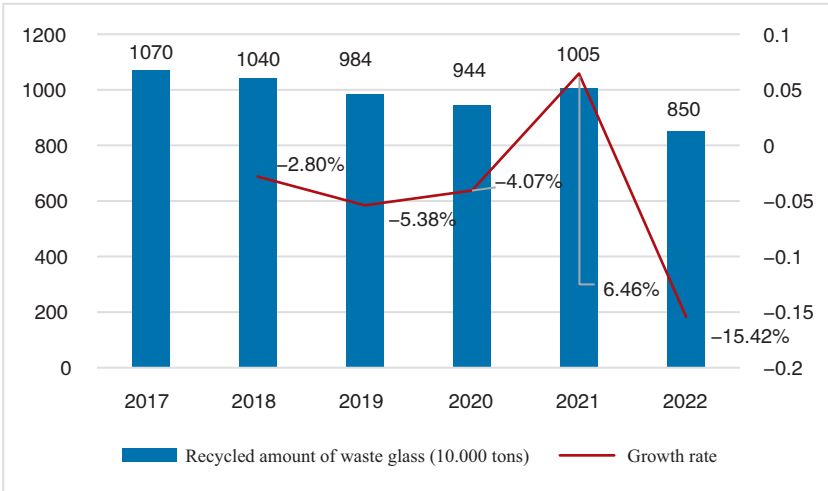

Figure 3-4 Recycled waste glass in China over recent years (10,000 tons)

2. Recycling mode

First, the main way is to produce glass products by using cullet; second, it is to reuse intact glassware like beer bottles, soda bottles, yogurt bottles, and the like; third, it is to produce building materials with recycled cullet, such as the glass beads, glass boulders, glass mosaic, colored glass balls, glass surface, glass bricks, faux marble, foam glass, etc. Other waste glass that cannot be recycled due to pollution and color disorder goes to the domestic waste treatment system.

3. Outstanding problems

There are two major problems in the recycling of waste glass. First, it is difficult and costly to recycle the waste glass such that the enterprises are unwilling to recycle

⑮ Source: China National Resources Recycling Association, *China Resources Recycling Industry Development Report 2022*.

the waste glass. To recycle the waste glass is hard and of poor economic viability such that the phenomenon the recycled glass is priced higher than the raw materials is prone to occur. Second, the recycling system is not connected and well-developed; it is hard for enterprises to collect and rrecycle waste glass. The waste classification system promoted by the environmental sanitation department generally classifies waste glass as recyclables according to the four-type classification of garbage. However, in the actual operation, the waste glass is generally mixed with other wastes or "separated first and then mixed," and finally enters the landfill or incineration terminal disposal system together with the domestic wastes.

(IV) Recycling of low-value plastic packaging is uneven

1. Level of recycling

Low-value plastic packaging covers all aspects of production and life, and it mainly comes in the form of commodity packaging or plastic shopping bags, garbage bags and delivery packages, etc.

It is calculated that in 2020 China generated 48.91 million tons of low-value plastic packaging and recycled 7.55 million tons of them, with the recycling rate standing at 15.4%. In 2021, the figures registered a slight increase. China used 50.21 million tons of low-value plastic packaging and recycled 9.8 million tons, with a recycling rate of 19.5%. In 2022, China used 50.66 million tons of low-value plastic packaging and recycled 8.25 million tons, with the recycling rate dropping to 16.3%.[⑯]

⑯ Source: *China Recycled Plastics Industry Development Report*, China National Resources Recycling Association. Data calculation goes as follows: Low-value plastic packaging includes other packaging except automobile waste plastics, waste plastics of electronic and electrical products, mulching film, uncontaminated infusion bottles/ bags, PET bottles and other waste PET. The recycling amount is derived from relevant data of China National Resources Recycling Association, and the generated amount is obtained by dividing the recycling amount by the recycling rate (the recycling rate of automobile waste plastics, waste plastics of electronic and electrical products, PET bottles and other waste PET is 90%, the recycling rate of mulching film is 80%, and the recycling rate of uncontaminated infusion bottles/ bags is 70%).

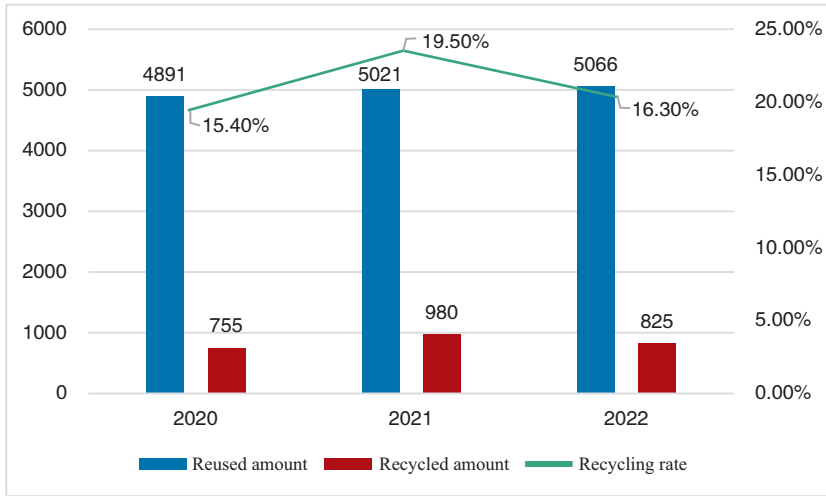

Figure 3-5 Recycling of low-value plastic packaging

2. Recycling mode

At present the low-value plastic packaging is light in weight and low in value, and most of the low-value plastic packaging is disposed together with the domestic waste and causes grave pollution so there is little economic value in recycling the low-value plastic packaging which is mostly incinerated or land-filled together with domestic waste. Still some places and enterprises carry out the recycling of low-value plastic packaging: First, chemical methods are adopted to crack part of low-value waste plastics for oil production or reuse as plastic raw materials; second, physical recycling is carried out in such cities as Xiamen and Hangzhou, and there are special enterprises engaged in centralized separation of low-value recyclables including low-value plastic packaging from other wastes, with the recycled plastics used by downstream waste plastic recycling enterprises; third, some traditional renewable resource recycling enterprises make use of the existing channels to recycle plastic meal boxes, makeup bottles, laundry bottles, plastic milk bottles and so on (commonly known as spent materials).

3. Outstanding problems

The recycling of low-value plastic packaging is faced with the triple dilemma of

contradiction among design, recycling chain and different processing paths. First, the recyclability is not fully considered in the design and production process of plastic packaging. Most plastic packages are made with composite materials, which are technically difficult to recycle, and can only be incinerated or land-filled after one-off use. Second, the recycling link is yet to be well developed, which makes it difficult to efficiently carry out centralized collection in a large amount. In the existing garbage classification system, the low-value plastic packaging is basically classified as other garbage, and few cities recycle the plastic garbage separately so that the recycling value of the low-value plastic packaging is neglected to a great extent. Third, the collection and recycling of the chemical cycle of the low-value plastic packaging are difficult to coordinate; it is difficult to carry out effective separation and large-scale collection of the low-value plastic packaging in the current domestic waste disposal system while the chemical cycle just requires a relatively centralized and stable supply of raw materials.

(V) Certain progress has been made in the recycling of beverage paper-based composite packaging

1. Level of recycling

Beverage paper-based composite packaging is often used for boxed milk, yogurt and other beverages. In 2020, the National Development and Reform Commission, the Ministry of Housing and Urban-Rural Development, the Ministry of Commerce, and the State Administration for Market Regulation issued the Implementation Plan for the Extended Producer Responsibility System for Beverage Paper-based Composite Packaging. We shall implement the extended producer responsibility system for beverage paper-based composite packaging, and encourage beverage paper-based composite packaging production (import) enterprises to form a consortium to conduct standardized recycling. According to relevant statistics, in 2021 the total input capacity of China's composite packaging market amounted to 640,000 tons including the 480,000-ton input capacity of enterprises which joined in the recovery consortium and the treatment capacity of 161,000 tons of the recycling enterprises in the recovery consortium; given that it contained approximately 6,000 tons of factory waste, the

actual recycling rate reached 33.3%.[17]

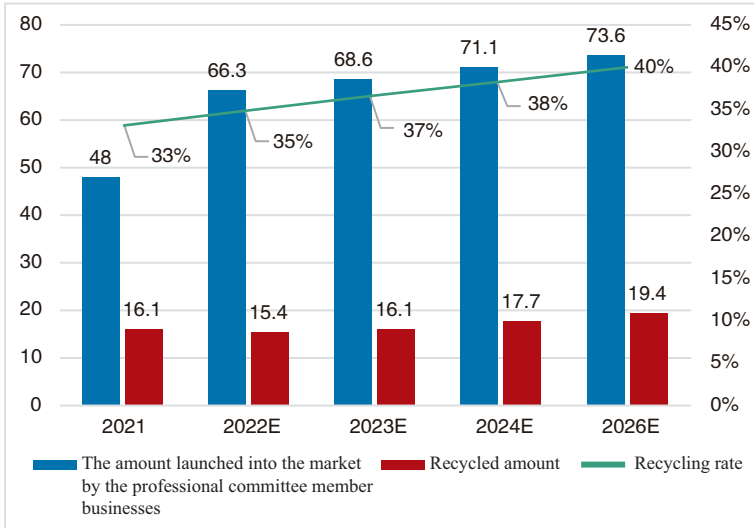

Figure 3-6 Recycling of beverage paper-based composite packaging in China

2. Recycling mode

At present, the beverage paper-based composite packaging recycling mode, mainly by the recycling enterprises on the composite material after separation of recycling. In that invention, the waste plastic was mainly used for producing recycled plastic granules or continuously used to produce wood-plastic composite materials and other new materials, or widely used in the production of floors, seats, garbage cans, industrial trays, fences and other products; waste aluminum is mainly used for renewable aluminum processing; waste paper is mainly used for the production and processing of paper products such as cardboard boxes.

3. Outstanding problems

The prominent problems existing in the recycling of beverage paper-based composite packaging mainly include the following two points: First, the economic

[17] Source: Statistics of relevant industry associations and enterprises; calculation of recovery rate: 16.1 / (48 + 0.6).

efficiency of the front-end recycling is insufficient; on the one hand, the recycling sources of beverage paper-based composite packaging are scattered, and the recycling is difficult. On the other hand, the process of composite material separation has high input cost and energy consumption, high technical requirements, difficulty in covering the cost, and poor economy; second, the demand for back-end regeneration application is not strong. Beverage paper-based composite packaging producers of recycled plastic products and recycled pulp and similar recycled products have no competitive advantage.

(VI) Mulching film is mostly collected but hard to use

1. Level of recycling

Because the used mulching film is prone to break, the collection of the residual film is time-consuming and laborious; it is difficult to put it into comprehensive recycling. In May 2018, China issued a new national standard on mulching film, requiring that the thickness of mulching film should not be less than 0.01 mm. Under the impetus of the new national standard, some regions have conducted purchases in cash, replacement of the old with the new, and bartering in order to improve the recycling of mulching film; they have established the mode of “village, town recycling and transshipment - district and county centralized sorting and storage - regional processing and utilization”, and built the recycling system of waste mulching film integrating selling, recycling and utilization. According to China Agricultural and Rural Statistical Yearbook, in 2021 China used 1.32 million tons of waste mulching film and recycled 800,000 tons with the recycling rate reaching 61%.

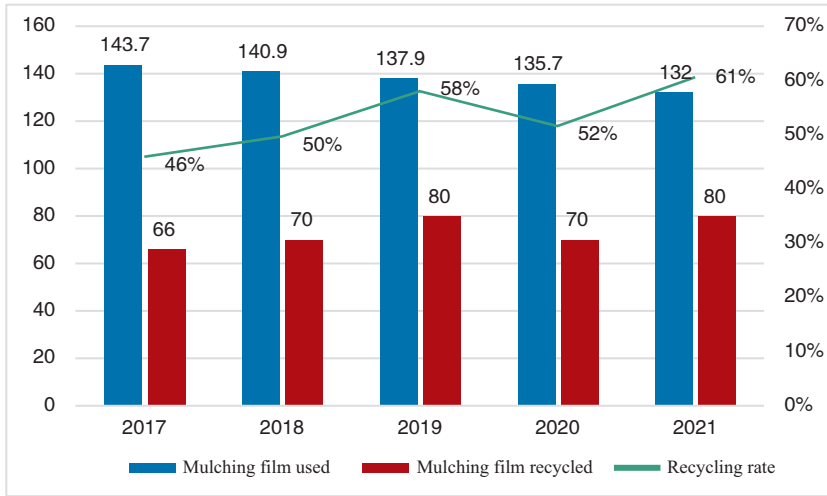

Figure 3-7 Recycling and utilization of mulching film in China (2017-2021)[18]

2. Recycling mode

There are mainly two modes in comprehensive utilization of waste mulching: One is to produce plastic granules from the recycled mulching film, In addition and recycled granules are processed to make low-end plastic products such as PE pipes, plastic containers (like the septic tank), drip irrigation belts and the like; second, the recycled waste mulching film is directly crushed and mixed with a certain proportion of slag to produce recycled products such as the well ring, well cover, grating for urban greening, etc.

3. Outstanding problems

First, although the state has issued a national standard on the production of mulching film, mulching film manufacturers are numerous and their products are intermingled in quality; ultrathin and other substandard film still widely exists, which exacerbates the difficulty of recycling. Second, because a lot of crop stalks and soil are often mixed in the collection process of the mulching film, the separation and cleaning of the film is laborious and costly, and thus basically has no economic viability. It is not

⑱ Source: *China Rural Statistical Yearbook 2022* and *China Recycled Plastics Industry Development Report.*

surprising that the enterprises have little enthusiasm for recycling it such that in some western regions, a large amount of collected mulching film is piled on field plots or wasteland, or directly goes to domestic waste incineration plants for incineration.

(VII) Poor recycling of pesticide and fertilizer packaging

1. Level of recycling

According to the 2022 China Rural Statistical Yearbook, the pesticide used nationwide in 2021 amounted to 1,239,200 tons, down 5.64% from 1.3133 million tons in 2020. The pesticide used nationwide in 2022 was estimated to amount to 1.1693 million tons. The amount of waste pesticide packaging can be calculated by referring to the total amount of pesticide used (preparation amount): (1) Bottled preparation amount: Bagged preparation amount = 62%: 38%; (2) Weight of bottled packaging = bottled preparation amount × (10% -20%); (3) Weight of bagged packaging = bagged preparation amount× (3% -5%); the median value shall be taken for calculation. In 2021, the total amount of pesticide packaging wastes generated in China reached about 134,000 tons, and about 126,500 tons in 2022.

According to the 2022 China Rural Statistical Yearbook, the amount of agricultural chemical fertilizer applied nationwide in 2021 was 51.913 million tons, down 1.13% from 52.507 million tons in 2020. It is estimated that the amount of agricultural chemical fertilizer applied nationwide in 2022 stood at about 51.3264 million tons. Supposing that more than 95% of the fertilizer packaging is the 50kg bags, the fertilizer packaging waste in 2022 is expected to exceed 975.2 million bags. As each bag weighs 115-125 grams, the annual fertilizer package waste amounts to 117,000 tons if the packaging bags are considered to weigh 120 grams on average.

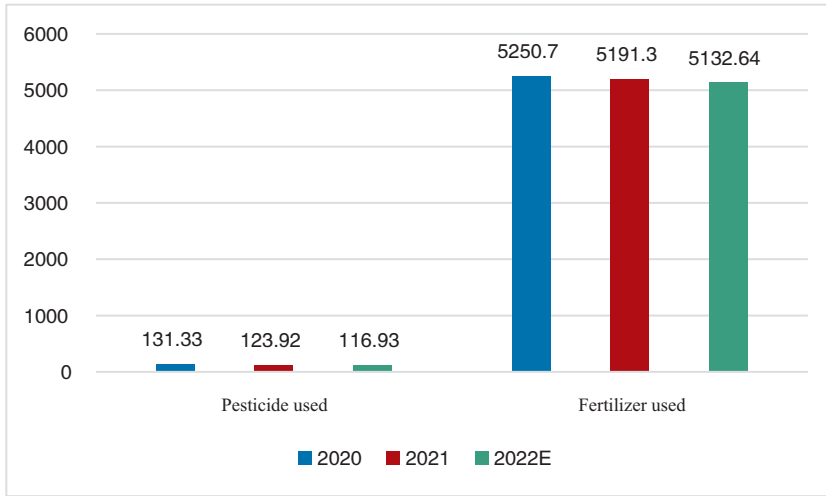

Figure 3-8 Use of pesticide and fertilizer packaging in China (2020-2022)

2. Recycling mode

Prior to 2021, pesticide packaging waste was treated as hazardous waste. The National Catalogue of Hazardous Wastes (2021 Edition) officially came into force on January 1, 2021, clearly stating that the pesticide packaging wastes (waste code 900-003-04) shall not be treated as hazardous wastes in the collection, transportation, recycling and disposal. The implementation of exemption management has greatly reduced the difficulty and cost of recycling, and it is conducive to improving the level of recycling, utilization and harmless disposal of pesticide packaging wastes. However, because pesticide packaging contains certain pesticide residue, if it is recycled together with other plastics, there are potential safety hazard. At present, the pesticide packaging in China is mainly treated by incineration or landfilling. A small amount of fertilizer packaging will be cleaned and used by farmers to hold things or recycle.

3. Outstanding problems

First, the innocuous disposal capacity is relatively insufficient, the disposal price is relatively high, and it is difficult to promptly and effectively dispose of the pesticide packaging wastes, which affects the enthusiasm for front-end recycling. Second, the recycling outlets at the grassroots level are under great pressure, and the collection

and temporary storage warehouses in some regions are in poor conditions and prone to potential safety hazards. Third, the long-term recycling mechanism is inadequate, the refundable deposit system for fertilizer and pesticide packaging has not been generally established, and the enthusiasm of farmers to participate in the endeavor is not high.

IV. Investigation into and analysis of common problems and influencing factors

(I) Major common problems

Recycling of high-value recyclables brings considerable economic benefits as they have high collection and recycling value. At present, a relatively mature industrial system for collection and recycling has taken form. In contrast, the recycling of low-value recyclables has no obvious economic viability on one hand, and causes no obvious environmental harm on the other; they are in the "marginal zone" of policy concern; and their recycling has not gotten much attention. Although the low-value recyclables have been gradually included in the scope of valuable renewable resources and the government and enterprises have taken some actions, the effect is not obvious. The main reasons are as follows:

1. Policy end: There is yet to be a sound unified low-value recyclables recycling policy system

First of all, low-value recyclables come in varieties, but there is a lack of a unified national classification standard and catalog. Some local governments have also formulated classification standards; however, they vary greatly from place to place, causing great confusion to the residents. The public can hardly understand the classification standards, let alone follow them. Second, in terms of fiscal policy support, most regions across the country have yet to roll out a special fiscal policy to support the recycling and treatment of low-value recyclables. Since the economic attributes of low-value recyclables such as waste plastic bags and waste glass far under-weigh their attributes related to environmental benefit and the recycling and processing costs are higher than their value, it is difficult to drive their recycling by relying on the market force only. As a result, the market for low-value recyclables is not hot all the time and

lacks the participation of formal enterprises. Finally, with regard to the guarantee of land use and other factors, although there are principled provisions in relevant state documents, no explicit land use and planning support policies for renewable resources recycling stations (sites) have been issued. There are some obstacles to the construction of recycling facilities for renewable resources, and the space for the recycling of low-value recyclables is even more limited.

2. Recycling end: The waste classification and recycling system is inadequate, and the effect of classification and placement of low-value recyclables at the source is poor

Low-value recyclables are not generally included in the garbage classification and recycling system although there are specialized enterprises that carry out recycling operations, such as the Internet-based classification and recycling platform, and glass recycling enterprises specializing in the recycling of waste glass and waste textiles which are still at the stage of individual enterprise exploration and cannot meet the overall demand for the recycling of low-value recyclables in cities. In addition, at the present stage, the garbage classification consciousness of the residents of our country still needs to be enhanced since "spectator mentality" still prevails. In the absence of mandatory requirements and supervision, the domestic waste is treated in a way people find convenient such that the kitchen waste, low-value recyclable and non-recyclable waste are mixed. According to the survey, 56.26% of the household garbage of residents in Beijing is low-value recyclables, but at present it is basically mixed with other garbage and sent to the incineration plant for disposal; likewise, a random survey in the Pearl River Delta region shows that the overall classification effect of domestic waste is just so so; only two high-rise residential quarters with elevators under closed management in the six investigation samples show good effect in garbage classification while the rest are just so so or simply in the state of no waste classification.[⑲]

3. Disposal end: The centralized sorting facilities in the city are limited, and the centralized sorting capacity is insufficient

The unit recycling and disposal cost can be effectively reduced by carrying out

⑲ Analysis of and Reflection on Current Domestic Waste Classification in the Pearl River Delta.

multi-variety recovery and centralized separation of low-value recyclables. Speaking from the existing urban infrastructure, centralized sorting holds great importance to the sorting and recycling of a wide variety of low-value recyclables, especially in the current situation where the residents have low enthusiasm for accurately placing garbage at the source according to the classification standard. However, at present, no centralized low-value recyclables sorting facilities have been put in place in various cities, and the low-value recyclables recycling and separation chain has not been opened yet. That is, the residents do no garbage classification, the renewable resources recycling system does no recycling, and the sanitation and domestic garbage treatment system does no sorting. Renewable resource recycling systems that are part of commercial systems only recycle high-value traditional varieties, but hardly recycle the low-value recyclables that come in so many varieties, possess low economic value and pose difficulties to sorting. The sanitation system under urban management is only responsible for the collection, cleaning and transportation of domestic wastes. There is no system designed for classified collection, classified transportation and centralized separation of low-value recyclables. Sometimes the phenomenon of "first separating and then mixing" occurs; the originally separated low-value recyclables enter the landfill or incineration terminal disposal system, which leads to a grave waste of resources.

4. Utilization end: People's enthusiasm for utilization is insufficient, the utilization technology is poor, and the utilization is small in scale and scattered

The low-value recyclables account for 30% of all wastes in weight but only 10% in value[20], which leads to the low enthusiasm of enterprises for collection and delivery of such wastes. According to statistics, the low-value recyclables generated in China in 2021 amounted to about 95.77 million tons, with the overall recycling rate standing at only about 26.6%. Moreover, low-value recyclables must be recycled on a large scale, but at present only a few enterprises have a large production capacity while most of the related enterprises are small in scale and scattered in distribution, with no

⑳ Analysis of Development Difficulties of China's Renewable Resources Industry in 2018: Severe Development Dilemma of Small and Medium-sized Enterprises [Figures] _ Economists Qianzhan.com.

large-scale clustering effect. For example, there are several thousand waste plastics processing and utilization enterprises in China, but only five batches of enterprises totaling 78 meet the Proper Conditions for Comprehensive Utilization of Waste Plastics Industry. Most of the enterprises have backward technological equipment and hardly meet the scale requirements. For example, the transportation cost accounts for a high proportion in the recycling cost of waste glass, and the long distance has become a key factor restricting the recycling rate. At present, the recycling of waste glass is generally carried out around glass product enterprises, and it is obviously different from region to region, which leads to the small-scale and scattered distribution of most enterprises. For example, Huaxing, a leading enterprise in the industry, and other enterprises generally have a single waste glass treatment plant with an annual production capacity ranging from 0.3 to 1.2 million tons, and they are generally small in scale.

(II) Investigation and analysis of major influencing factors

In the research process of this report, a special survey was conducted on the recycling of low-value recyclables among residents and enterprises. The urban residents, rural residents and the recycling enterprises of waste plastics, waste textiles, waste glass, waste paper-based composite packaging, waste mulching film and waste pesticide and fertilizer packaging were respectively distributed with questionnaires. There were 491 groups of resident-end sample data, including 220 about urban residents and 271 about rural residents; and 66 groups of enterprise-end sample data, including 8 groups about waste textile recycling enterprises and 3 groups about waste plastics recycling enterprises, and covering 44 enterprises for waste glass recycling, 5 enterprises for recycling waste paper-based composite packaging, 5 enterprises for recycling waste mulching film, and 1 enterprise for recycling waste pesticide and fertilizer packaging.

1. Investigation into recycling and utilization of low-value recyclables by residents

(1) Most residents have little understanding about low-value recyclables

Urban and rural residents generally pay little attention to the issue of waste recycling, with only about 25% of residents showing some concern for it. The people

generally have a poor understanding of the concept of low-value recyclables. More than 80% of the population indicated “no knowledge at all” or “little knowledge” while less than 20% of the population knew something about the concept of low-value recyclables.

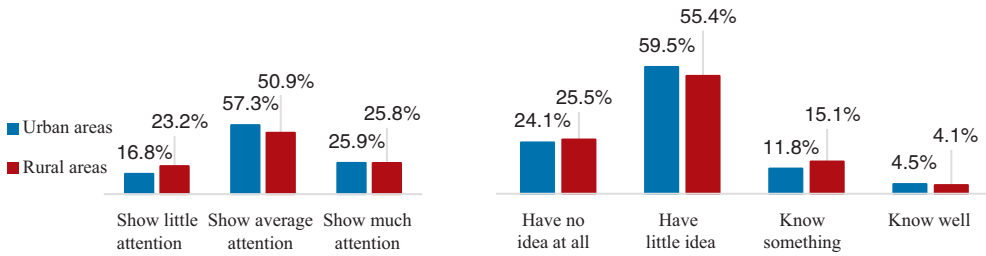

Figure 4-1 Residents’ attention to the issue and familiarity with the concept

Most residents do not know which wastes are low-value recyclables, and generally believe that plastic bottles / barrels / bags, pop cans, express delivery boxes, glass bottles and the like that are common in daily life are low-value recyclables while the mulching film, pesticide bottles and other agricultural wastes are not. More than 70% of the residents mistakenly believe that plastic bottles / barrels, pop cans and express delivery boxes are low-value recyclables, about 50% of the residents believe that large pieces of garbage are not low-value recyclables, and less than 30% of the residents believe that the mulching film, pesticide bottles and other agricultural wastes are low-value recyclables.

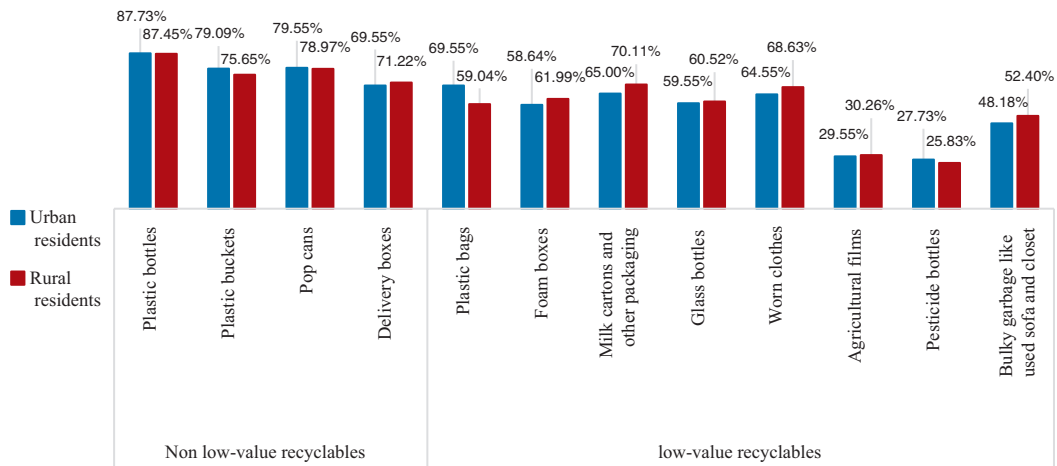

Figure 4-2 Residents’ perception of low-value recyclables

(2) The standard treatment rate of low-value recyclables is relatively low

There are four ways to deal with low-value recyclables in urban and rural areas: to go for secondary use or second-hand trade, to be directly discarded with other wastes, to be placed in special garbage bins, and to be sold to private waste collectors[21]. In general, the standard treatment rate of different low-value recyclables is different. The paper-based composite packaging that has fuzzy classification and is difficult to treat, the bulky garbage, the mulching film and the pesticide and fertilizer packaging which are used in large quantities in rural areas only register a relatively low standard treatment rate among all the low-value recyclables. As rural residents are more likely than urban residents to fully utilize the materials, the direct discarding rate of low-value recyclables among the former is also lower.

Plastic packaging, foam boxes and waste textiles: Urban and rural residents similarly handle plastic packaging ; about 80% of the residents reuse plastic packaging, like the plastic bags for shopping in supermarkets or as garbage bags. About 50% of the residents put the plastic packaging into a special garbage bin while nearly 30% of the residents directly discard the plastic packaging together with other garbage. The treatment of foam boxes is slightly different from that of waste textiles, the direct discarding rate is 5% -8% lower than that of plastic packaging, and the standard disposal rate is higher. For example, the foam boxes are reused to hold articles or as flower beds, etc.; waste textiles are sold to private waste collectors (stations) and so on. Likewise, there are significant differences between urban and rural residents in the treatment of foam boxes and used textiles. The overall standard treatment rate by rural residents is higher than that by urban residents: 31% of rural residents directly discard foam boxes while the figure among urban residents is 42%. Rural residents sell foam boxes to private waste collectors (stations), and put them for reuse or into a special garbage bin at a ratio 6% - 8% higher than the level for urban residents. In addition, the proportion of rural residents directly discarding waste textiles is 30% while that

[21] In the questionnaire are mostly multi-choice questions about waste treatment modes. The sum of the percentages under different modes is greater than 100%.

of urban residents is 37%. The situation of disposing of waste textiles by selling them to private waste collectors (stations) is similar. The proportion of rural residents who choose to sell waste textiles on the second-hand market is 44% while that of urban residents is slightly lower, at 35%.

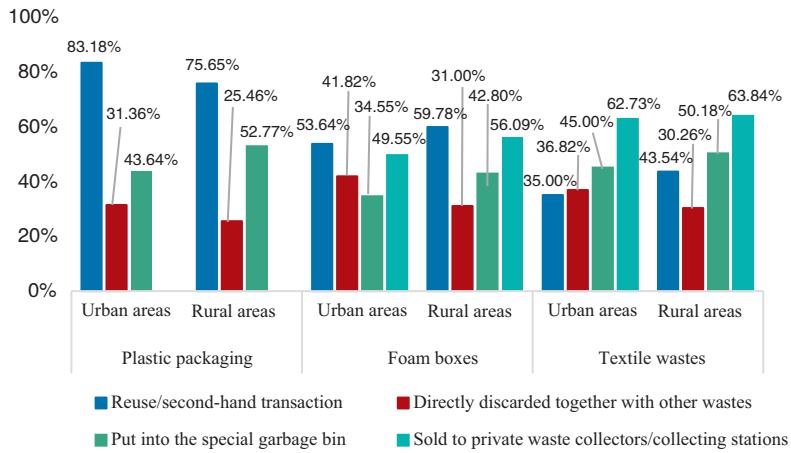

Figure 4-3 Disposal of plastic packaging, foam boxes and waste textiles

Waste plastic toys, glass products and paper-based composite packaging: On the whole, about 60% -70% of the residents choose to sell these wastes to private waste collectors (stations), about 40% of the residents directly discard them, and about 50% of the residents put them in special garbage bins. In terms of the difference between urban and rural areas, the direct discarding rate among rural residents is lower than that among urban residents; the direct discarding rate of plastic toys and glass products stands at about 30%, and the direct discarding rate of paper-based composite packaging is slightly higher, at 36%, 9% -13% lower than that the level among urban residents; rural residents are more likely to sell wastes to private waste collectors (stations) than urban residents since 67% -73% of rural residents and 54% -64% of urban residents do so.

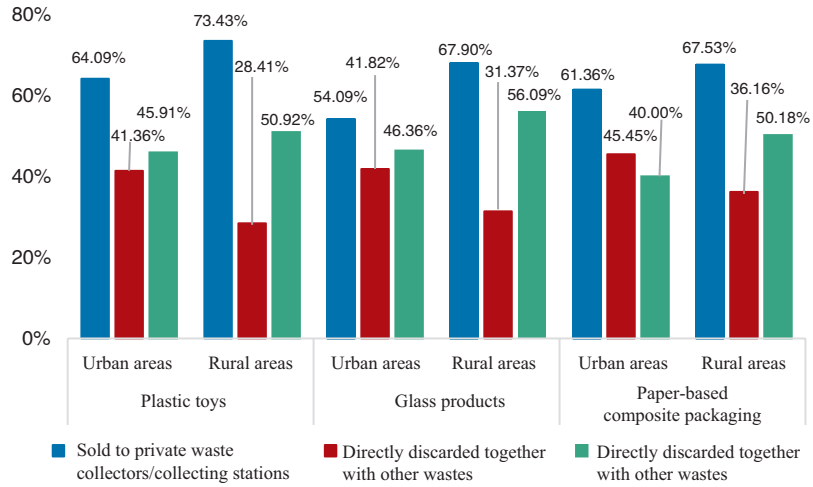

Figure 4-4 Treatment of plastic toys, glass products and paper-based composite packaging

Bulky garbage: Urban and rural residents treat bulky garbage almost in the same way. About 50% of the residents sell the large-sized garbage in the second-hand market, about 62% -72% of the residents sell it as waste, about 30% of the residents directly put it next to the garbage bin, and about 35% of the residents indicate they do not know how to dispose of the garbage or they might pile large garbage in the passageways and other places.

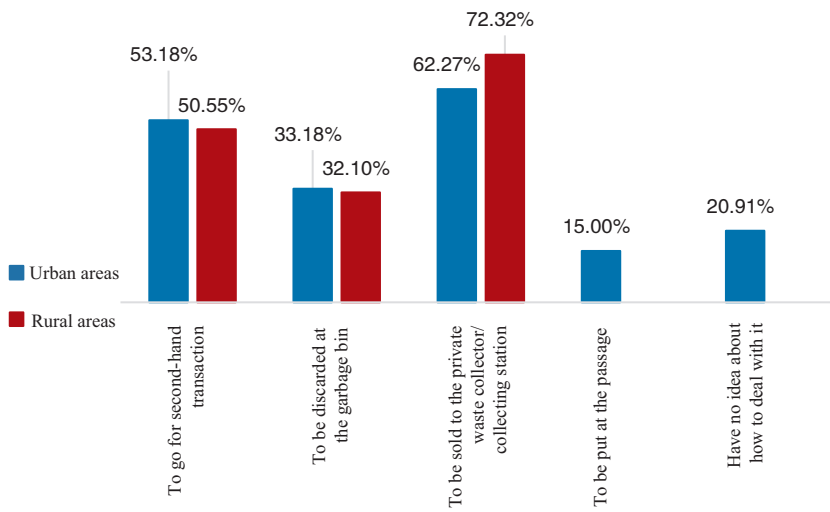

Figure 4-5 Disposal of large garbage

Mulching film and pesticide and fertilizer packaging: The investigation into the treatment of agricultural wastes such as the mulching film and pesticide and fertilizer packaging conducted among rural residents only shows that the standard treatment rate is low on the whole, and the problem of direct discarding (80% -89% of the time) is prominent, as seen in direct discarding together with other wastes, direct discarding on farmland without treatment, and direct stacking on the field. The recycling rates of mulching film and pesticide and fertilizer packaging are 35% and 33% respectively, which may be related to the current actions of some environmental protection companies; 49% -57% of the residents will put them into the garbage bin, which shows that the farmers have certain awareness of standard treatment.

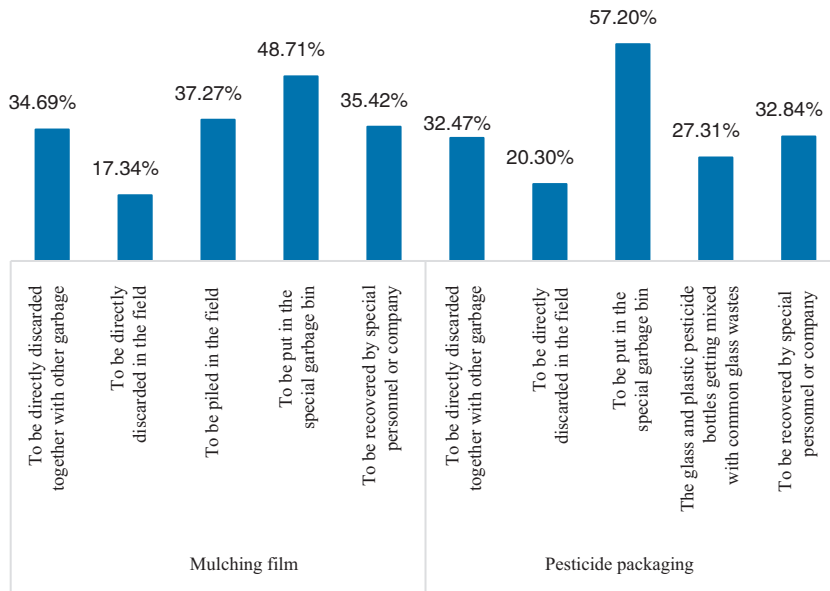

Figure 4-6 Treatment of mulching film and pesticide/fertilizer packaging

(3) Residents have a positive attitude towards the recycling of low-value recyclables

Of the residents surveyed, about 94% believed that it was necessary to support the recycling of low-value recyclables by themselves, and about 86% said that they were willing to participate in the recycling of low-value recyclables. In addition, about 83% of the residents said they would voluntarily deliver the things to the corresponding

recycling bucket or to the community recycling spot, and about 17% of the residents found it was too troublesome to recycle the low-value recyclables. On the whole, the residents hold a relatively positive attitude to the endeavor.

At present, the waste recycling channels among the residents mainly include recycling through community organizations, self-delivery into recycling boxes, non-governmental recycling, second-hand trade and public donation. Recycling through community organizations and self-delivery of recycling boxes are most common. The preference of urban and rural residents is different. Urban residents are more inclined to self-delivery into recycling boxes, and then recycle through community organizations while rural residents are more inclined to recycle through community organizations, which is followed by selling things to recovery personnel on the move, and then self-delivery to the recycling box.

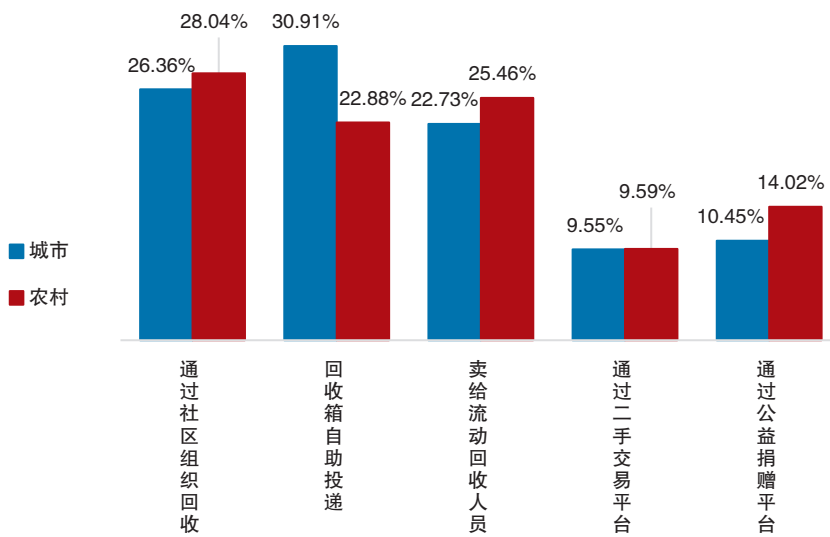

Figure 4-7 Ways of recycling most preferred by residents

(4) Policy and recycling infrastructure penetration is poor

At present, the promulgation and penetration of policies related to low-value recyclables in China are poor. Only about 8% of residents know about the specific contents of relevant policies, and about 36% of residents have only heard about relevant policies. However, about 38% of the residents did not know whether relevant policies existed; and about 19% of the residents clearly indicated that relevant policies did not

exist in their places.

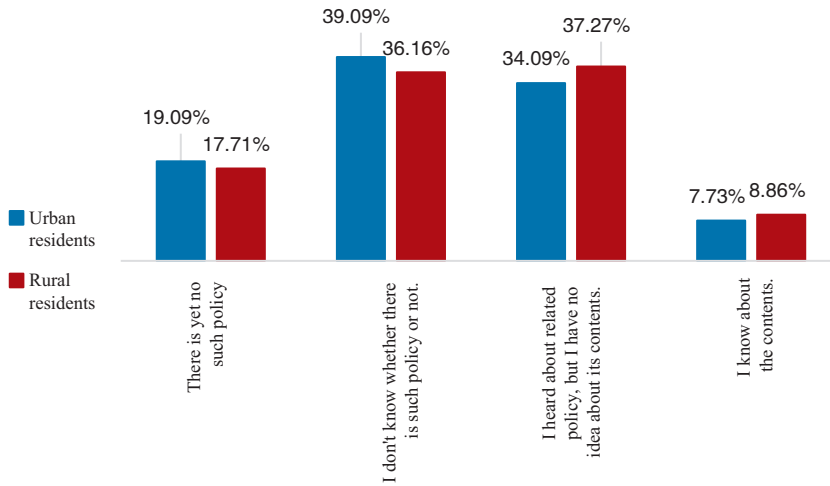

Figure 4-8 Residents' understanding about the policy

Judging from the current waste classification, the waste classification policy is better implemented in cities than in rural areas. About one-third of rural areas still do not implement waste classification while the proportion is less than one-fourth in cities. In most of the urban areas where waste classification is conducted, wet waste, the waste is classified into three categories of wet, recyclable and hazardous waste; and in some areas there is the fourth category of low-value recyclables which are collected separately. In addition, about 43% of the areas have waste separation supervisors, and there is no significant difference between urban and rural areas in this regard, as shown by the samples.

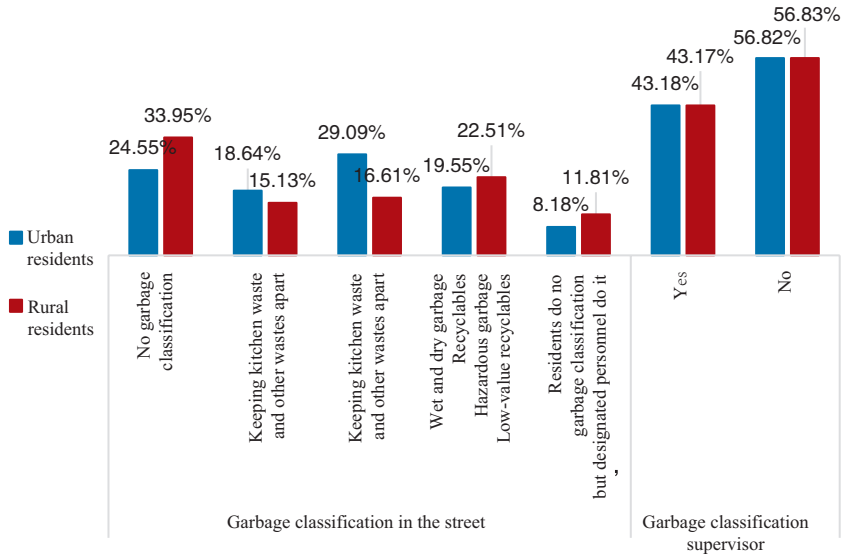

Figure 4-9 Implementation of waste classification

(5) Influencing factors and potential incentive measures

The responses of urban and rural residents regarding the impact of and incentives for recycling behaviors were relatively consistent as they all indicated that convenience (i.e. distance from the collection / recycling point) was the first factor to be considered; the practical difficulty (the difficulty of distinguishing low-value recyclables) came next, and the recycling price (the return on recycling) was the factor least considered.

In terms of incentives, "popularizing the knowledge on recycling of low-value recyclables" is the most important and urgent measure in the residents' view, followed by obtaining certain recycling rewards (not necessarily economic incentives; daily necessities are very encouraging), understanding about the process and significance of recycling (the final disposal of waste), the call and encouragement of government departments, the creation of convenient recycling methods and channels, and the release of relevant regulations and laws of which the restrictions and requirements also provide the impetus for residents to participate in the recycling of low-value recyclables.

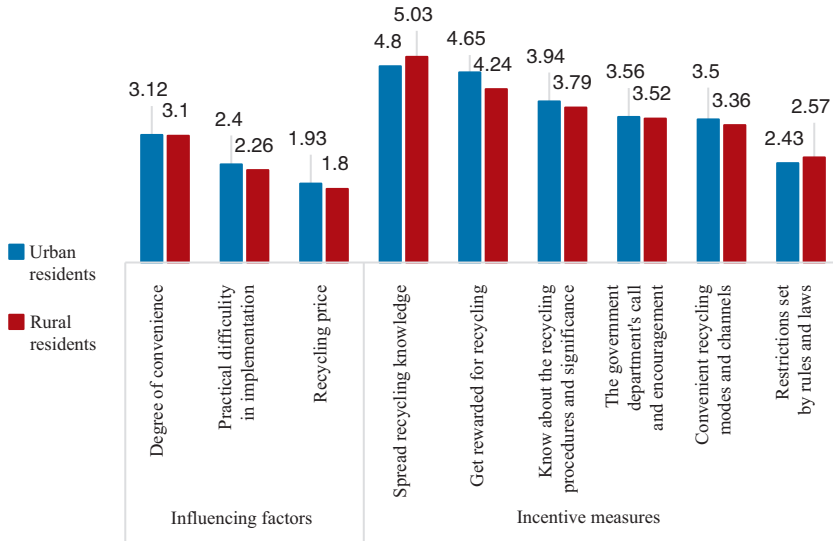

Figure 4-10 Ranking of influencing factors and incentive measures by the score

Note: The influencing factors and incentive measures are ranked by the score; the factor ranked first registers the highest score.

The following conclusions can be drawn from the above analysis:

Conclusion 1: The recycling level of low-value recyclables in urban and rural areas is approximately the same. They are at the initial stage of concept popularization and pilot exploration, with a low recycling rate, and the residents are not clear about relevant concepts and local policies. The problems such as imperfect infrastructure, absence and inadequate penetration of relevant policies are obvious and common.

Conclusion 2: For rural residents, the promotion effect of waste classification on the collection and recycling of low-value recyclables is not obvious, and there are recycling ways suitable for their own development level and regional characteristics, like the second-hand transactions and sales to private waste collectors. The overall utilization rate of waste is higher than that of urban residents. For urban residents, waste classification has an obvious role in promoting the collection and recycling of

low-value recyclables. However, as the current waste classification policy is not fully implemented, the overall utilization rate of waste is low.

Conclusion 3: Improving the convenience of recycling and reducing the difficulty of related practices should be the starting point of the government endeavor in the future. It is advisable to set appropriate recycling networks and develop appropriate incentive measures according to the different characteristics of urban and rural areas; for example, incentives should be provided through the self-delivery points set in cities and through grass-roots organizations in rural areas.

2. Investigation into recycling and utilization of low-value recyclables by enterprises

(1) Recycling enterprises are generally small in scale

On the whole, all enterprises engaged in the recycling of low-value recyclables have long-related working experience, but the enterprises engaged in the recycling of different types of low-value recyclables are quite different in scale. While the enterprises engaged in the recycling of textile, glass and mulching film wastes are relatively large, the enterprises engaged in the recycling of paper-based composite packaging, plastics and pesticide and fertilizer packaging wastes are relatively small, with the latter being almost half as large as the former. The enterprises engaged in the recycling of glass and mulching film are large while the enterprises engaged in the recycling of textiles, plastics, paper-based composite packaging and pesticide and fertilizer packaging are small, with the latter being almost half as large as the former.

According to the survey results, 91% of the low-value recyclables enterprises surveyed have been established for more than five years, only three waste glass recycling enterprises have been established for some time ranging from three to five years, and two waste glass recycling enterprises and one waste plastics recycling enterprise have been established for some time ranging from one to three years.

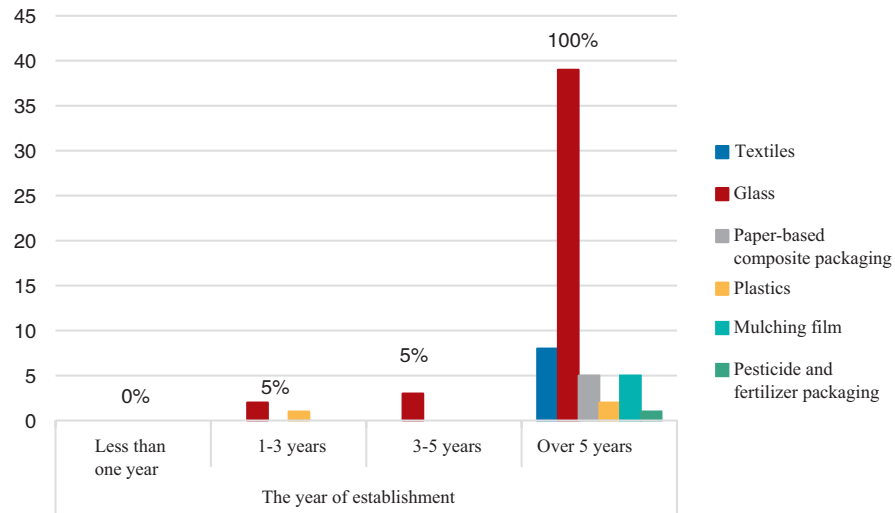

Figure 4-11 Time of establishment of recycling enterprises

The recycling scale of waste textiles, waste glass and waste mulching film enterprises is generally large, and the monthly recycling amount of most enterprises exceeds 40 tons, with the monthly recycling amount standing at about 35-40.5 tons on average. The number of enterprises for recycling waste paper-based composite packaging and low-value waste plastics is small, but the recycling scale is medium, with the monthly recycling amount exceeding 20 tons and reaching 25 tons on average. The recycling scale of pesticide and fertilizer packaging recycling enterprises is small, with a monthly recycling amount of about 20 tons.

Table 4-1 Recycling scale by enterprises

Monthly recovery volume / ton	Textiles	Glass	Mulching film	Monthly recycling volume / ton	Paper-based composite packaging	Plastics	Monthly recycling volume / ton	Pesticide and fertilizer packaging
＜ 10	1	4	1	＜ 5	0	0	＜ 2	0
10-20	0	1	0	5-10	0	0	2-5	0
20-30	0	0	0	10-15	0	0	5-10	0
30-40	0	1	1	15-20	0	0	10-15	0
＞ 40	7	38	3	＞ 20	5	3	＞ 15	1
Average	40	40.5	35	Average	25	25	Average	20

Waste glass enterprises have the largest recycling scale, and most of such enterprises' monthly recycled glass output exceeds 40 tons; they are followed by mulching film enterprises, most of which have a monthly output of more than 30 tons. The textile recycling scale is about 20 tons / month, and the enterprises in the industry almost have the same scale. The monthly output of recycled textiles of seven enterprises is above 20 tons, and that of one enterprise is less than five tons. The recycling situation of low-value plastic packaging and paper-based composite packaging is similar to that of textiles, and the recycling scale of pesticide and fertilizer packaging is the smallest among the six types of low-value recyclables.

Table 4-2 Enterprise recycling scale

Monthly recycling capacity / ton	Glass	Mulching film	Monthly recycling capacity / ton	Textiles	Monthly recycling capacity / ton	Pesticide and fertilizer packaging	Paper-based composite packaging	Plastics
＜ 10	3	1	＜ 5	1	＜ 2	1	1	0
10-20	2	0	5-10	0	2-5	0	0	0
20-30	0	0	10-15	0	5-10	0	0	0
30-40	1	1	15-20	0	10-15	0	0	0
＞ 40	38	3	＞ 20	7	＞ 15	0	4	3
Average	40.7	35	Average	22.5	Average	1	16.2	20

At present, the four types of low-value recyclables including waste textiles, waste glass, waste plastics and waste paper-based composite packaging are recycled through self-built recycling channels, urban environmental sanitation systems, cooperation with recycling outlets, and purchase from recycling workers and other means (from recycling companies or directly from the waste-generating company), etc. Different types of low-value recyclables are recycled in different ways:

Waste textiles: "Purchase from recycling staff" is the most important recycling method, accounting for about 1/3; recycling through self-built recycling channels comes second, accounting for about 1/4; the recycling conducted through cooperation with recycling outlets accounts for about 17%.

Waste glass: “Purchase from recycling staff” is also the most important recycling method, accounting for about 47%; recycling through cooperation with recycling outlets accounts for about 1/4; recycling through self-built recycling channels accounts for about 20%. Another 4% of the enterprises use urban sanitation systems for recycling.

Waste paper-based composite packaging: It is mainly recycled through self-built recycling channels and recycling through the urban sanitation system, each accounting for 31%, which are followed by recycling through cooperation with recycling outlets and acquisition from recycling staff, accounting for 23% and 15% respectively. Waste plastics are mainly recycled through cooperation with recycling outlets and acquisition from recycling staff, but most of the plastics recycled through the above methods are medium- and high-value plastics (there may be misunderstanding).

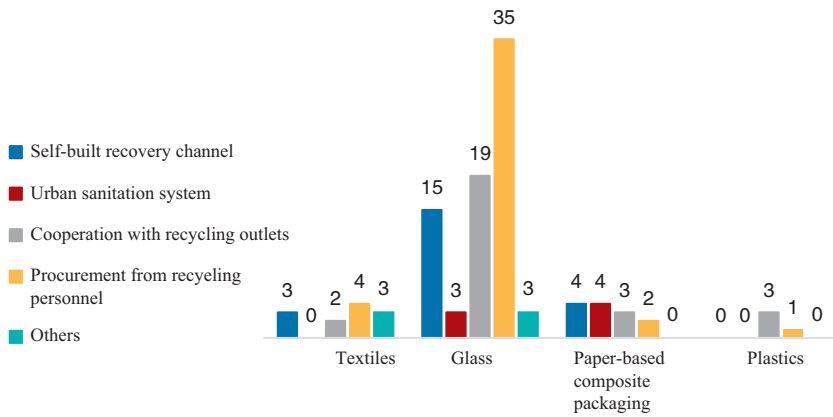

Figure 4-12 Recycling methods of waste textiles

Plastic film, pesticide and fertilizer packaging: It is recycled mainly through self-built recycling channels, recycling and purchase from farmers, and cooperation with other recycling individuals or enterprises. At present, recycling and purchase from farmers is the most important recycling method of waste mulching film, accounting for 36% of the total, which is followed by recycling through self-built recycling channels and cooperation with other recycling individuals or enterprises, accounting for 31%; another enterprise cooperated with the local county government to build recycling channels for recycling.

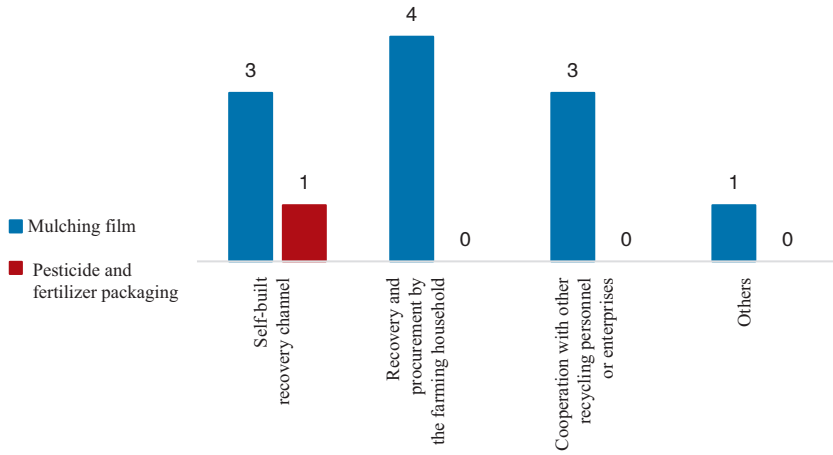

Figure 4-13 Recycling modes of waste mulching film and pesticide/fertilizer packaging

(2) Policy and funding support is generally insufficient

At present, most regions have yet to issue policies regarding low-value recyclables, which means that low-value recyclables recycling enterprises lack support from the government, and local governments generally pay less than enough attention to this regard. According to the survey, less than 40% of the cities have issued policies related to low-value recyclables, and only 35% of the enterprises have got government support. The survey also shows that 35% of the cities attached average importance to the recycling of low-value recyclables and only a quarter of the cities attached high importance to the issue. On the contrary, as many as 40% of the cities pay less than enough attention to the recycling of low-value recyclables.

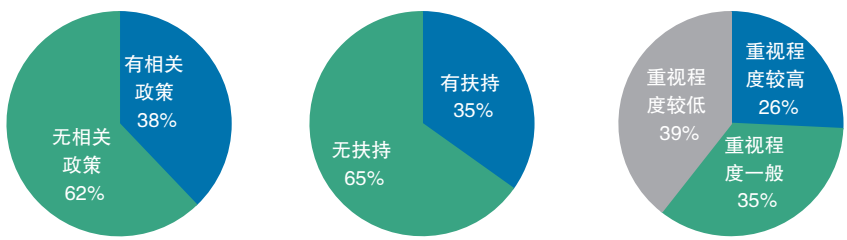

Figure 4-14 Local authorities' concern for this regard

(3) Enterprises generally face challenges and desire support

At present, the recycling system of low-value recyclables is yet to be improved,

and the enterprises engaged in the recycling industry are also faced with many challenges which are mainly related to the low demand for recycled products, insufficient supply of raw materials, and technical bottlenecks. Enterprises generally face the biggest challenge in that the market demand for recycled products is neither high nor stable, which is followed by immature recycling technology, a hardly stable supply of waste materials, and cumbersome procedures to go through to get qualifications regarding environmental protection and so on. In addition, the waste glass recycling enterprises reported that the recycled cullet had such problems as unstable composition, high recycling price and small recyclable amount, and two waste mulching film recycling enterprises also reported that there were such problems as the substandard mulching film hardly recyclable and so on.

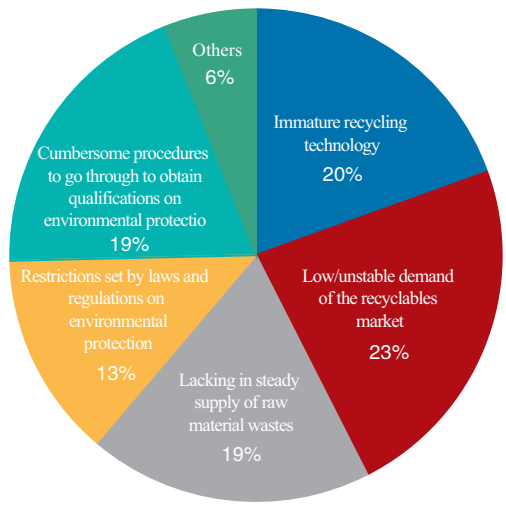

Figure 4-15 Challenges facing businesses generally

According to the survey, enterprises recycling different categories of low-value recyclables face different challenges. With regard to waste textiles, the biggest challenges faced by recycling enterprises lie in immature recycling technologies, an unstable supply of waste raw materials, and cumbersome procedures for obtaining qualifications on environmental protection. Only 13% of the enterprises indicated that they faced the problem of low/unstable market demand for recycled products. As

for waste glass, the biggest challenge faced by recycling enterprises lies in the legal restrictions and cumbersome procedures for obtaining qualifications on environmental protection; only 2% of enterprises reported the lack of a stable supply of raw waste materials. For paper-based composite packaging, the biggest challenge facing recycling enterprises lies in the cumbersome procedures for obtaining qualifications on environmental protection, the lack of a stable supply of raw waste materials, and low/unstable market demand for recycled products. As for waste plastics and waste mulching film, the biggest challenge faced by recycling enterprises lies in the low / unstable market demand for recycled products, which is followed by the lack of a stable supply of waste materials, and legal restrictions regarding environmental protection as well as the cumbersome procedures for obtaining qualifications on environmental protection. As for the waste pesticide fertilizer packaging, the biggest challenge facing recycling enterprises is the immature recycling technology.

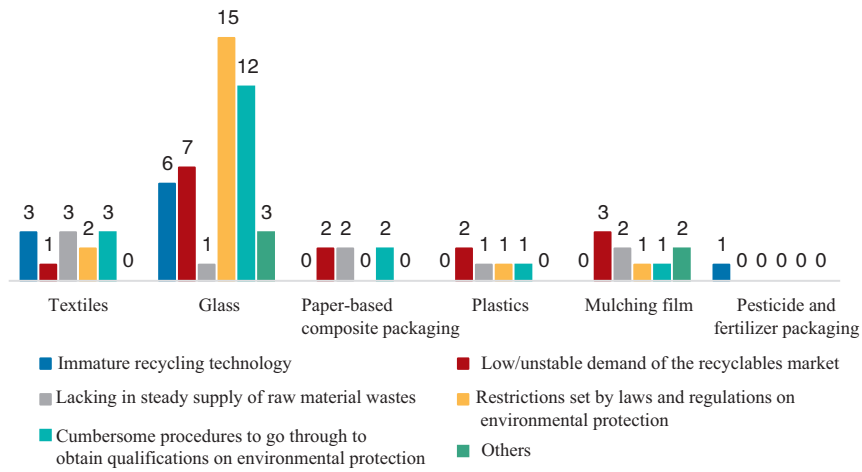

Figure 4-16 Challenges facing different businesses

Policy aspirations: The enterprises generally most wish for the government to issue preferential tax policies, accounting for nearly half of the total, which are followed by financial support policies and land use support policies. In addition, the enterprises also desire policy support for technological innovation.

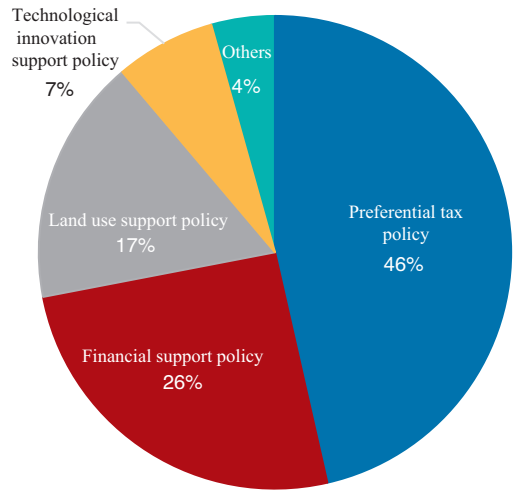

Figure 4-17 Enterprises' general policy aspirations

The enterprises recycling different categories of low-value recyclables desire different support: For waste textiles, the recycling enterprises most wish that the government would issue land use support policies, followed by financial support policies. For waste glass, the recycling enterprises most wish the government to roll out preferential tax policies, followed by financial support policies. For waste paper-based composite packaging, the recycling enterprises most wish the government to issue preferential tax policies, followed by land use support policies. For waste plastics, the recycling enterprises most wish that the government would issue financial support policies, and they have also mentioned environmental protection regulations, opening-up and import policies. The waste mulching film, and waste pesticide and fertilizer packaging recycling enterprises most wish that the government would issue financial support policies and tax incentives.

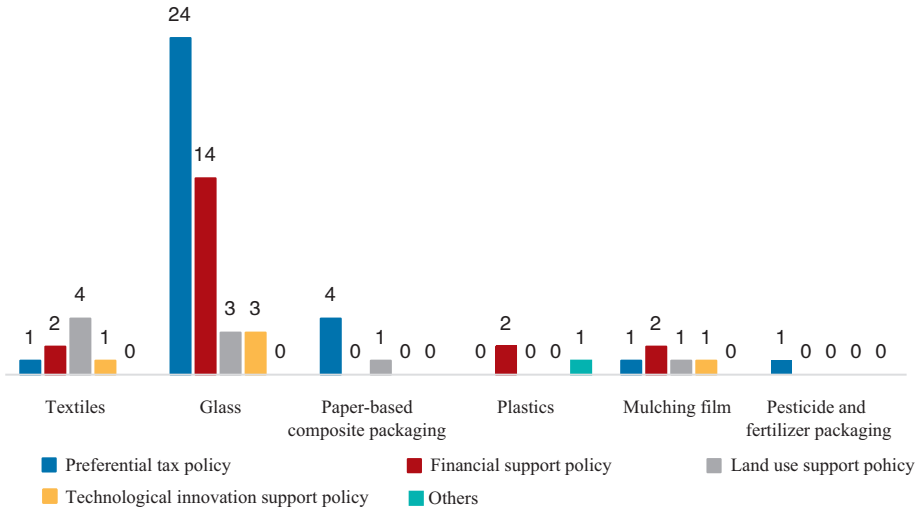

Figure 4-18 Different enterprises' policy aspirations

The enterprises generally indicate it is most conductive to promoting the recycling of low-value recyclables to offer financial support and conduct tax relief and exemption, which is followed by the formulation of relevant laws and regulations, the strengthening of publicity and education, the introduction of the recycling industry standards, the establishment of relevant industry associations or organizations, and the improvement of recycling infrastructure. In addition, some recycling enterprises have mentioned measures such as setting up a comprehensive recycling supervision platform for deposit refunding, establishing a cross-departmental coordination mechanism, enhancing supervision over environmental protection, and opening up the import of recycled raw materials.

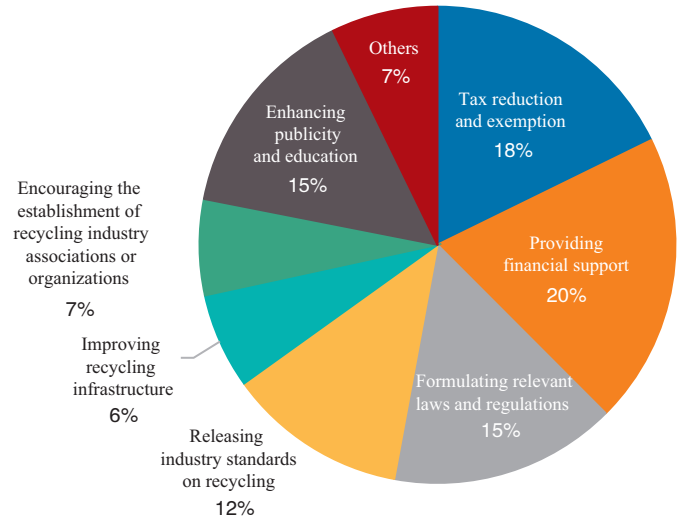

Figure 4-19 Promotional measures expected by enterprises

V. Typical experiences and practices of developed countries

At present, the economic efficiency of the recycling of such typical wastes as household appliances, scrapped cars, and discarded packaging in developed countries and regions is relatively poor. Therefore, developed countries and regions have not clearly defined low-value recyclables, but generally adopt long-term mechanisms such as the extended producer responsibility system to compensate for the poor economic efficiency of waste recycling. Among them, Japan, Singapore, France and other countries began to explore the recycling system for typical recyclables relatively early, and have now established sound recycling systems. Their experiences can be summarized as follows: First, it is to issue relevant laws and regulations to put in place a sound legal system; second, it is to promote and implement the extended producer responsibility system; third, it is to clarify the responsibilities and obligations of producers, sellers, consumers and other relevant entities; fourth, in the field of recycling and reuse, the franchising mode is explored and implemented.

(I) Japan's EPR recycling system for low-value packaging

In 1995, the Japanese government enacted the Container Packaging Law,

proposing to establish a recycling system for waste container packaging. This law began to be partially implemented in 1997 and has been fully implemented since 2000.

Coverage: When the law came into effect in 1995, glass containers and PET bottles were the main objects recycled. In 2000, paper and plastic containers were also covered. At present, the container packaging wastes stipulated in the Container Packaging Law mainly include eight kinds under four categories: Plastics, glass, paper and metal. Among them, plastics include PET bottles and plastic container packaging; in the glass category are mainly glass bottles which may be colorless, brown or in other colors; in the paper category are the paper container packaging, cardboard boxes and corrugated paper; and in the metal category are mainly the two types of aluminum cans and iron cans.

Operation mechanism: The recycling process of container packaging wastes in Japan is shown in Figure 5-1. In the first place, consumers purchase products with container packaging from certain enterprises for consumption, and after consumption classify the waste container packaging which is to be collected by cities, towns and villages; then the cities, towns and villages put the container packaging wastes to re-commercialization operators for unified re-commercialization; finally, re-commercialization operators will sell the recycled products.

Funding: Japan has established a container waste treatment fund, which is mainly borne by enterprises including container manufacturers, users and importers. At the same time, for the container packaging wastes produced by the enterprises whose business scale does not reach the legal standard, the treatment expenses shall be borne by the city, town and village according to the legal provisions. The fund is managed by the Japan Container and Packaging Recycling Association (JCPRA), a non-profit corporate consortium, and is mainly used to pay the specific recycling entities for recycling container packaging wastes by the cities, towns and villages.

Licensing: The JCPRA Association selects re-commoditization operators through bidding, signs implementation contracts with them, and signs entrustment contracts with the enterprises that pay the waste treatment fund to ensure smooth connection between related channels.

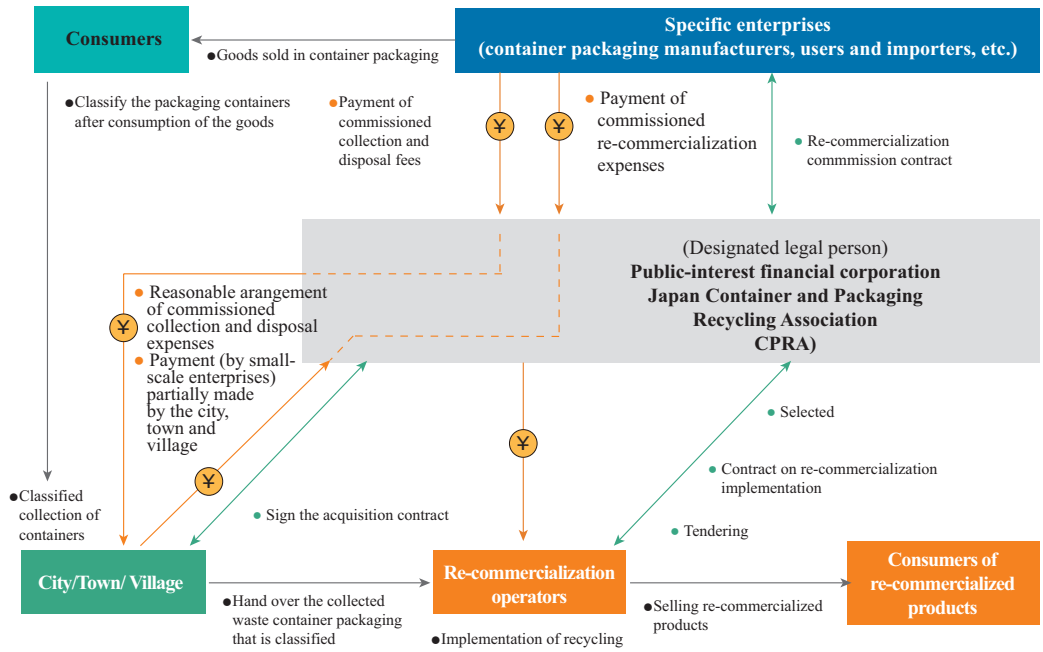

Figure 5-1 Recycling system of low-value recyclables in Japan

(II) "Green Dot" recycling system for waste packaging in Germany

Germany started early in the field of solid waste management. Since the 1970s, the German government has gradually established a legal and regulatory system for solid waste treatment and disposal, reduction management and recycling, and has continuously sought to develop and improve the operation system for waste recycling. Among them, the "green dot" recycling system for waste packaging is the most typical one.

Continuously improve packaging regulations: In 1972, Germany introduced the Waste Treatment Act, aiming to strengthen the management of production and consumption wastes. Later, it was amended into the Law on Restricted Disposal of Wastes, which stipulates the minimum recycling rates of various packaging materials for production enterprises, and states that the enterprises that fail to meet the target shall pay a fine. In 1991, Germany passed the Packaging Act, requiring manufacturers to collect, recycle or reuse the discarded packages of all commodities, and the extended

producer responsibility system was formally established in Germany. Specifically, packaging manufacturers have three obligations: to select an agency in the DSD to apply for licensing; to register with the central registry of packaging products; and to report data to the central registry.

Figure 5-2 Green Dot recycling system for waste packaging in Germany

Establish a sound "Green Dot" recycling system: In 1990, 95 packaging manufacturers, retailers, raw material suppliers and waste recycling departments jointly set up a non-governmental organization Duales System Deutschland (DSD). The manufacturer of packaging materials signs an agreement with the DSD to apply for using the "green dot" sign authorized by DSD on the packaging of its products, pays DSD a certain mark use fee, and entrusts DSD with the recovery work. The DSD organizes the recovery and recycling of waste packaging. The authorized enterprise prints the "green dot" sign on the packaging of its products, the consumers who buy the products with the "green dot" sign shall put the packaging into the yellow garbage bin in garbage classification, and the DSD is responsible for recycling and innocuous disposal of the wastes in these yellow bins. The DSD Company does not directly participate in garbage collection and treatment, but signs the entrustment treatment contract with the professional recycling enterprises and pays a certain fee so that these

enterprises do the recycling of the waste packaging.

(III) Integrated operation mode of high- and low-value recyclables in Singapore

In 2001, Singapore began to advance the privatization process of waste collection in an all-round way. The waste collection and transportation enterprises with related qualifications are the main entities of waste classification and disposal, and the government is responsible for the qualification assessment, examination and operation supervision of the enterprises.

The government has licensed waste recycling. The government selects waste collection enterprises in a certain area through open bidding and issues licenses for the enterprises to carry out waste sorting and recycling. The government is responsible for managing the terminal treatment facilities such as the waste landfill and incineration plant, and bears the operating expenses. In addition, the government strictly supervises waste recycling companies and specifies the time and frequency of waste collection. In order to ensure maximum classified disposal of collected wastes, the government has also clearly defined the amount and types of waste sent by recycling enterprises to incineration plants.

Enable enterprises to earn profits and bear losses by themselves by engaging in the recycling of high- and low-value recyclables. In Singapore, non-approved scavenging is illegal, and recycling companies are responsible for the collection of all domestic wastes in a given area during the concession period, and are responsible for their profits and losses by recycling both high- and low-value recyclables. Currently, Singapore has four licensed waste recycling enterprises (800 Super, Colex, Voria, Semb-waste) to provide domestic waste and recyclable waste collection services for the related areas.

The residents pay the waste disposal fee. In Singapore, the garbage charging system is in force, under which residents are required to pay a garbage disposal fee, and the government levies different garbage disposal fees on residents according to the nature of the residence (public housing or private residence) and the area of the residence. Stores are charged according to the amount of waste produced each day.

Moreover, residents in Singapore need to carry out a preliminary rough classification of domestic waste, place it at a fixed time and place specified by recycling enterprises, and then waste collection enterprises carry out further classification of the collected garbage.

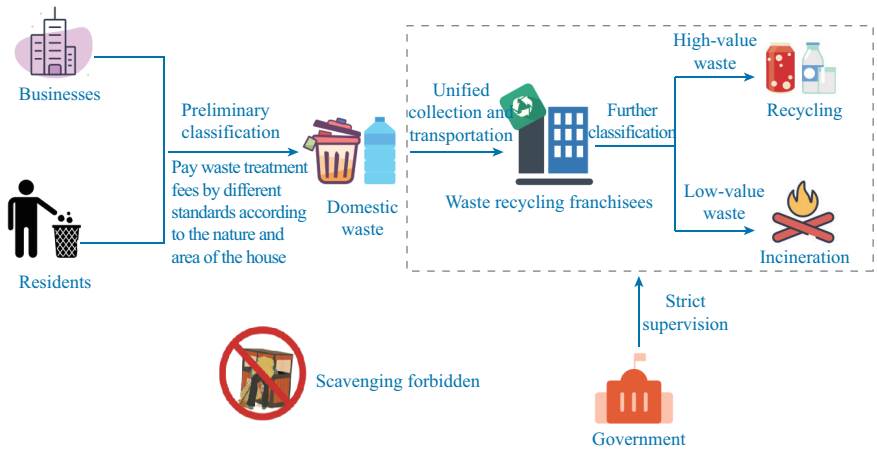

Figure 5-3 Domestic waste collection, transportation and treatment system in Singapore

(IV) The professional recycling mode of pesticide packaging in representative countries

The current mature recycling mode of pesticide packaging materials (mainly bottle containers) in some countries can be summarized as "organization by the association + franchise + source control," and waste collection contractors set up collection points. The farmers regularly hand over the cleaned pesticide bottles to the collection spot to be transported and disposed of by the waste collection contractor.

Define the responsibilities of each participating entity: The government is responsible for formulating top-level laws, policies and standards and allowing enterprises to carry out franchise operations; the industry association is responsible for organizing relevant enterprises in the industry to participate in the recycling system and coordinating the project implementation; producers work closely with industry associations to ensure that the pesticide packaging produced by them enters the recycling system; operators are responsible for the operation of the collection points

and provide the farmers with necessary training; farmers are required to clean pesticide packaging and deliver the cleaned packages to collection spots.

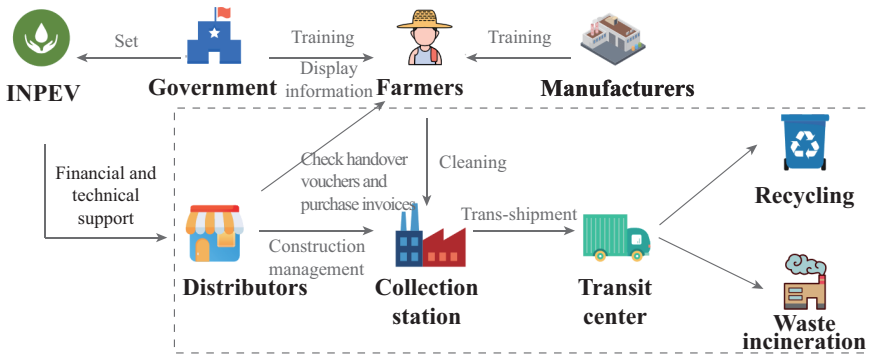

Figure 5-4 The recycling mode of pesticide packaging

Multiple cost-bearing models: Given the diversified cost payers, the cost-sharing models of waste pesticide packaging recycling can be divided into two categories: the multi-party payment model and the single-party payment model. The single-party payment model can be further divided into three types: The first type follows the polluter-pays principle, in which the farmers mainly bear the recycling costs; the second type follows the extended producer responsibility system in which the cost of recycling is mainly borne by the pesticide production and distribution enterprises; the third type is that the government purchases services and bears the major cost of recycling. For example, countries such as Belgium, France, and Germany adopted the extended producer responsibility system in which the cost of pesticide packaging disposal is borne by the producer while in countries such as Italy, the United Kingdom, Japan, and Australia farmers pay for the disposal of the waste.

Specialized enterprises are responsible for recycling operation: For example, Phytofar-Recover is authorized in Belgium to take charge of the recycling of pesticide packaging nationwide and collect it in a centralized manner after the spraying period from September to November each year, to conduct classified collection of recycled materials by the material like metal cans, paper, plastics or according to whether are hazardous wastes or not, and to recycle or incinerate the recycled packaging. In Brazil, for example, legislation has been adopted to promote the recycling of waste pesticide

packaging. The law requires the user of the pesticide to clean the packaging and deliver it to the collecting station; the pesticide dealer is responsible for checking the grower's hand-over certificate and purchase invoice, and for building and managing the collecting station. The manufacturer, together with the distributor and the government, carries out skill training among pesticide users, with the labels of the pesticide clarifying the way to handle the empty containers, and provides the recycling stations with waste transshipment, recycling and treatment services. In Brazil, a non-profit national institute for the empty container treatment has been set up to work with 99% of Brazilian pesticide manufacturers, distributors and growers on the recycling of waste pesticide packaging and provide financial and technological support.

VI. Typical cases of recycling and utilization of low-value recyclables in China

At present, the collection and recycling of low-value recyclables in China are still mainly carried out by enterprises on their own, and the long-term mechanism has still been inadequate since the refundable deposit system for waste pesticide packaging is just explored and implemented in some areas.

(I) Case Study: The Blue Mountains Project

1. Large-scale recycling of plastic food containers

In August 2017, Meituan launched The Blue Mountain Project , the first environmental protection initiative in China's food delivery industry. The Blue Mountain Project is a single-use plastic packaging management program aimed to provide systematic solutions for the lifecycle management of takeaway packaging. It advocates a balanced emphasis on "reduction, substitution, and recycling," involving active participation from all stakeholders along the industry's value chain. Through fostering co-governance among upstream and downstream partners, the project drives collective efforts towards achieving sustainable practices and environmental stewardship.

Recycling of plastic food containers has shown substantial value-creation

potential. Industry data shows that more than 90% of plastic food containers are made of polypropylene (PP), which is a food-grade plastic. Recycling of these plastic food containers, particularly those composed entirely of transparent PP, can create considerable economic value.

Large-scale recycling of plastic food containers is hindered by difficulties in waste classification and the associated high costs. Consumers' habit of mixing food remnants with discarded plastic food containers poses a significant challenge to recycling efforts. Furthermore, the lightweight nature of these containers means that a substantial volume is required for recycling to be economically viable. Additionally, the recycling value of mixed-color plastic food containers is significantly lower than that of transparent containers. Only transparent ones hold considerable economic value. The intended use of recycled plastic pellets directly influences the recycling cost, which in turn affects recyclers' motivation.

To address these challenges, The Blue Mountain Project collaborates with local recyclers and businesses involved in downstream plastic regeneration activities to implement a multi-pronged approach that promotes large-scale recycling of plastic food containers. The approach aims to elevate the recycling value of these containers, promote the development of standards for plastics that can be easily recycled and regenerated, and thereby systematically increase the recycling of plastic food containers.

Stage	Challenge	Solution provided by the Green Mountains Program in collaboration with partners	Example
Recycling	Challenges relating to Waste Classification: Plastic food container recycling necessitates the separation of food residues from the containers. Unfortunately, the exclusion of plastic food containers from conventional recycling systems has led to a widespread misconception among consumers regarding their recyclability.	• In collaboration with stakeholders, the program implements a strategy to promote plastic food container recycling in communities adhering to the four-category waste classification system. This strategy includes targeted training and education initiatives, along with the provision of an additional collection bin specifically designated for plastic food containers. • It promotes the inclusion of plastic food containers into the low-value recyclables system.	• In 2020, Xiamen City published the Xiamen City Domestic Waste Low Value-Added Recyclables Catalog, which officially recognized lightly polluted plastic food containers as recyclable materials. In April 2021, the Meituan Green Mountains Program collaborated with Xiamen Luhai Environmental Protection Co., Ltd. to launch an initiative aimed at enhancing plastic food container recycling practices among residents on Xiamen Island. Through a series of 110 offline educational events, community supervisors received in-depth training on effectively guiding residents in the proper sorting and recycling of plastic food containers. This initiative has led to a significant increase in the plastic food container recycling rate in the city. • In October 2021, Aihuishou and the Meituan Green Mountains Program joined hands to launch a plastic food container recycling project in Yangpu District, Shanghai. Leveraging Aihuishou's established collection and transportation network in the district, the project employs AI-powered recycling machines and stations to efficiently collected plastic food containers. It has also expanded the meticulous waste sorting system dedicated to plastic food containers. The average daily recycling volume of plastic food containers has reached 3-5 tons/day. • In May 2023, the Shenzhen Municipal Urban Management and Law Enforcement Bureau and the Meituan Green Mountains Program launched the Dandelion Plastic Food Container Recycling Project, actively engaging 86 commercial office buildings across 9 districts in the city in the classification and recycling of takeaway packaging waste. • In October 2023, the Green Mountains Program embarked on a collaborative project with three recycling companies in Beijing to pilot takeaway packaging recycling in several districts, including Changping, Chaoyang, Shunyi, and Xicheng. This initiative involved the installation of recycling bins dedicated to plastic take-out containers at garbage collection points, marking a significant step towards establishing a comprehensive "full chain" recycling system for plastic food containers. The envisaged system encompasses the seamless flow of plastic food containers from recycling sites to community transfer stations and ultimately to renewable resource sorting centers.
	Challenges Impeding Large-Scale Recycling of Plastic Food Containers: Scattered across residential areas, restaurants, and office buildings, these containers are not readily accessible for efficient collection and processing, making it difficult for recycling companies to achieve economies of scale.	• The program identifies optimal locations for recycling stations based on order data. • It strategically chooses businesses as key partners for its large-scale recycling strategy.	
	High Recycling Costs: The decentralized nature of plastic food container sources increases collection and transportation costs and the involvement of numerous intermediaries in the transportation and packaging process further dilutes profits across the supply chain.	• To enhance the economic attractiveness of plastic food container recycling and increase profit margins for recycling companies, efforts have been focused on constructing centralized collection and handling facilities and eliminating unnecessary intermediaries. • Green Mountains Technology Fund has actively supported large-scale, automatic and efficient plastic food container sorting projects.	

Stage	Challenge	Solution provided by the Green Mountains Program in collaboration with partners	Example
Regeneration	Recycled pellets generally have low values: Limitations in technical capabilities, a lack of standardization in container design and the diverse range of materials and colors used in plastic food containers diminish the value of recycled pellets.	• Collaborative efforts among industry stakeholders can lead to the development of evaluation and standardization systems that identifies and promotes easily recyclable and regenerable plastic products. • The Green Mountains Technology Fund eeks to create a self-sustaining ecosystem for plastic food container recycling by supporting the translation of R&D results from recycling companies into practical applications, promoting the development of high-value applications for recycled pellets, and expanding the demand for recycled materials. • The program proactively initiates recycling projects and diligently explores replicable models.	• As one of the earliest members of the Green Recycled Plastic Supply Chain Co-Working Group, it has formulated the "Implementation Rules for the Evaluation of Designs for Easily Recyclable and Regenerable Plastic Products - Disposable Plastic Packaging Containers for Takeaway/Takeout Food, and worked with the Working Committee on Renewable Resource Supply Chain Management to release the List of Enterprises Participating in the Plastic Food Container Recycling Pilot Project. These concerted efforts have paved the way for large-scale, standardized, and environmentally responsible development within the plastic waste recycling industry. • In June 2021, Meituan established the Meituan Green Mountains Technology Fund, a public welfare fund with an initial investment of 500 million yuan, founded the Green Mountains Technology Award, a public welfare recognition program for promising young scientists, and spearheaded several green technological innovation demonstration projects. It has joined hands with Donghua University and several other companies to launch the “High-Value Application of Plastic Pellets Recycled from Polypropylene Containers” project to develop technology crucial for the transformation of plastic food containers into fine-denier and high-strength polypropylene fibers, which can be used to manufacture high-end sportswear, backpacks, safety ropes, and other products. • In February 2023, the Green Mountains Program and Chenguang launched the first carbon-neutral stationery project in China made from pellets recycled from plastic food containers.

As of October 2023, the Green Mountains Program had launched large-scale garbage classification and plastic food container recycling projects in cities in 14 provinces across the country, including Xiamen, Shanghai, Hangzhou, Shenzhen, and Beijing, and had recycled a total of 14,700 tons of plastic plastic food containers in collaboration with local recycling companies. It had funded green technological innovation demonstration projects, built a plastic food container recycling production line with a production capacity of over 10,000 tons and reused more than 4,400 tons of recycled plastic, and successfully transformed waste plastic food containers into high-value products, such as fine-denier polypropylene fibers. According to the Research Report on Plastic Food Container Recycling and Regeneration by the Recycled Plastics Branch of the Working Committee on Renewable Resource Supply Chain Management, China's plastic food container recycling rate was about 23.3% in 2021. The plastic food container recycling rate of some pilot projects operated by the Green Mountains Program has reached 60%. The program's success can be attributed to its focus on economies of scale.

(II) The third party handles waste pesticide packaging recycling and deposit refunding

In Baoding City, Hebei Province, the recycling of pesticide packaging adopts the refundable deposit mode, and it is accomplished through the mechanism of "the government leading, department supervision, enterprise operation, and full participation of sellers and users". The main parties in concern include local governments, recycling operators, pesticide sellers and pesticide buyers.

The recycling mode of pesticide packaging involving a deposit shall be implemented by the principle of "whoever buys the pesticide shall return the packaging, and whoever sells the pesticide shall collect the packaging". The concrete process goes as follows: The pesticide dealer sells the pesticide at a price covering a deposit; the pesticide operator sets up a recycling device for the pesticide packaging waste in its business spot to recycle the waste; the pesticide user pays the deposit in advance and gets a refund for the deposit through participating in the recycling of pesticide packaging

waste; the government pays for the construction of the pesticide packaging recycling system and the costs of cleaning, transportation and harmless treatment of the wastes. After pesticides are sold at a price including the deposit, they are recycled, transported, stored and disposed of. In this process, the government relies on the real-time and traceable monitoring and display platforms established by recycling operators to seamlessly connect pesticide dealing stores, transportation vehicles, waste collection and temporary storage points and harmless treatment units, and to carry out real-time whole-process monitoring on the pesticide sales, collection and refund of the deposit, waste transportation, delivery, collection and disposal at the collection and temporary storage spots. See Figure 6-1 for detailed logic of pesticide packaging deposit refunding mode.

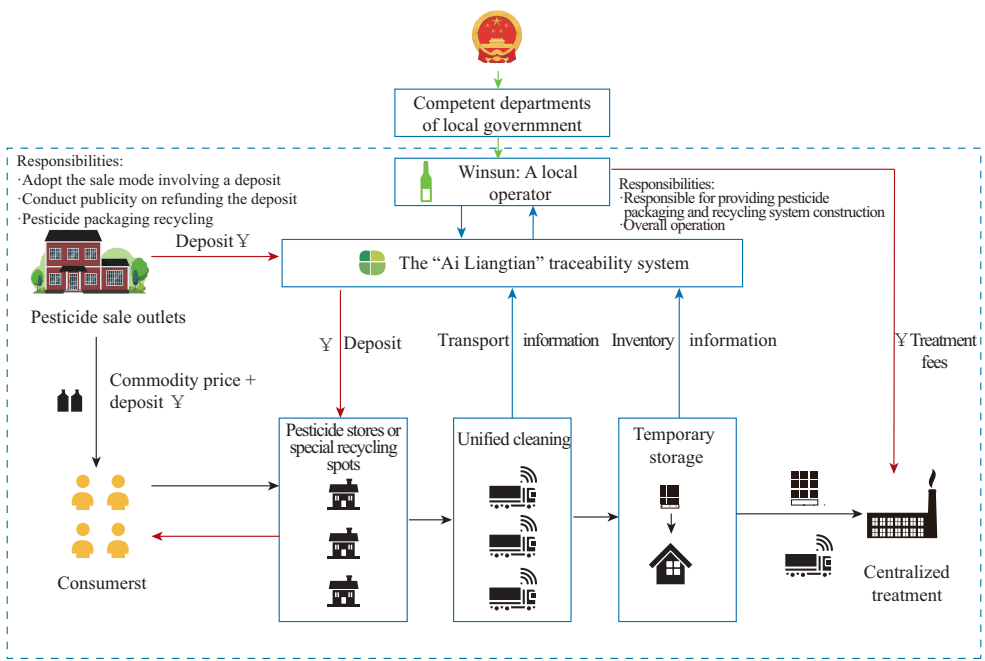

Figure 6-1 Recycling mode of waste pesticide packaging involving deposit refunding

So far, Winsun has adopted the pesticide packaging recycling mode by refunding the deposit in more than 70 cities and counties of six provinces including Hebei, Sichuan, Hubei and Henan, with the average recycling rate of pesticide packaging basically staying above 85%, which has effectively addressed the problem of pesticide packaging recycling and enhanced the intelligent supervision capability of the government over

pesticide packaging recycling.

(III) Full-chain recovery and reuse mode of waste textiles

Yuyue Home Textiles has a complete industrial chain integrating textile R & D design, organic raw material planting, functional fiber development, spinning and weaving, dyeing and finishing, finished sewing and waste textile recycling. In addition, a circular development industrial system based on "resources-products-renewable resources" has been established, and the product quality conforms to the national and industrial standards and meets the application requirements of various textiles such as garments and home textiles. The business passed the certification by the Global Recycled Standard (GRS) in 2019.

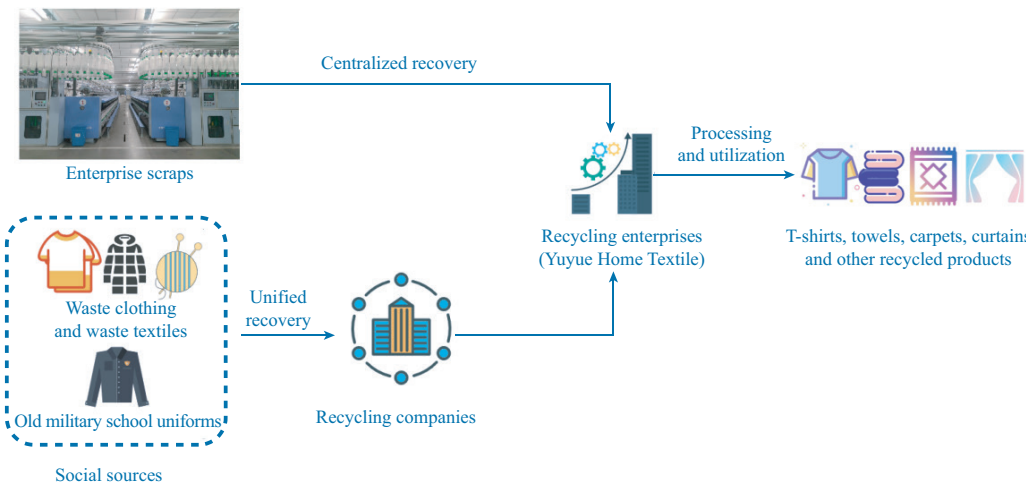

Figure 6-2 Closed recycling mode of waste textiles

Recycling of unused waste textiles. Yuyue Home Textile Co., Ltd. recycles the sewing leftover materials, the dyed and printed defective cloth, the retreated yarn from woven fabric, the defective spun fabric and the like generated in the production process. It takes physical methods to loosen recycled fibers, and get recycled products through yarning and weaving, including various recycled fibers, yarns and fabrics as well as the recycled cushions, canvas bags, woven carpets, curtains, tea towels, bed products, moving blankets, T-shirts, woven cushions, woven containers and other home textile

products. The annual recycling treatment capacity exceeds 2700 tons, and the use of each kilogram of waste textile reduces the carbon dioxide emission by 3.6 kilograms, saves 6,000 liters of water, and reduces the use of 0.3 kilograms of fertilizer and 0.2 kilograms of pesticide.

Recycling of used waste textiles. Relevant enterprises step up efforts to recycle waste textiles from society, undertake the task of recycling waste and used military uniforms, and attach importance to back-end product innovation. They have cooperated with Haier, Ikea and other B-end customers to conduct R & D and production of various industrial products. Currently, such products as industrial fabrics, logistics pallets, desks, chairs, other furniture, boards, thermal insulation building boards, fiber felts and the like have been developed from recycled textiles. The recycling and utilization of waste and old textiles are realized, with the annual recycling capacity exceeding 10,000 tons.

(IV) Diversified waste glass recycling practice

Guangdong Huaxing Glass Co., Ltd. has carried out the recycling of cullet through various modes like cooperation with private recycling businesses of renewable resources, municipal waste classification companies and breweries to form a complete closed loop covering glass bottle production, filling by glass bottle using enterprises, multi-channel recycling, cleaning line treatment and cullet recycling. Relevant enterprises shall strengthen the expansion and development of recycling channels at the provincial and municipal levels; and encourage recycling businesses to increase the recycling amount of cullets to reduce the loss of cullets, to recycle the scrapped glass from customers' factories, and to reduce waste of resources and disposal costs associated with landfill disposal. Relevant enterprises and recycling businesses have continuously strengthened the upgrading of cleaning equipment, enhanced the efficiency of cullet cleaning and treatment and the stability of cleaning effectiveness, increased the proportion of cullet used, and reduced the use of raw materials such as raw ore and chemicals. As result, the pollutant emission and solid waste treatment costs as well as the waste product proportion have been reduced, the finished products have been improved, the reduction of weight and the savings of transportation costs are realized.

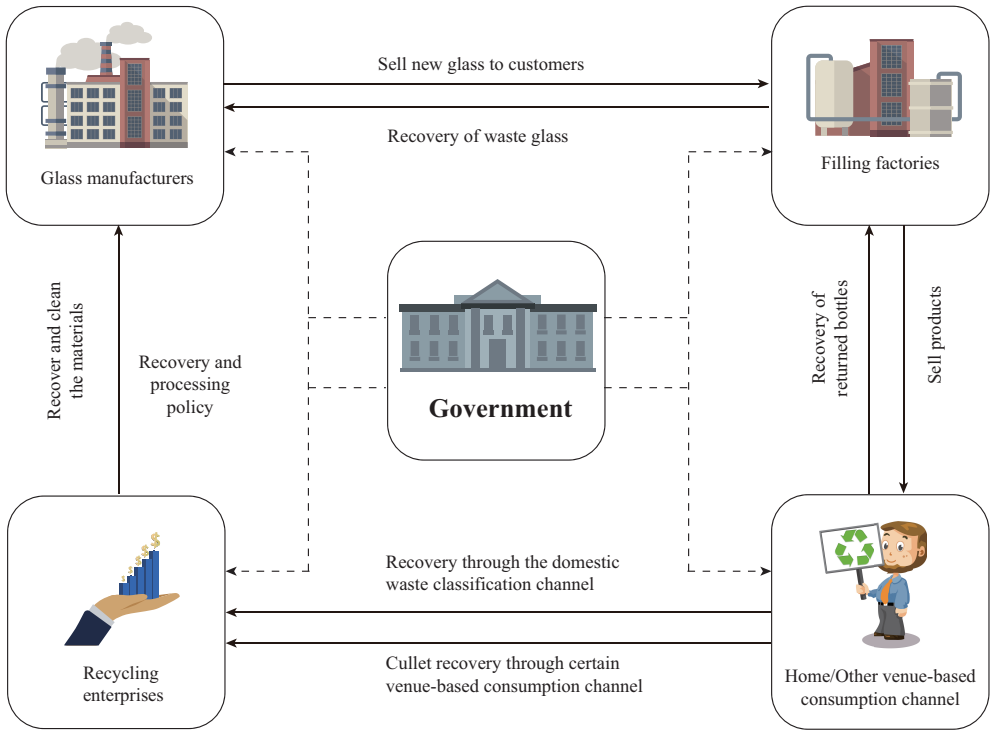

Figure 6-3 Diversified recycling modes of waste glass

At present, enterprises purchase and use more than two million tons of cullet every year through such multiple channels as recycling of discarded glass from factories, recycling of classified domestic waste, recycling of cullet from diverse venues, and recycling of old bottles. Thus, the consumption of natural resources is reduced. As many as 18,250 m^3 of natural gas can be saved, the emission of carbon dioxide can be reduced by 4.38 million tons, and the effect of resource-saving, energy conservation and carbon reduction is very remarkable.

VII. Suggestions on building and improving the recycling system of low-value recyclables

(I) Selection of the best recycling mode for different categories of low-value recyclables

Different recycling modes can be adopted according to the source characteristics of

different low-value recyclables, the recycling methods and the enthusiasm of the market entities for independent recycling. Specifically, waste glass and waste textiles should be recycled independently; the mulching film, pesticide and fertilizer packaging should be recycled through a mechanism involving the deposit; the government-led centralized recycling model should be adopted for large pieces of garbage; the recycling of other packaging wastes such as low-value plastic packaging and paper-based composite packaging should adopt the mode of unified recovery and centralized separation and utilization.

1. Independent recycling mode of waste glass and waste textile based on franchising

In comparison with other low-value recyclables, the components of the waste glass and the waste textile are relatively simple; the waste glass is easy to break, and if it is mixed with other wastes, it is difficult to get them apart; and waste textiles are prone to be contaminated by other wastes. Therefore, specialized enterprises are there to do such recycling as the independent recycling model based on franchising is an appropriate recycling model for waste glass and waste textiles.

The operation mechanism is shown as follows:

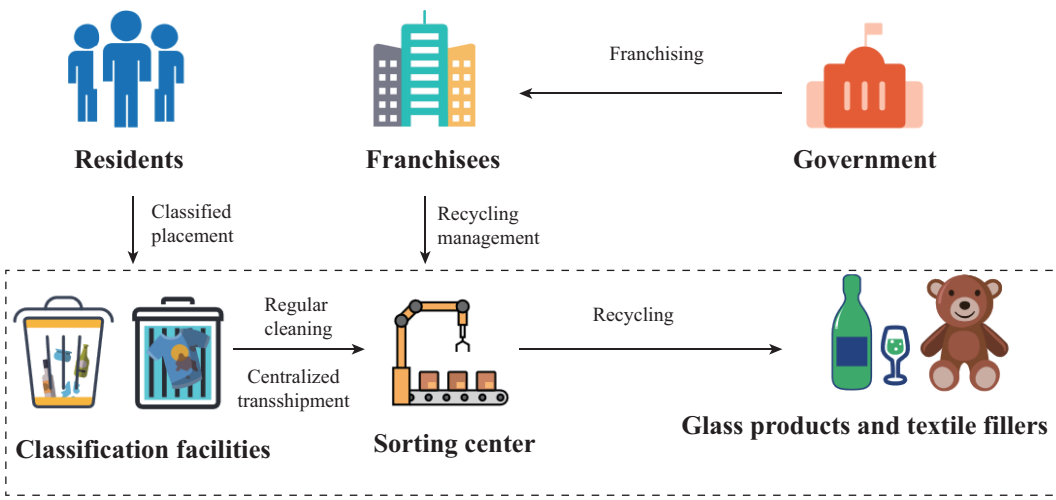

Figure 7-1 Independent recycling mode of waste glass and waste textiles

First of all, the government will select an appropriate enterprise through public

bidding and grant it franchise for a certain period of time, so as to ensure that the waste glass and waste textiles in the area can be exclusively recycled by the franchisee. Second, the franchisee cooperates with the property management company to place special recycling boxes for waste glass and waste textiles in residential quarters and office premises, and carries out unified registration and numbering management. Third, according to the collection rules of waste glass and waste textiles, franchisees use special transport vehicles to regularly clean up the recycling boxes and transport in the centralized manner collected waste glass and waste textiles to the sorting center for preliminary sorting and processing. Finally, the classified waste glass or waste textiles are delivered to the downstream glass product processing and utilization enterprises or waste textile processing and utilization enterprises for recycling according to different grades and requirements. The government offers subsidies according to the actual recycling amount of the franchisees.

2. Integrated recycling mode for fertilizer and pesticide packaging and mulching film based on deposit refunding

Agricultural production wastes such as pesticide and fertilizer packaging and mulching film are widely seen, and they are easy to leak into the natural environment and pose grave environmental hazards. The refundable deposit model should be adopted to recycle such wastes in provinces to effectively increase the enthusiasm of growers to participate in the waste recycling, uplift the recycling rate, and eventually spread the model across the country.

The operating mechanism of the recycling mode can be summarized as “recycling by market entities, disposal by professional institutions, and support by public finance.” In the principle of the extended producer responsibility system, the producers of chemical fertilizers, pesticides and mulching film, agricultural equipment dealers and agricultural equipment sales outlets shall be the main bodies, and shall collect a certain deposit in the process when the above-mentioned packaging materials are delivered or when farmers purchase pesticides. The farmers shall get a refund for the deposit when returning the pesticide packaging. The producers of fertilizer pesticides and mulching film shall, by themselves or by entrusting professional enterprises to, carry

out standardized recovery, treatment and utilization of the discarded fertilizer pesticide packaging or mulching film. The specific recycling mode is shown in the figure 7-2 below.

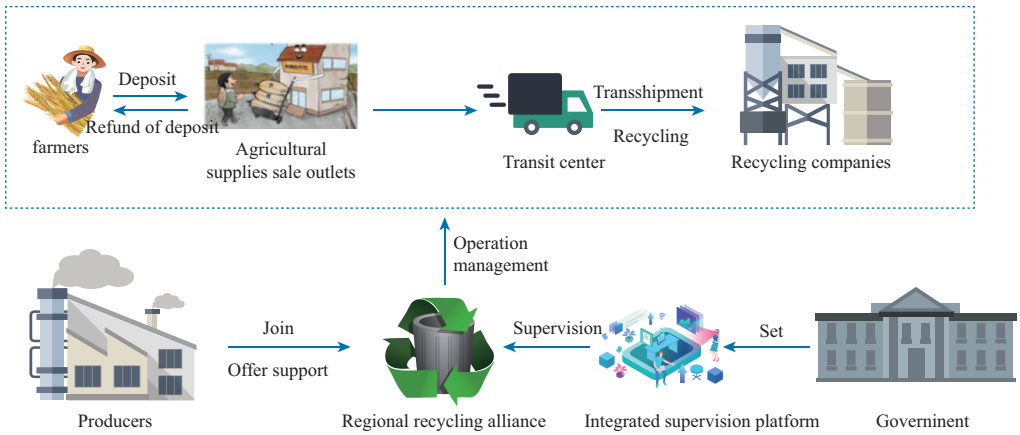

Figure 7-2 Recycling mode of pesticide and fertilizer packaging and mulching film involving refundable deposit

First, in the principle of "whoever produces and whoever sells shall be held accountable", the sale of agricultural supplies is carried out by involving a deposit, certain deposits are collected on the chemical fertilizers, pesticides and mulching film sold, and corresponding documents are issued. With the purchase ledger and sales ledger of agricultural supplies set, a management platform for deposit collection and refunding has been put in place. Second, we should encourage the establishment of regional recycling alliances or specialized third-party service enterprises, and accept the entrustment of enterprises producing fertilizers, pesticides and mulching film to carry out unified recycling and deposit management and operation services. The recycling alliance or a third-party enterprise performs the extended responsibility on behalf of the production enterprise. Finally, agricultural supplies dealers and sales outlets should assist in the management of deposit collection and refunds as well as the recycling of waste chemical fertilizer packaging and waste mulching film. The recycling alliance or the third-party enterprise shall be responsible for providing the transportation service in time to put the above wastes collected by the outlets to the recycling enterprise for recycling or safe disposal. In this process, the government has

established a comprehensive supervision platform to conduct real-time supervision over the collection and refund of deposits at agricultural supplies sale spots, and carry out full-life-cycle traceability management of fertilizer and pesticide packaging and mulching film, to prevent arbitrary disposal or non-standard disposal and utilization, and at the same time, provide necessary financial subsidies or tax incentives and other policy support according to the actual recycling amount.

3. Collaborative recycling model for bulky garbage in association with urban environmental sanitation or renewable resources recycling system

In comparison with other low-value recyclables, bulky waste has the characteristics of being large, heavy, hard to move, and of low value. Except for the well-preserved and functional large pieces of garbage that can still be used for second-hand transactions, the mattresses, sofas and other large pieces of garbage that are seriously damaged and difficult to recycle shall incur high transportation costs but have low utilization value, so they are typical low-value recyclables. At present, there are some enterprises in the market to cooperate with the urban sanitation system or the renewable resources recycling system to conduct recovery and utilization of such wastes.

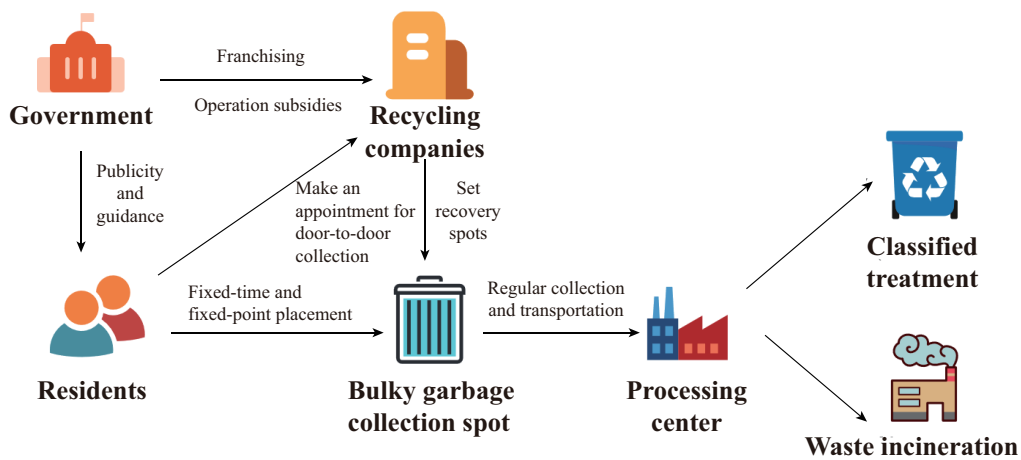

Figure 7-3 Fixed-point large garbage recycling mode associated with urban environment sanitation system

In terms of infrastructure construction: The recovery and disposal of bulky waste can be constructed in coordination with the urban sanitation infrastructure or the sorting

center for renewable resources, temporary storage points for bulky waste can be set up in residential communities or waste transfer stations, and the bulky waste treatment and utilization center shall be constructed in the domestic waste treatment center or the renewable resources sorting center. In terms of management and operation: Residents can put large garbage into temporary storage points of residential quarters by themselves, or make online reservations by telephone or through the Internet platform or mobile phone APP so that the professional recycling enterprise comes to collect and transport the waste to a recycling center where the bulky wastes shall undergo centralized dismantling and get sorted out and recycled by the category and material while the unrecyclable things shall be incinerated by the waste incineration plant. In terms of operational mechanism: Local governments may adopt the mode of franchising or government purchase of services, and determine franchisees (environmental sanitation enterprises or enterprises for recycling renewable resources) by means of open market operations such as bidding. Responsible for providing unified collection, transportation and treatment services for bulky garbage in the region, the franchisee may charge residents waste recovery and treatment fees and accept the supervision and administration of relevant government departments.

4. Centralized recycling handled by the third-party operator for recyclable glass packaging

There are lots of reusable glass bottles like beer bottles, yogurt bottles and other beverage bottles used and emptied on a daily basis at scattered sources including homes, restaurants, night markets, and bars. Therefore, the reverse logistics has the characteristics of being scattered, uncertain and complex. At present, the three modes of enterprise self-operation, third-party outsourcing and combination of self-operation and outsourcing are the mainstream modes of recycling beer bottles and other reusable glass bottles, all of which mainly rely on the market entities, and pose high requirements on the initiative of consumers and dealers. However, although the beer in non-returnable bottles is sold by involving a deposit, some consumers are not aware that the deposit is not uniform. This coupled with the growing comprehensive recycling cost and the fact the new bottle production cost is no more than the comprehensive cost for old bottle

recycling makes the consumers and dealers unwilling to take the initiative to recycle, which leads to degradation of the recycling system and a low recycling rate of the non-returnable bottles. In addition, given that lots of production enterprises, dealers and recycling businesses in a specific region are different in scale, it is hard to build a unified recycling system. Therefore, the recycling system built by market forces is no longer applicable while the centralized recycling mode with the participation of the government will be a better choice. The operation mechanism of this mode is shown in the figure below.

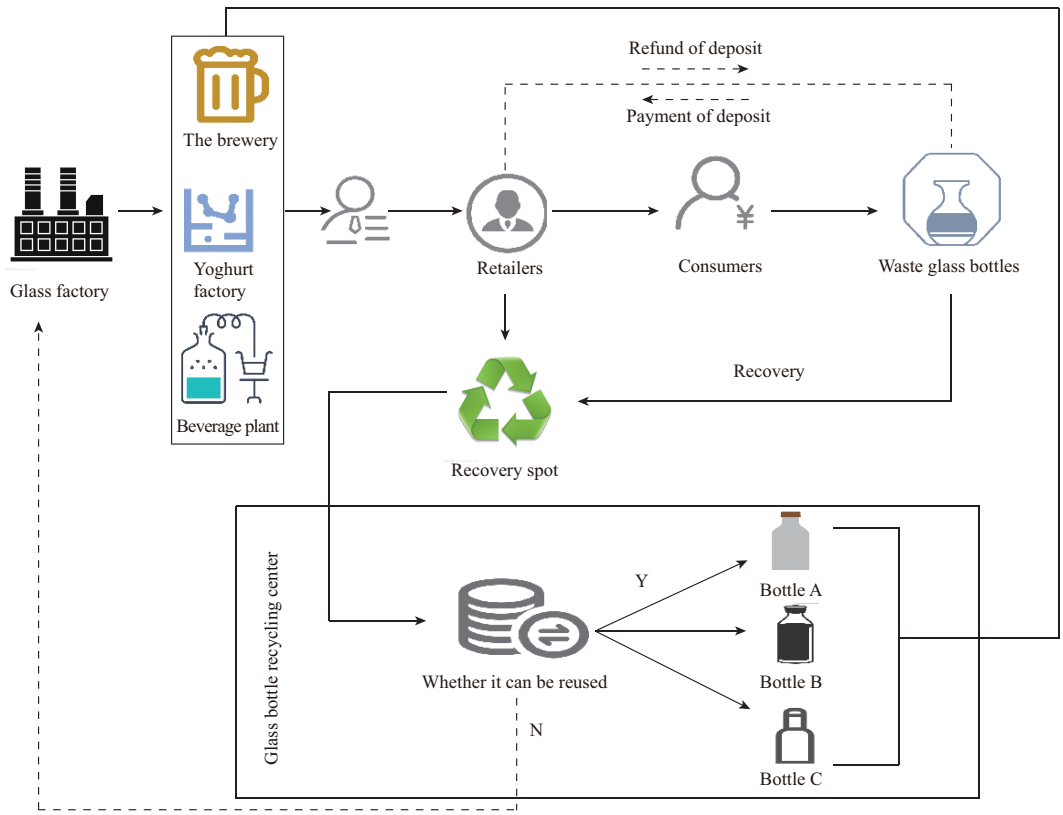

Figure 7-4 The recycling mode at glass packaging recycling center

The operation mechanism of this mode can be summarized as follows: Government participation, guidance and overall planning; market-oriented operation of the recycling system; and processing and utilization by back-end enterprises. First, on the government side, the government participates in the establishment of a recycling

center for glass packaging to recycle reusable glass bottles in a certain area; brings in professional operators with technological and financial strength; standardizes recycling outlets, criteria and operation rules; and provides support accordingly. Second, at the recycling end, the operators of the recycling system shall take the lead in investing in, building and operating the recycling system; setting up recycling spots combining manual and automatic recycling; and refunding the deposit in time. Beer companies are encouraged to improve the deposit refunding mode for non-returnable beer bottles; the retailers and the consumers should know that beer sale invovles a deposit, and they should know about the exact amount of the deposit; the consumers shall get refunded for returned beer bottles. As thus, the refunding rate for the non-returnable beer bottle deposit is increased. Finally, at the treatment end, the glass bottles are classified and utilized comprehensively in the recycling center. The broken glass bottles with poor quality are sent to a glass factory for use as raw materials; the reusable glass bottles are further classified according to bottle type and quality grade, and then sent to corresponding enterprises for reuse.

5. Centralized and unified recycling mode for other mixed low-value recyclables

In addition to the above-mentioned low-value recyclables requiring the establishment of an independent waste collection, transportation and treatment system, there are also a large number of other low-value recyclables, like the low-value waste plastic packaging (delivery packages, commodity packaging, shopping bags), mixed waste paper, beverage paper-based composite packaging, and other composite packaging. The value of these individual pieces of packaging is even lower such that it is not worthy to conduct recovery and utilization of them piece by piece, so it is advisable to adopt a unified recovery and centralized sorting mode. The specific operating mechanism is shown in the figure below:

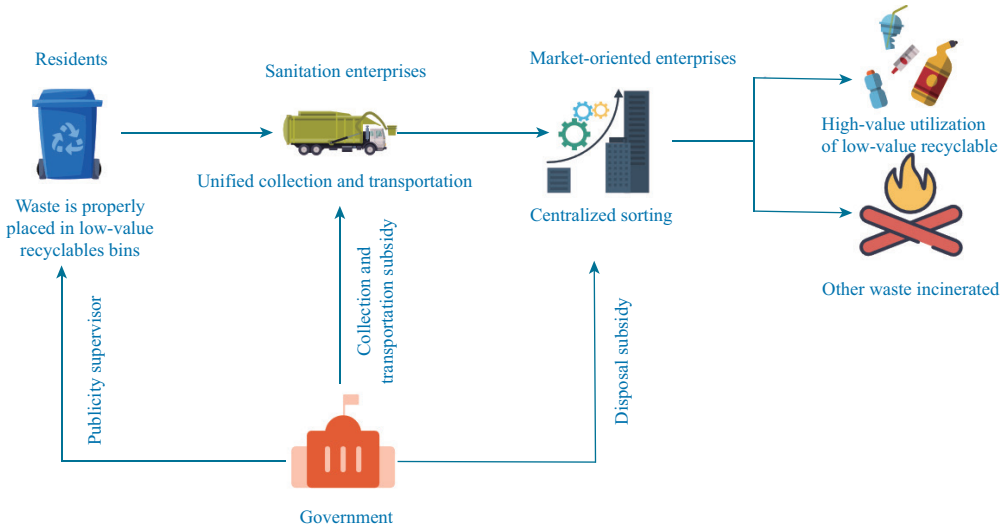

Figure 7-5 Centralized sorting mode diagram of low-value recyclables

In the construction of the recycling system: At the front end, the development of two integrated systems shall be promoted, and recyclables recycling buckets are put at the community waste placement spots so as to facilitate waste placement and centralized collection. We guide the residents to put the low-value recyclables in a classified manner, and arrange supervisors to supervise the work. In the middle link, we encourage the use of the transportation capacity of the environmental sanitation enterprises for rational planning, and adopt the staggered peak direct transportation mode to concentratedly collect the low-value recyclables and transport them to the corresponding sorting center. At the terminal, specialized enterprises use a combination of mechanical and manual methods to carry out centralized sorting of various low-value recyclables, and the classified low-value recyclables shall be delivered to specialized renewable resource processing and utilization enterprises for recycling while the non-reusable things shall be delivered to the waste incineration plant for unified disposal. In terms of operational mechanism design, local governments have incorporated classified low-value recyclables into domestic waste, issued the Guiding Catalogue on Low-value Recyclables, and set special-purpose recovery buckets to carry out the recycling of low-value recyclables. The construction of low-value recyclables recycling facilities

has been incorporated into relevant environmental infrastructure construction plans, centralized sorting centers for low-value recyclables have been built, and the mode of franchising has been adopted to entrust professional enterprises to carry out unified collection, transportation, sorting, processing and utilization. The funds originally used for subsidizing domestic waste incineration shall be paid to the enterprises engaged in the collection, transportation, sorting and processing of low-value recyclables to support the sound development of these enterprises.

(II) Definition of the responsibilities and obligations of the government, enterprises, residents and other relevant entities

1. The state should strengthen top-level design and institutional supply

Centering on the goal of increasing the comprehensive utilization rate of wastes, we should take the construction of the low-value recyclables recovery and utilization system as an important component of the waste recycling and utilization system construction. We should speed up efforts to build and improve a recycling system for low-value recyclables through a variety of policies and measures, including laws, regulations, planning, industry rules, taxation, finance and standard certification; and shore up the weak links in the waste recycling system construction.

(1) The construction of a recycling system of low-value recyclables should be included in the Circular Economy Promotion Law. After the revision of the Circular Economy Promotion Law, the low-value recyclables system construction has been incorporated into the law; the responsibilities and obligations of government departments, enterprises, residents, recycling operators, recycling enterprises and other market entities in the low-value recyclables system construction have been specified; the producer's extended responsibility system is implemented to push enterprises to carry out targeted recycling and deposit refunding and the punishment of illegal acts has been stepped up so as to provide legal support for the construction of the low-value recyclables recycling system.

(2) The low-value recyclables recycling system construction should be included into all strategic plans. We should enhance the strategic positioning of the recovery and

utilization of low-value recyclables, and incorporate the low-value recyclables recycling system construction as an important content of implementing the overall conservation strategy into the waste recycling and utilization system construction. We shall issue guidelines or implementation plans for the construction of a recycling system for low-value recyclables, strengthen investigation into and supervision over the recycling industry, set appropriate targets for the recycling of key low-value recyclables, push local governments to issue special programs and implementation plans, and encourage the implementation of pilot projects.

(3) A guiding catalog and guidelines for recycling low-value recyclables should be issued. For one thing, the competent government departments should issue guiding catalogs of low-value recyclables applicable to the whole country, to specify the scope and varieties of the low-value recyclables at the current stage. For another, guidelines for the recycling of low-value recyclables in China should be developed and issued, to guide the specific work carried out by various localities regarding the formulation of laws, regulations and policies, implementation of systems, construction of recycling systems, selection of separation technologies and processes, and modes of processing and utilization. The guidelines should be promptly updated according to the characteristics of low-value recyclables, recycling situation and industrial technology development.

(4) The policy support for the low-value recyclables recycling system construction should be strengthened. The competent government departments shall include the construction of the recycling system for low-value recyclables into the scope of special investment support covered by the central budget for pollution control and energy conservation and carbon reduction. We will guide relevant industries to set investment funds to support the construction of a recycling system for low-value recyclables, enable the enterprises that recycle low-value recyclables to enjoy preferential policies for value-added tax on products and services in the comprehensive utilization of resources, and increase the preferential treatment related to value-added tax collection and drawback. The recovery and utilization of low-value recyclables shall be included in the guiding catalog of green industries, and the development of green credit, green bonds and other green financial products shall be guided to increase support for relevant enterprises.

(5) Efforts should be accelerated to improve relevant standards and certification systems for recycled products. The competent departments of the government should formulate and improve the standards for low-value recyclables; issue technical specifications for the industries of recovery, sorting, processing and utilization of low-value recyclables; improve the labeling system for recyclables such as waste textiles, paper-based composite packaging for beverages, waste plastics and waste glass; and explore the establishment of standards and labeling systems on the contribution of low-value recyclables' recovery to carbon emission reduction, to guide market-based trading of relevant recycled products by involving the carbon offset mechanism.

(6) Carry out pilot demonstration of recycling system construction. The competent departments of the government can select representative cities from among those generating a lot of low-value recyclables, conducting effective garbage classification, and running a well-established renewable resources recovery system for pilot demonstration. We will establish a sound recycling system for low-value recyclables centering on selected key products; explore and improve the certification or franchise system for qualified enterprises; increase the support for the use of land, energy use and other factors; and put in place a smooth operating low-value recyclables recovery system with well-developed functions, so as to shed light on the related work of other areas.

(7) Encourage associations and non-governmental organizations to actively participate in and promote the endeavor. The competent departments of the government should encourage domestic and foreign NGOs to proactively associate themselves with the hot and tough issues at home and abroad such as plastic pollution control and recycling of waste textiles, and support cities in carrying out pilot work on the low-value recyclables system construction. We encourage industry associations to give full play to their professional and organizational strengths in contacting the government and enterprises, and give publicity about exemplary cases in the process of planning and operating the system for recycling low-value recyclables, with a view of creating a favorable situation in which the whole society extensively participates in the construction of the low-value recyclables recycling system.

(8) Continuously increase the promotion and use of recycled products. The competent departments of the government shall establish the promotion and use mechanism of the low-value recyclables, promote the green procurement of the government, and give priority to the procurement of the products produced by using the recycled low-value recyclables as raw materials. We encourage leading enterprises to actively perform their social responsibilities, give priority to the use of recycled raw materials in the production of relevant products, strengthen the green supply chain management, actively participate in and support the recycling of low-value recyclables, speed up the construction of a closed recycling system, and perform the obligations of using recycled materials and reducing carbon emission.

2. Local governments should work out specific plans to speed up the process

At the local level, efforts should be made to establish and improve an operational system that is conducive to the performance of relevant responsibilities by all entities, strengthen institutional guarantee for the construction of a recycling system for low-value recyclables, and explore innovation systems such as the franchise system. The areas with favorable conditions are encouraged to experiment first.

(1) Formulation of local catalogs of low-value recyclables and specific implementation programs. According to the national catalog of low-value recyclables and relevant principles, local governments should establish catalogs of selected low-value recyclables in light of regional economic development, waste treatment status and residents' waste classification habits; define and classify low-value recyclables; and provide the guidance manual for classified placement of low-value recyclables. The requirements for the recovery and utilization of low-value recyclables shall be stipulated, and the implementation rules for recycling low-value recyclables shall be formulated. In view of the regional waste recycling system construction, the specific implementation plan for effective connection between low-value recyclables with the domestic waste classification system and the processing and utilization system of renewable resources shall be formulated.

(2) Explore and implement a franchise system for the recycling of low-value recyclables. Since the recycling of low-value recyclables has poor economic viability

and is vulnerable to the impact of market fluctuation, local governments should implement a strict access management system since the very beginning in order to avoid that phenomenon that "bad money drives out good money" when the self-employed and small workshops rush to the recycling system. A franchise system for recovery and utilization of waste textile and waste glass should be implemented to encourage integrated recovery and utilization management. The recovery of other low-value recyclables should be integrated with the domestic waste recycling system; the construction and operation of sorting centers for low-value recyclables shall be franchised to promote the centralized and large-scale development of the industry.

(3) Strengthen the factor guarantee for the construction of a low-value recyclables recycling system. Local governments should incorporate the construction of low-value recyclables recycling facilities into the basic public service functions of the city, clarify the industrial positioning, continue to advance the integration of urban sanitation systems and renewable resources systems, increase the support for land use by the recycling of low-value recyclables, incorporate the low-value recyclables sorting center construction into the urban environmental infrastructure construction plan, and encourage the centralized layout and coordinated development of domestic waste disposal facilities. Considering the financial capacity of the region and the profitability of low-value recyclables recycling enterprises, we appropriately increase subsidies for the recycling of low-value recyclables according to the original subsidy standards for the collection, transportation and disposal of domestic garbage, and guide and encourage enterprises to actively carry out the recycling of low-value recyclables under the precondition of avoiding increasing the financial burden,.

(4) Establish and improve the supervision and management system for the recovery and utilization of low-value recyclables. In light of the actual regional development situation, local governments should register the operators of low-value recyclables and conduct dynamic management according to related regulations. We will encourage regions where conditions permit to develop information-based data management platforms for real-time monitoring of the classification, recovery, transportation and sorting of low-value recyclables, so as to facilitate the review, supervision and

administration of the recycled amount and the grant of subsidies. The classified placement of low-value recyclables will be put into the classification assessment system of domestic waste in various places, and the assessment will be stepped up. In order to create a good business environment for franchisees, we should strengthen the investigation and punishment of the illegal operators of low-value recyclables from the aspects related to environment, safety, fire control, industry and commerce.

(5) Strengthen publicity and guidance to enhance the recycling awareness of enterprises and residents. Local governments should strengthen publicity and education on the recycling of low-value recyclables. Centering on the seven types of low-value recyclables such as waste textiles, low-value plastic packaging, waste glass, paper-based composite packaging of beverages, waste mulching film, waste pesticide bottles and large pieces of garbage, we popularize the knowledge on garbage classification requirements, recycling value, utilization direction and typical patterns, to enhance the awareness and participation of urban and rural residents. Combined with the knowledge of waste classification, the requirements for classified recovery of low-value recyclables will be integrated into the publicity and education system on domestic waste classification to enhance the recycling awareness of the whole society.

3. Enterprises should strengthen innovation and improve the industrial system

(1) Strengthen innovation in technology and equipment. Enterprises should actively develop automatic equipment for recycling low-value recyclables, improve intelligent sorting technology, and increase the classification and separation efficiency of low-value recyclables, to reduce labor costs. At the same time, the research and development of technologies for the processing and utilization of low-value recyclables should be stepped up to turn low-value recyclables into products with high added value. In addition, the intelligent management system should be adopted to carry out refined management on the treatment of the low-value recyclables, so as to increase the recycling efficiency.

(2) Strengthen innovation of the operation mode. Enterprises should explore and implement the integrated development mode of resources. A multi-entity cooperation platform should be set up to encourage domestic waste classification and recycling

enterprises, low-value recyclables recycling enterprises, and renewable resources processing and utilization enterprises to give full play to their respective organizational and technological advantages and carry out joint operations, so as to increase the operating efficiency of the low-value recyclables recycling system. Domestic garbage classification and recycling enterprises can utilize the strengths of their networks to carry out classified collection and centralized transportation of low-value recyclables which undergo centralized sorting at the sorting center. Various low-value recyclables sorted out are provided to renewable resources processing and utilization enterprises to be made into high-value products, so as to realize efficient utilization of resources.

(3) Increase the use of recycled raw materials. In line with the current requirements for low-carbon development and circular development, enterprises that recycle low-value recyclables should actively strengthen cooperation with manufacturers of textiles, glass, plastics and other products, to help the manufacturers build a closed recycling system and promote green and low-carbon development. The manufacturers of plastics, glass, textiles and other products should, in light of the whole lifecycle management concept, strengthen the eco-friendly design of the products, increase the use of recycled raw materials, strengthen the green supply chain management, promote the coordinated utilization of multiple varieties of low-value recyclables, and build a complete industrial chain for the recycling of low-value recyclables. Thus, coordinated development of the upstream and downstream of the industrial chain can be realized.

4. Consumers actively participate in the recycling of low-value recyclables

(1) Actively participate in publicity and guidance among consumers. Consumers should use social media, Douyin, WeChat, Weibo and other me-media communication platforms to stress the importance of recycling low-value recyclables among the people around. They should share the experience of recycling low-value recyclables with their family members, friends and colleagues to promote the dissemination of environmental protection concepts and actions.

(2) Actively participate in the recycling of low-value recyclables. Consumers should take the initiative to assume the responsibility for classified recycling of low-value recyclables. We should do a good job in conducting classified recycling of low-

value recyclables according to related requirements, enhance our consciousness of classified recycling in daily life and office work, put such low-value recyclables as waste paper, milk cartons, plastic bags, glass bottles and used clothes into special recycling boxes, and actively participate in the recycling of low-value recyclables at communities or enterprises.

VIII. Prospects:

With the rapid economic and social development and the continuous improvement of people's consumption level in China, the production of low-value recyclables keeps increasing, but the construction of the recycling system for low-value recyclables is relatively backward. As a result, the recycling of low-value recyclables has become the worst part of waste recycling. Increasing the collection and recycling efficiency of low-value recyclables and helping to establish a standardized and orderly resource recycling system represents the major measures to shore up the drawbacks in domestic waste classification, promote the reduction of domestic waste at the source, and uplift the level of waste recycling.

The low-value recyclables have dual attributes of being related to resources and pollution. Under certain economic and social conditions, some of the current low-value recyclables have certain economic value, and certain economic benefits can be obtained by recycling them. However, with the rapid economic and social development, the comprehensive costs including the cost of human resources and the transportation cost will continue to rise. As a result there are changes in the price relations between some existing high-value recyclables and primary resources. The recycling of some low-value recyclables (such as waste glass, waste textiles, paper-based composite packaging for beverages, waste pesticide packaging, beer bottles, etc.) will gradually become unprofitable and ignored while it is possible that some of the existing high-value recyclables will gradually become low-value recyclables. Therefore, establishing and improving the collection and recycling system of low-value recyclables, giving full play to the guiding role of the "competent government" and addressing the lack of

spontaneous collection and recycling in the market is not only important for the current collection and recycling of low-value recyclables, but also of long-term strategic significance to the resource recycling system construction in China.

At present, the amount of recycled low-value recyclables in China has reached 25.47 million tons, which helps to reduce carbon dioxide emission by 72.15 million tonsV. If the recycling rate is increased from the current 26.6% to 50% by the year 2030, 47.9 million tons of low-value recyclables can be recycled every year, which will create more than 45 million tons of renewable resources such as recycled plastics and recycled paper, and reduce carbon dioxide emission by 127.47 million tonsW. In this way, China can not only achieve the goal of decoupling economic and social development from resource consumption and environmental pollution, but also effectively avoid the leakage of plastic environment, help China blaze a new path of sustainable development and thereby make positive contributions to the sustainable development of human society.

㉒ Data calculation methods: According to Shandong Association of Circular Economy, the recycling of one-ton waste glass reduces carbon emission by 1.26 tons, *[Dynamics of the Association] High-end forum on the waste glass recycling eco-industry held in Laiwu against the background of pursuing carbon peaking and carbon neutrality goals*. According to China Association of Circular Economy, the recycling of one-ton waste textiles reduces carbon emission by 3.6 tons, *Research report on the contribution of circular economy to carbon peaking*; and the recycling of one-ton waste plastics reduces carbon emission by 2.9 tons, *Research report on the contribution of circular economy to carbon peaking*.

㉓ The data calculation method is the same as above.

Key supporting units

Waste Textile Comprehensive Utilization Committee of China Association of Circular Economy

Beijing Sankuai Online Technology Co., Ltd. (Meituan)

Beijing Yingchuanggaoke New Technology Development Co., Ltd.

Yuyue Home Textile Co., Ltd.

Guangdong Huaxing Glass Co., Ltd.

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