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Market Research on Waste2Resources in China

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WASTE TO RESOURCES MARKET STUDY REPORT

Market Research on Waste2Resources in China

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MARKET RESEARCH REPORT ON WASTE2RESOURCES IN CHINA

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Content

1. INTRODUCTION

1.1 Background

Consulate General of the Kingdom of the Netherlands in Guangzhou (hereinafter referred to as “the Client”) has appointed Arcadis Shanghai Limited (hereinafter “ARCADIS”) to provide a Market Research on Waste Treatment in China (hereinafter referred to as the “Project"). Arcadis understands that the client’s intention is to engage the Consultant to provide the Market Research (hereinafter referred to as the “Service”) following the PRC laws, regulations and following Client’s policy.

1.2 Objectives

The project intends to identify and analyse the key waste treatment methods and technologies being utilized in China; Evaluate the current market landscape including major industry players, market trends, challenges, and opportunities. Investigate the regulatory frameworks related to waste and wastewater treatment in China, assessing their impact on industry operations and compliance requirements; Analyze the environmental impact and sustainability of different waste treatment practices and provide recommendations, based on opportunities and challenges, for potential market entrants and investors interested in the waste treatment sector in China.

1.3 Scope of Services

The scope of the W2R Market Study service, as outlined in the Terms of Reference (TOR) include:

- Conduct a detailed review of existing literature, reports, and data related to waste treatment in China.
- Identify and profile key stakeholders, including government agencies, companies, research institutions, and NGOs operating in the waste treatment domain. Distinguish between national, provincial and municipal level.
- Analyse the practice of waste treatment technologies such as recycling, incineration, composting, and landfill management in China compared to the practice in the Netherlands.
- Assess the market size, growth potential, and competitive landscape of the waste treatment industry in China, preferably distinguishing between provinces and (a selection of) main municipalities
- Review existing policies, regulations, and incentives governing waste management practices in China.
- Identify emerging trends and innovations in waste treatment within the Chinese market.

1.4 Workflow

The project kick-off meeting was on September 27, 2024, with the official launch on November 28, 2024. From December 15, 2024, to January 10, 2025, researchers from Arcadis focused on background research and market research, mainly on China's solid waste and wastewater disposal laws, regulations, and economic development status. From January 18 to 20, 2025, they analyzed China's solid waste and wastewater markets and compared domestic and international technologies. The preliminary draft of the market research was completed on January 20, 2025. After communication in weekly meetings with the client and the Dutch embassy, Arcadis researchers updated the report on February 12, 2025. From

February 15 to 20, 2025, they investigated the solid waste/wastewater treatment market in China, collecting data and interviewing stakeholders. Progress meetings were held on February 20 and 27, 2025, to present research results via reports and PPTs. Two result-sharing sessions were conducted on March 5 and 13, 2025.

1.5 Methodology

In the process of market research, we have adopted different research methods, mainly including background information collection and stakeholder interviews. It mainly includes the following parts

1.Government Policy Research and Market Research: Combine with relevant national, provincial, and municipal laws and regulations, the current policy management of waste by Chinese governments at all levels will be studied. Data was collected to investigate China's solid waste market environment, demand, supplier behaviour, and competitive landscape (data from the National Bureau of Statistics). Dutch companies' waste technology and standards were assessed to determine the scale and basis for enterprise classification in the waste industry. A comprehensive understanding of existing operating enterprises' production and pollutant discharge was gained through on-site investigations. Drawing on the Netherlands' advanced experience, a technical development path for Dutch companies' waste recycling, treatment, incineration, and recycling in China was identified.

2.Stakeholder Interview and Predictive Research: Key stakeholders in the waste treatment sector will be identified and interviewed. Based on the current waste market situation and expected growth target model, predictions and analyses of China's waste policy and marketization will be conducted. The report explores the future development trend of China's solid waste recycling industry and offer solutions for Dutch enterprises to enter the Chinese solid waste market. The research focuses on analyzing the market capacity of solid waste, industry entry barriers, capacity utilization of existing enterprises, PEST analysis, competitor analysis of Chinese solid waste enterprises, and market entry strategies for Dutch enterprises.

3.Comparative analysis of Dutch companies' technology: We also communicated and exchanged ideas with relevant government agencies, external research teams, and Chinese industry enterprises, and discussed and analyzed the preliminary market analysis and the technical situation, application scenarios, etc. of Dutch enterprises in the early stage. The main aspects involve policy recommendations, market forecasts, and development strategies for foreign-funded enterprises. Based on the technical characteristics of relevant enterprises in the Dutch companies and localization needs, we analyzed the current technology usage of enterprises in the Chinese industry and evaluate the differentiated advantages of Dutch enterprises' technology. And a comparative analysis was conducted on the government's subsidies for advanced foreign technologies. The technical feasibility, compliance path, and commercialization potential of Dutch Dutch companies entering the Chinese market were systematically evaluated, in order to develop more accurate localization strategies.

Table 1 List of stakeholders interviewed

No.	Name	Category	Content

1.	生态环境部对外合作与交流中心 Foreign Environmental Cooperation Center, Ministry of Ecology	Government	3iPET International Platform for Environmental Technology
2.	农业农村部对外经济合作中心(中国—欧洲联盟农业技术中心) Ministry of Agriculture and Rural Affairs FOREIGN ECONOMIC COOPERATION CENTER, MARA, P.R. CHINA CHINA-EU CENTER FOR AGRICULTURAL TECHNOLOGY	Government	Policy development and technical advancement of agricultural solid waste resource disposal technology
3.	中国膜工业协会 Membrane Industry Association of	Industrial Association	Membrane treatment industry development
4.	WRI 世界资源研究所 World Resource Institute	Research Agency	Agricultural solid waste and wastewater market research
5.	瑞典环境科学研究院 IVL Swedish Environmental Research Institute	Research Agency	The development and transfer of foreign advanced technology industries to China
6.	清华大学环境学院 Tsinghua University	University	Technology research and transformation of Chinese demonstration project
7.	北京高能时代环境技术股份有限公司 Beijing GeoEnviron Engineering & Technology, Inc(BGE)	Quoted company	Solid waste and water treatment system service provider
8.	中国化学工程集团有限公司 China National Chemical Engineering Group Corporation Ltd	Quoted company	Ecological environment technology market research
9.	北京排水集团 BELJING DRAINAGE GROUP CO.,LTD	Quoted company	Research on wastewater treatment market and membrane treatment technology
10.	博天环境集团 Poten Enviro Group	Quoted company	Industrial water treatment and membrane treatment technology
11.	中建政研 Zhong jianzhengyan Group	EOD mode consulting service agency	EOD model development feasibility investigation
12.	维尔利集团 Welle group	Quoted company	Solid waste and water disposal technology
13.	中国光大环境集团 EVERBRIGHT ENVIRONMENT	Quoted company	Market and technical feasibility of domestic waste incineration disposal
14.	广东省环境技术科学学会 Guangdong Society of Environmental Sciences	Non-profit academic social organization	Market study of waste management and wastewater management

15.	广州环保投资集团有限公司 GRANDTOP	State-owned enterprise	Market research on waste & wastewater treatment technology
16.	瀚蓝环境股份有限公司 Grandblue Environment Co., Ltd.	Quoted company	Market research on waste & wastewater treatment technology
17.	上海浦发环境服务有限公司 Shanghai Pudong Environmental Services Co., Ltd.	State-owned enterprise	Market research on waste & wastewater treatment technology
18.	南京环保产业协会 Nanjing Environmental Protection Industry Association	Industrial Association	Market research on waste & wastewater treatment technology

Please refer to the following text for details of the results of the market research.

2. OVERVIEW OF CHINA'S SOLID WASTE TREATMENT INDUSTRY

2.1 Current Status of the Industry

In recent years, China has introduced a series of intensive policy measures aimed at supporting and guiding the healthy development of the solid waste treatment industry, and promoting its gradual transition to a new stage of standardization and specialization. Under the guidance of industry norms, the scale of China's solid waste treatment and disposal industry has steadily expanded in recent years, technological levels have continued to improve, and the domestication level of solid waste treatment equipment has significantly increased. In particular, the core equipment for domestic waste incineration has reached the level of developed countries in the world, and domestic grate furnaces account for more than 80% of the domestic market share. At the same time, urban mining development technology and emerging industrial waste recycling and utilization technology have begun to take off.

Driven by policies, China's solid waste treatment industry has achieved certain development results. Some niche markets, such as waste-to-energy incineration of municipal solid waste, have gradually entered a mature stage. With a large amount of increment and stock, the solid waste treatment industry harbors a huge market space. The continuous strengthening of policies and the intensification of competition have driven the continuous growth of the industry's market size. Data shows that in 2023, the scale of China's solid waste treatment industry has increased from 895.94 billion yuan in 2017 to 1,057.147 billion yuan, with a compound annual growth rate of 2.39%. Among them, the market scale of industrial solid waste disposal accounts for a larger proportion, at 83.84%, while municipal waste treatment and agricultural waste treatment account for 9.9% and 6.27%, respectively.

2.2 Classification of solid waste

The Law of the People’s Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes (hereinafter referred to as the "Solid Waste Law") classifies solid waste into five categories based on the source of production and the harm to the environment: industrial solid waste, domestic waste, construction waste, agricultural solid waste, and hazardous waste. The classification methods and definitions are as follows.

Table 2 Solid waste classification

Solid waste Type	Definition
Industrial solid waste	Refers to solid waste generated during industrial production activities.
Domestic waste	Refers to solid waste generated in daily life or activities that provide services for daily life, as well as solid waste that is considered household waste according to laws and administrative regulations.
Construction waste	Refers to the waste generated by the construction units, new construction, renovation, expansion, demolition, pipe networks, etc., as well as the waste generated by residents'

	decoration, abandoned soil, materials and other solid waste generated during a house renovation.
Agricultural solid waste	Refers to the solid waste generated in agricultural production activities. It mainly comes from plant planting, animal breeding (residues produced during livestock and poultry breeding) and agricultural plastic film residues, etc.
Hazardous waste	Refers to solid wastes with hazardous characteristics that are listed on the national hazardous waste list or recognized as such by the national criteria and methods for identifying hazardous wastes.

2.3 The Solid Waste Treatment Industry Chain

The solid waste treatment industry chain covers all links from the generation, collection, transportation, treatment to the final disposal of solid waste. The upstream of the solid waste treatment industry chain mainly involves the manufacturing and supply of solid waste treatment equipment. The midstream can be divided into solid waste classification, solid waste transfer, and solid waste treatment. The downstream mainly involves the recycling and reuse of waste resources after solid waste treatment.

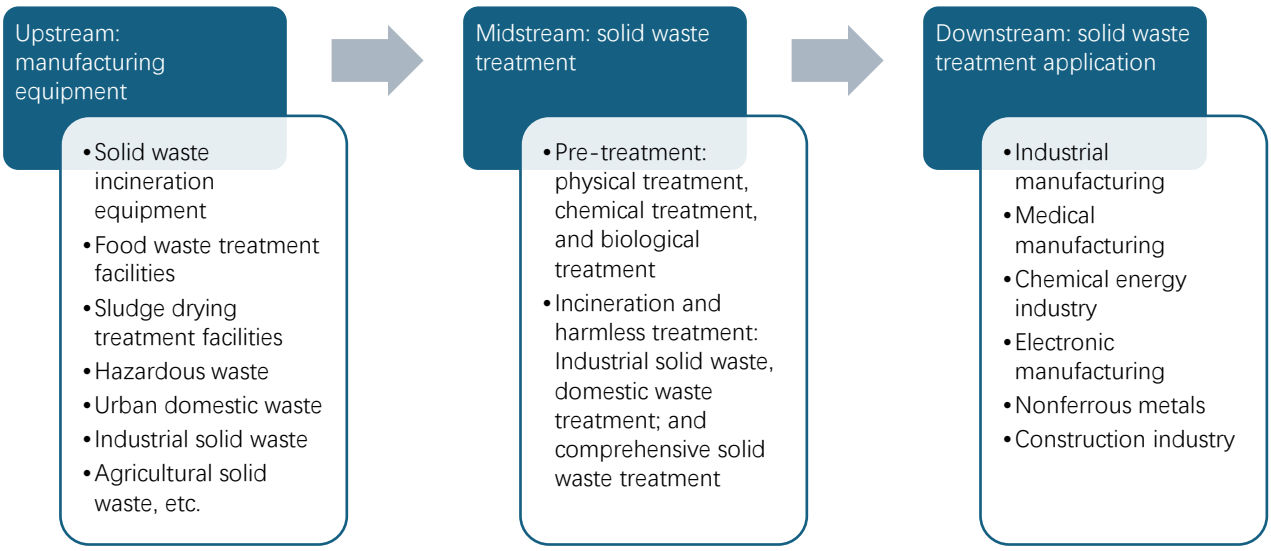


Figure 1 Solid waste treatment industry chain

2.4 Comparison of China's and the Netherlands' Solid Waste Management Practices

2.4.1 Laws, Regulations, and Policy Systems

- China: Centered on the Solid Waste Law, and complemented by policy tools such as the "Zero-Waste City" pilot program (covering 60% of cities by 2027) and the Guiding Opinions on the Comprehensive Utilization of Bulk Solid Waste during the 14th Five-Year Plan Period, a "pilot - promotion" model has been established. For example, Baotou City has promoted the management

of Baotou Steel slag through tax incentives, achieving a comprehensive utilization rate of industrial solid waste of 53.32% in 2023. However, there is regional imbalance in policy implementation; for instance, the agricultural film recycling rate in rural areas is only 80%.

- Netherlands: Based on the EU framework, it has established a "law - standard - economic instrument" triad system. The Environmental Protection Regulation explicitly prohibits landfilling of hazardous waste, levies a landfill tax (about 90 euros per ton), and sets quantitative goals through the "Circular Economy 2050 Blueprint" (halving raw material consumption by 2030). Its laws are highly rigid, such as the mandatory classification of construction waste, with violators facing heavy fines.

2.4.2 Waste Sorting and Recycling

- China: Launched nationwide waste sorting in 2019, with cities like Shanghai and Beijing establishing intelligent recycling networks. However, the overall recycling rate is around 30%. The resource utilization rate of construction waste is only 5%, far lower than the Netherlands' 96%. The technical bottleneck lies in the low sorting efficiency of mixed waste. For example, in a Shenzhen incineration plant, manual sorting still accounts for 40%.
- Netherlands: Implemented refined sorting since 1979, with residents' sorting accuracy exceeding 90%. Construction waste treatment adopts a "purification - separation - regeneration" process, achieving 99.8% reuse of inert materials through magnetic separators and X - ray separators. Its automated sorting systems, such as the CDW plant in Rotterdam, can process up to 200 tons per hour, with labor costs accounting for less than 10%.

2.4.3 Treatment Technologies and Facilities

Table 3 Comparison between China and Netherlands on treatment technologies practices

Field	China	Netherlands
Waste-to-Energy	Largest global scale (installed capacity reached 85GW in 2023), but power generation per ton of waste is only 300kWh, with dioxin emission concentration at approximately 0.1ng TEQ/m³.	Power generation per ton of waste reaches 450kWh, using SNCR (Selective Non-Catalytic Reduction) + activated carbon adsorption technology, with dioxin emissions ≤0.01ng TEQ/m³.
Biological Treatment	Composting plants have an average organic matter conversion rate of 60%, and anaerobic digestion projects achieve a methane recovery rate of 75%.	Composting plants exceed an organic matter conversion rate of 80%, and third-generation anaerobic reactors achieve a methane recovery rate of 90%.
Hazardous Waste	Incineration accounts for 60% of disposal, landfilling 30%, but the coverage rate of the	Incineration accounts for 90% of disposal, landfilling approaches zero, and the nationwide

Hazardous Waste Information System (HWIS) is less than 50%.	unified hazardous waste tracking system (RIO) enables full-process traceability.

2.4.4 Circular Economy and Market Mechanisms

- China: Characterized by policy - driven features, such as the "Corporate Income Tax Preferential Catalogue for Resource Comprehensive Utilization" which provides a 15% reduction in corporate income tax, and central budget - based investment support for tailings utilization projects. However, the market acceptance of recycled materials is low. For example, the price of recycled plastics is 10% - 15% higher than that of virgin materials, resulting in insufficient motivation for enterprises to reuse.
- Netherlands: Market mechanisms are dominant, with a "quality labeling + price balancing" strategy to enhance the competitiveness of recycled materials. For example, the construction industry is required to use 30% recycled aggregates, and the government provides a subsidy of 15 euros per cubic meter for recycled concrete, making its price 5% lower than that of virgin concrete. In 2023, the circular economy generated a value of 7.3 billion euros, accounting for 1.2% of GDP.

2.4.5 Supervision and Data Governance

- China: Relying on the "Internet + Supervision" platform, such as the solid waste management information system of the Ministry of Ecology and Environment, which has realized electronic waybills for cross - provincial transfers. However, the degree of data integration is insufficient. For example, data on industrial solid waste and urban waste have not yet been connected. The environmental protection inspection system promotes the rectification of problems, but the long - term mechanism still needs to be improved.
- Netherlands: Established a unified national waste data center (PDO) that monitors 52,000 waste - generating units in real - time, with data updates at a frequency of minutes. Its "digital twin" technology can simulate the flow of solid waste under different policies. For example, in 2024, the model predicted the impact of carbon tariffs on plastic recycling, optimizing policy design.

2.4.6 Rural and Agricultural Solid Waste

- China: Focuses on straw (comprehensive utilization rate of 87.6%), agricultural film (recycling rate of 80%), and livestock manure (comprehensive utilization rate of 76%), promoting the "straw - returning - to - field + biogas project" model. However, the recycling rate of pesticide packaging waste is only 50%, and there is a phenomenon of random disposal in remote areas.
- Netherlands: Agricultural solid waste accounts for less than 5%. Through the "manure quota system" (limiting the application of 170kg of nitrogen per hectare of farmland) and precision fertilization technology, livestock manure is transformed into high - value - added organic fertilizer. Its "Agriculture 4.0" project uses the Internet of Things to monitor soil nutrients, reducing the use of chemical fertilizers by 20%.

2.4.7 International Cooperation and Technology Export

- China: Participates in the revision of the Basel Convention and promotes solid waste management cooperation along the "Belt and Road," such as exporting waste incineration technology to Southeast Asian countries. However, its technological standards have not yet formed international influence. For example, although the emission standards for incinerators are stricter than those of the EU, they are not widely recognized internationally.
- Netherlands: Leads the EU's circular economy legislation and exports technology to countries like China and Indonesia through the "Dutch Waste Management Alliance." In 2024, it cooperated with Guangzhou to build a smart sorting center for construction waste. The microbial degradation technology developed by Wageningen University has been applied in 12 countries.

3. WASTE 2 RESOURCE MARKET ANALYSIS

3.1 Policy, Regulations and Incentives

3.1.1 Legal System and Institutional Framework

3.1.1.1 Supervision System and Departmental Division of Labor

Under China's Solid Waste Law, local people's governments at all levels are primarily responsible for managing solid waste pollution in their areas. The central government implements a target responsibility system and evaluation system to ensure these targets are met. The State Council's competent ecological and environmental authorities oversee the national solid waste pollution control, while other central departments (such as development reform, industry and information technology, natural resources, housing and urban-rural construction, transportation, agriculture and rural areas, commerce, health, and customs) manage solid waste pollution within their respective areas of responsibility. Local ecological environment departments also implement unified supervision in their regions, with other local departments handling specific responsibilities related to solid waste management. The statistics of the relevant sectors involved in solid waste management are shown in Appendix 1 Table 1.

3.1.1.2 Laws related to solid waste

At present, China's laws and regulations on solid waste management are mainly: national laws, administrative regulations, departmental regulations, local regulations and environmental technical standards. The hierarchy of laws and regulations in China is categorized from highest to lowest: Constitution>laws>administrative regulations>local regulations. Laws are enacted by the National People's Congress and its Standing Committee, and administrative regulations are enacted by the State Council. In addition, the Constitution is the fundamental law, and no law or regulation may contradict it.

- National laws

In China, the National People's Congress, and its standing body, the Standing Committee of the National People's Congress, formulated specialized laws on solid waste management or specialized provisions or contents of other laws enacted that deal with solid waste management. The relevant laws on solid waste management in China are shown in Appendix 1 Table 2.

- International solid waste management conventions

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, adopted in 1989 and commonly referred to as the Basel Convention, is the only global international legal instrument aimed at controlling the transboundary movements and disposal of hazardous wastes and other wastes. Its core principles include:

- Minimizing the generation and hazardousness of hazardous wastes (reduction at source);
- Ensuring the environmentally sound management of wastes, including their disposal, as close as possible to the place of generation (proximity principle);
- Reducing the transboundary movements of hazardous wastes to a minimum.

In accordance with the Convention, the Chinese Government regulates the import management of hazardous wastes in China and prevents the pollution of the environment by imported hazardous wastes.

- Administrative regulations

The normative documents formulated and promulgated by the State Council, the highest administrative organ of the country, in organizing and managing the affairs of the country are called administrative regulations. They include special regulations on solid waste management or relevant provisions in other regulations formulated by them. At present, there are no specialized administrative regulations on solid waste management, but there are some fragmented provisions on solid waste management in other regulations, some of the important ones and some of their contents are listed in Appendix 1 Table 3.

- Sectoral administrative regulations

Normative documents formulated by administrative authorities under the State Council in accordance with laws and administrative regulations are called administrative regulations. They include administrative normative documents relating to solid waste management. Some of the more important departmental regulations on solid waste management are shown in Appendix 1 Table 4.

- Local regulations or administrative rules of local governments

Local regulations or administrative rules of local governments are normative documents formulated by local governments, local people's congresses and standing committees of the people's congresses per national regulations. Local regulations are applicable only in the region and cannot contradict national laws, administrative regulations and departmental rules. Important local regulations on solid waste management have been enacted in Appendix 1 from Table 5 to Table 10.

- Environmental standards

Environmental standards are technical specifications for environmental protection laws and regulations that are developed to implement various specialized environmental protection laws and regulations. Environmental technical standards for solid waste management have been enacted in Appendix 1 from Table 11 to Table 15.

3.1.2 Incentive policies

3.1.2.1 Zero-Waste Cities building system

- The Development Process of Zero - Waste Cities

"Zero-Waste Cities" is an advanced urban management concept. "Zero-Waste" does not mean that no solid waste is generated, nor does it mean that solid waste can be fully utilized in a resourceful manner; rather, it refers to an urban development model that is led by the new development concept and minimizes the environmental impacts of solid waste by promoting the formation of a green mode of development and way of life. Rather, it refers to an urban development model that takes the new development concept as its lead, promotes the formation of a green mode of development and way of life, continues to promote the reduction

of solid waste at source and the utilization of resources, reduces the amount of landfill to the maximum extent possible and reduces the environmental impact of solid waste to a minimum.

Scope: Not limited to the boundaries of the built-up area, but includes the entire territory under the administrative jurisdiction of the city.

Table 4 Policies of “Zero-Waste Cities”

Time	Event Description
June 2018	The CPC Central Committee and State Council issued a document proposing "Zero-Waste Cities" pilots and promoting solid waste resource utilization.
December 2018	The Central Committee for Deepening Reform approved the "Zero-Waste Cities Pilot Work Program" (Guo Ban Fa [2018] No. 128), advancing pilot construction.
April 2019	The Ministry of Ecology and Environment announced 11 pilot cities (e.g., Shenzhen, Baotou) and 5 special regions (e.g., Xiongan New Area) for "Zero-Waste Cities" trials.
May 2019	The Ministry established an expert committee for pilot construction and released guidelines for implementation plans and evaluation indicators.
2019	The Government Work Report emphasized "strengthening classification and disposal of solid waste and municipal garbage to promote reduction, resource utilization, and harmless treatment."
2021	The Ministry of Ecology and Environment and 18 other agencies issued the "14th Five-Year Zero-Waste Cities Construction Plan," aiming to involve around 100 prefecture-level cities.

Since the pilot "Zero-waste city" initiative was launched, China has made significant progress in integrated solid waste management. The initiative has promoted sustainable urban development by organically integrating urban management with solid waste management, thereby enhancing comprehensive urban governance. In the industrial sector, green production practices have driven the reduction and resource utilization of key industrial solid wastes at the source, as well as their final disposal, supporting the green transformation and high-quality development of the economic structure. In agriculture, efforts have focused on reducing the generation of waste at the source and fully utilizing major agricultural wastes such as livestock manure and crop straw, advancing the construction of a modern agricultural system. In the domestic sphere, the initiative has encouraged a shift towards green lifestyles, managing the entire process of source reduction, resource utilization, and final disposal of household and other domestic solid wastes. Additionally, the initiative has strengthened the prevention and control of environmental risks posed by hazardous wastes at the source, improved supervision during and after events, and enhanced the capacity for the collection, utilization, and disposal of hazardous wastes, while also refining relevant policies, standards, and regulations, thus effectively controlling environmental risks and solidifying the foundation for environmental security.

"During the 14th Five-Year Plan period(2020~2025), the general idea of expanding and deepening the construction of "Zero-Waste Cities" is to implement Xi Jinping's thought on ecological civilization in depth, base on the new stage of development, implement the new development concept, build a new development pattern, promote high-quality development, and integrate urban development and solid waste management. The overall idea is to implement Xi Jinping's idea of ecological civilization, base itself on the new stage of development, implement the new development concept, build a new development pattern, promote high-quality development, integrate urban development and solid waste management, adhere to the principle of "trivialization", focus on pollution reduction, carbon reduction and synergistic efficiency enhancement, and push forward the construction of "Zero-Waste Cities" in 100 or so prefectural-level cities or above.

The complete list of “Zero-Waste Cities” can be found in “Notice on the Announcement of the List of Zero-Waste Cities Construction during the 14th Five-Year Plan Period” （关于发布“十四五”时期“无废城市”建设名单的通知）, on the public website of Ministry of Ecology and Environment.

The goal of the construction of the "Zero-Waste Cities" is that by 2025, the solid waste generation intensity of the "Zero-Waste Cities" will be reduced at a relatively fast pace, the comprehensive utilization level will be significantly improved, the harmless disposal capacity will be effectively guaranteed, the synergistic effect of pollution reduction and carbon reduction will be brought into full play, and the concept of "Zero-Waste" will be widely accepted and the governance system and governance capacity will be significantly improved. Solid waste management information "a network", and "no waste" concept is widely recognized, and solid waste governance systems and governance capacities have been significantly improved. A typical case of "Zero-Waste Cities" is described as listed below.

Pilot construction of a Zero-Waste Cities in the Beijing Economic and Technological Development Area (BEDA)

Objective: To build four major systems - institutional, technological, market - based, and project - engineering - to achieve the reduction, resource utilization, and harmless treatment of solid waste, promote green urban development and enhance comprehensive governance capabilities, and form a replicable model for the construction of "waste - free cities."

Core Measures:

- Institutional System Construction: Establish a government - led "waste - free city" working mechanism, clarifying the collaborative management responsibilities of various departments. Set up a 500 - million - yuan - per - year special fund for technological innovation, focusing on supporting solid waste reduction, resource utilization technologies, and innovative enterprises. Pilot the unified management of solid waste in commercial parks (such as the "Yicheng Wealth Center" implementing the "1 + 4" treatment standards), standardizing the classification, collection, and disposal processes of solid waste in parks. Introduce the "Action Plan for Domestic Waste Classification" and the "Regulations on the Management of Construction Waste Disposal," mandating the classification management of domestic and construction waste.
- Institutional System Construction: Establish a government - led "waste - free city" working mechanism, clarifying the collaborative management responsibilities of various departments. Set up a 500 - million - yuan - per - year special fund for technological innovation, focusing on supporting solid waste reduction, resource utilization technologies, and innovative enterprises. Pilot the unified management of solid waste in commercial parks (such as the "Yicheng Wealth Center" implementing the "1 + 4" treatment

standards), standardizing the classification, collection, and disposal processes of solid waste in parks. Introduce the "Action Plan for Domestic Waste Classification" and the "Regulations on the Management of Construction Waste Disposal," mandating the classification management of domestic and construction waste.

- Market System Development: Introduce three internationally advanced solid waste disposal companies to enhance the professional treatment capacity of industrial solid waste. Establish an environmental protection investment fund to support the development of energy - saving and environmental - protection industries through green finance. Mandate that hazardous waste disposal units purchase environmental liability insurance to improve the market mechanism for environmental risk prevention and control. Guide two local companies to transform into the solid waste treatment field, cultivating local market entities.
- Project Engineering Implementation: Develop a Smart Waste - Free Information Management Platform (including a mobile app) to achieve digital - based supervision of the entire process of solid waste generation, transfer, and disposal by enterprises. Improve the resource system, realizing domestic waste classification collection in two sub - districts, and unblocking the transfer channels within and outside the district. Create a "Waste - Free City Cell" project: build 78 grassroots demonstration units (including green enterprises, communities, families, schools, etc.), promoting public participation.

Outcome of implementation

- Institutional and Management Effectiveness: The pilot park (e.g., "Yicheng Wealth Center") has achieved a 50% reduction in solid waste, with a significant increase in the economic benefits of recyclables. Across the district, 360 companies have registered on the smart management platform, 224 have completed information filing, and 95 companies have processed 1,683 solid waste transfer manifests through the platform, greatly improving regulatory efficiency.
- Technology and Industrial Upgrading: The popularization rate of green production technologies in the industrial field has increased, with national-level green factories/supply chain companies becoming industry benchmarks.
- Biomedical Park's Hazardous Waste Collection and Transportation Pilot: The pilot project in the biomedical park has realized centralized and standardized management of hazardous waste, reducing the environmental risks of laboratory hazardous waste.
- Market and Economic Impact: The combination of introducing international advanced enterprises and the transformation of local enterprises has initially formed a solid waste treatment industry cluster characterized by "technological leadership + local service." Environmental protection investment funds and green financial policies have activated market vitality, attracting social capital to participate in the construction of a "waste-free city."
- Social and Environmental Impact: The recycling system for renewable resources has covered residential areas, with the rate of garbage classification collection gradually increasing. The demonstration effect of grassroots "waste-free cells" has begun to show (e.g., 14 green communities and 16 "waste-free" individuals). The comprehensive solid waste management capability of the whole district has been significantly enhanced, providing a replicable experience template for the subsequent construction of a "waste-free city."

Pilot Construction of Zero-Waste Cities in Guangzhou

Pilot work on the construction of "Zero-Waste Cities" is being carried out throughout Guangzhou. Districts can create demonstration projects with regional characteristics in accordance with industrial characteristics in the course of promoting the fine management of industrial solid waste, the reduction of domestic waste at source and its resource utilization, the resource utilization of construction waste, the recycling of agricultural solid waste, and the prevention and control of environmental risks from hazardous waste. The objectives of the pilot is broken down into two phases.

Pilot construction phase: By the end of 2023, the comprehensive management and regulatory system for the construction of "zero waste cities" will be basically improved, the green manufacturing system will be initially established, a number of green production projects will be completed, the intensity of general industrial solid waste generation will be zero growth, and the comprehensive utilization rate of general industrial solid waste will reach 90%, the intensity of industrial hazardous waste generation has decreased by 5% compared with 2020, the comprehensive utilization rate of hazardous waste has increased to 50%, and hazardous waste has basically realized comprehensive standardized control; the classification of domestic garbage has been steadily promoted, the recycling utilization rate has reached 42%, and "zero landfill" of primary garbage has been realized; the proportion of green buildings in new civil buildings has reached 90%, and the proportion of assembled buildings in new buildings has reached 35%, and the proportion of construction waste in new buildings has increased to 35%. The proportion of green buildings in new civil buildings reached 35%, and the utilization rate of construction waste resources reached 25%; the comprehensive utilization rate of straw reached 93%, the recycling rate of the agricultural film reached 90%, and the comprehensive utilization rate of livestock and poultry waste reached 80%; the publicity work for the construction of a "Zero-Waste Cities" was carried out comprehensively to create a strong atmosphere of the creation of a "Zero-Waste Cities". The publicity work for the construction of "Zero-Waste Cities" is carried out comprehensively, creating a strong atmosphere of "Zero-Waste Cities".

The stage of in-depth promotion: By 2025, the relevant institutional system of "Zero-Waste Cities" will be more perfect, the construction of the market system and technical system will have achieved some success, and the long-term mechanism for the construction of "Zero-Waste Cities" will help build a modern environmental governance system. The green manufacturing system has been further improved, the intensity of general industrial solid waste generation has been reduced, the comprehensive utilization rate of general industrial solid waste has reached 92%, and the intensity of industrial hazardous waste generation has been further reduced; the work of domestic waste classification has been further promoted, and the recycling rate of domestic waste has reached 42.8%; the proportion of green buildings in new civil buildings has reached 100%, and the proportion of assembled buildings in new buildings has reached 50%, and the utilization rate of construction waste resources has reached 50%, and the utilization rate of construction waste resources has been reduced to 50%. The proportion of green buildings in new civil buildings has reached 100%, the proportion of assembled buildings in new buildings has reached 50%, and the utilization rate of construction waste resources has reached 28%; the recycling rate of the agricultural film has reached 95%, and the comprehensive utilization rate of livestock and poultry waste has reached more than 80%; the cultivation of a "no-waste culture" has achieved remarkable results, and a good

atmosphere has been formed for the whole society to participate in the construction of a "no-waste city". A favourable atmosphere was formed for the whole society to participate in the construction of the "Zero-Waste Cities".

Pilot Construction of Zero-Waste Cities in Foshan

The construction of "Zero-Waste Cities" has been comprehensively promoted by focusing on the four major areas of industrial solid waste, domestic solid waste, agricultural solid waste and hazardous waste, as well as the four major systems of system, technology, market and supervision. Exploring the creation of "Zero-Waste Cities" with regional characteristics, forming a pattern of staggered "urban areas" and integrating into the construction of the provincial "Zero-Waste pilot zone" synergy mechanism.

By 2023, the city's industrial solid waste reduction and resource utilization level will be comprehensively improved, the intensity of industrial solid waste generation will tend to be zero growth, the comprehensive utilization rate of general industrial solid waste will reach 90%, the comprehensive utilization rate of hazardous waste will reach 60%, and hazardous waste will realize comprehensive safety control; the coverage rate of domestic garbage classification will reach 100%, and the use rate of express green packaging will reach more than 60%; the coverage rate of pesticide packaging waste and agricultural film recycling system will reach 100%; the main agricultural waste will realize effective use. The coverage rate of pesticide packaging waste and agricultural film recycling system has reached 100%, and the main agricultural waste has been effectively utilized. The construction of the city's environmental protection industrial park has continued to advance, and the solid waste multi-dimensional common governance system has taken initial shape; the basic realization of the "one network" of solid waste management information has been achieved.

By the end of 2025, the intensity of industrial solid waste generation in the city will have steadily decreased, the level and proportion of comprehensive utilization will have been substantially increased, the gap in regional disposal facilities will have been filled, and the synergistic effect of pollution reduction and carbon reduction will have been obvious; the level of solid waste information management will have been significantly improved, and the whole process of solid waste will have been realized as "inquiring, traceable and supervisable". The concept of "no waste" has been widely recognized, and the solid waste management system and capacity have been significantly upgraded.

3.1.2.2 Emission permit management system

Emission licensing is an important part of the national environmental governance system and is the core system of the regulatory system for fixed pollution sources.

The goal of the discharge permit management system is that by 2025, China will have fully completed the management of industrial noise and industrial solid waste discharge permits, and basically completed the management of marine engineering discharge permits; formulated and revised a batch of technical specifications for discharge permits, such as pollutant emission accounting methods; and completed the integration of ecological and environmental statistics and discharge permits for the thermal power, iron and steel, and cement industries nationwide.

By 2027, the system of discharge permits for fixed pollution sources will be more complete, all major pollutant emissions will be permitted and controlled, the regulatory system for fixed pollution sources will be implemented with the discharge permit system as the core, the "one-card" management of discharge permits will be fully implemented, and the management of all elements of the discharge permits for fixed pollution sources, the full linkage, and the full-cycle management of the discharge permits for fixed pollution sources will be realized.

At this stage: all solid waste/hazardous waste disposal organizations are required to meet the management requirements of the Ministry of Ecology and Environment's sewage discharge permit, which is implemented concerning the relevant requirements of the Technical Specification for the Application and Issuance of Sewage Discharge Permit for the Management of Industrial Solid Waste and Hazardous Waste (HJ1033-2019). Among them, the waste mineral oil processing industry applies to the "Technical Specification for the Application and Issuance of Emission Permits for Waste Resource Processing Industry (HJ 1034-2019)".

The standard specifies the industrial solid waste and hazardous waste management sewage disposal unit sewage license application and issuance of the basic situation of filling in the requirements of the permit to determine the emission limits, the actual emission accounting, the method of compliance determination, as well as self-monitoring, environmental management accounts and sewage discharge permit implementation report and other environmental management requirements, put forward the industrial solid waste and hazardous waste management pollution prevention and control of feasible technical requirements.

According to the Emission Permit Management System (EPMS), information on the number of enterprises disposing of the relevant solid and hazardous wastes[1] is shown in the following figure.

[1] Except for hazardous waste management, the number of enterprises in Beijing was not queried

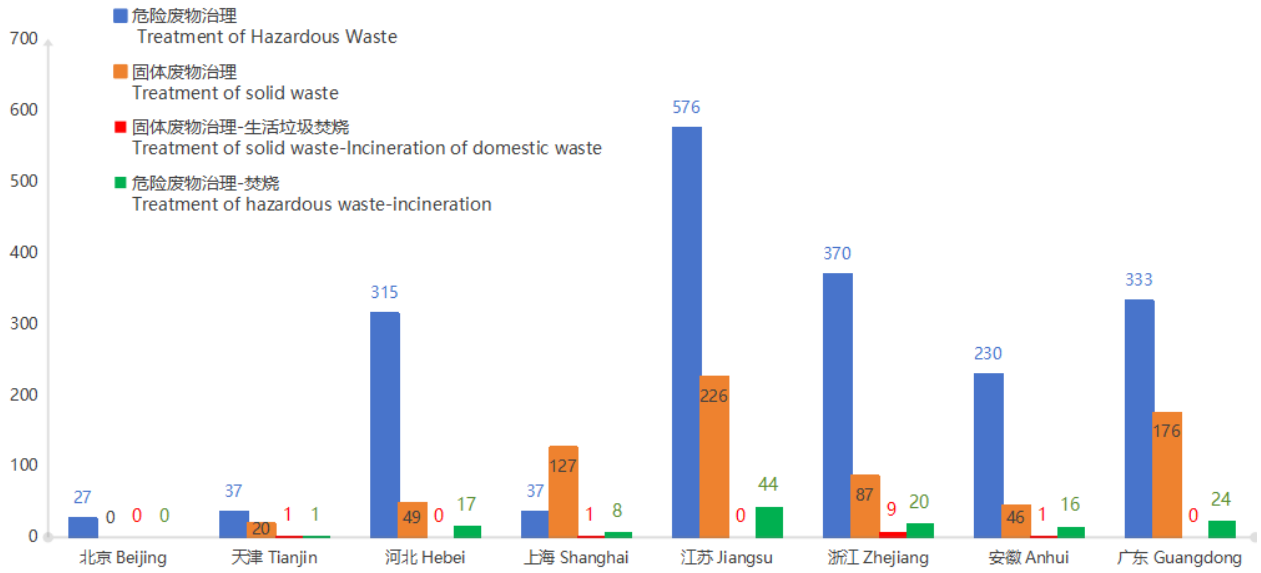


Figure 2 Number of enterprises disposing of the relevant solid and hazardous wastes

Based on the statistical analysis of the above enterprise data, the largest number of hazardous waste management enterprises is in Jiangsu, followed by Guangdong and Hebei regions; the distribution of solid waste management enterprises ranked in the top three are Jiangsu, Guangdong and Shanghai.

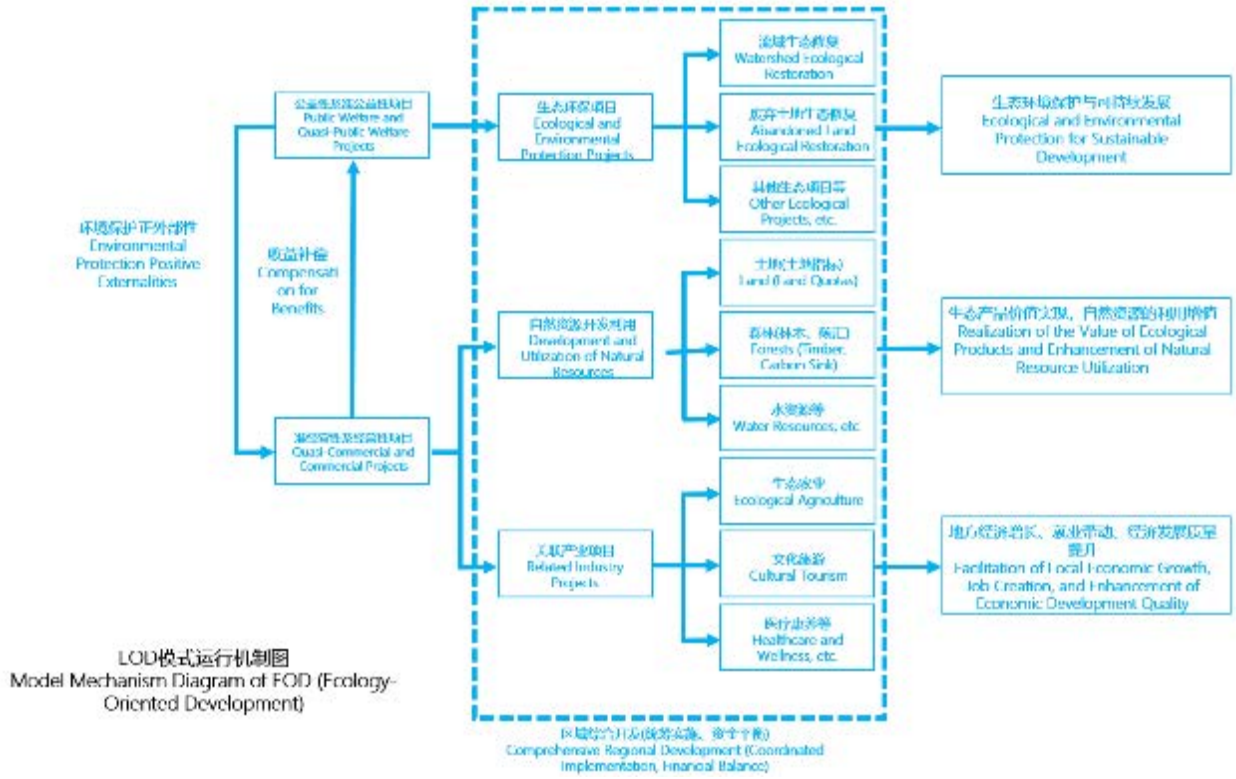
The largest number of solid waste management-domestic waste incineration enterprises is in Zhejiang Province with 9 enterprises, and the largest number of hazardous waste management-incineration enterprises is in Jiangsu with 44 enterprises, followed by Guangdong and Hebei. Jiangsu is also distributed with 20 hazardous waste incineration enterprises.

Beijing's part of the solid waste/hazardous waste enterprise data is not published for the time being, according to the Beijing Ecological Environment Bureau data information, in 2023, Beijing's implementation of the Hazardous waste transfer form system of industrial enterprises number is 2,115, hazardous waste disposal and utilization of 57,500 tons volume (disposal of 29,900 tons, the use of 28,500 tons), the volume of inter-provincial disposal and utilization of 91,600 tons (disposal of 57,500 tons, the use of 34,100 tons), self-disposal and utilization of 10,800 tons (0.97 million tons of disposal, the use of 0.11 million tons). 34,100 tons).

3.1.2.3 EOD model system EOD

On September 16, 2020, the Ministry of Ecology and Environment and three other units issued the Notice on Recommending Pilot Projects of Ecology-Oriented Development Mode (Huanban Caixin [2020] No. 489), pointing out that (Ecology-Oriented Development, or EOD mode for short) is to be guided by the idea of ecological civilization, aiming at sustainable development, based on ecological protection and environmental governance as the basis, supported by the operation of characteristic industries, and taking regional comprehensive development as the carrier, it adopts such methods as industry chain extension, joint operation, and combined development, to promote the effective integration of ecological environmental

governance projects with strong public welfare and poor profitability and related industries with good profitability, to promote in a coordinated manner, and implement in an integrated manner, so as to internalize the economic value brought by ecological environmental governance, and it is a kind of innovative project organization and implementation. It is an innovative way of project organization and implementation.



LOD模式运行机制图
Model Mechanism Diagram of EOD (Ecology-Oriented Development)

Figure 3 Model Mechanism Diagram of EOD

On August 31, 2018, the Ministry of Ecology and Environment issued the "Guiding Opinions on Further Deepening the Reform of "Putting in Place, Managing and Serving" in the Field of Ecology and Environment and Promoting High-Quality Economic Development", proposing to explore and carry out ecology and environment-oriented urban development (EOD) models, promote the integration of ecological and environmental governance with eco-tourism, town and city development, and other industries, and to create benchmarking and demonstration projects in different fields.

In April 2021, the Ministry of Ecology and Environment (MEE) issued the Circular on Agreeing to Carry Out Pilot Projects of Ecology and Environment Oriented Development (EOD) Mode, agreeing to 36 projects to carry out the first batch of pilot projects of EOD between 2021 and 2023, marking that the EOD mode has been formally pushed to the implementation level.

In March 2022, with the introduction of the "Guidelines for Entry into the Reserve Bank of Ecological and Environmental Protection Financial Support Projects (for Trial Implementation)", EOD was changed from a

pilot to an entry, which means that projects using the EOD model have gradually matured into a stage of steady progress and standardized management.

To date, two batches of national pilot projects have been banked, and the declaration of EOD bank has been developed towards normalization. At present, Shandong, Anhui, Jiangsu, Guangxi and other provinces have introduced relevant policies, the establishment of EOD local project library and achieved corresponding results.

According to the information on the 70 pilot projects' materials that have been made public, the total investment amount is 442.017 billion RMB. By the end of 2022, CDB has issued loans of 22.5 billion RMB to 25 pilot projects.

According to the Ministry of Ecology and Environment's "Guidelines for Entry into the Reserve Bank of Ecological and Environmental Protection Financial Support Projects (for Trial Implementation)," entries should fall into the following areas:

(i) Air pollution control

These include clean heating in winter in the northern region, comprehensive treatment of volatile organic compounds, deep treatment of industrial enterprises, clean energy substitution of coal-fired facilities in industrial enterprises, ultra-low emission renovation of key industries, cleaner production renovation of key industries, comprehensive treatment of boilers, comprehensive remediation of air-related industrial parks and clusters, elimination of high-emission motor vehicles and replacement of new ones, treatment of emissions from ships and off-road mobile sources, treatment of malodors of typical industries, and capacity building for responding to heavily polluted weather. Capacity Building for Response to Heavily Polluted Weather, etc.

(ii) Protection of water ecosystems

Including black-smell water body management, sewage treatment facilities and supporting pipeline network construction and renovation, sewage treatment plant sludge treatment and disposal, sewage regeneration and resource utilization, industrial and mining enterprises and medical institutions, water pollution control, water pollution control in industrial parks, water pollution control of ships and ports, endogenous pollution control of water bodies, watershed ecological protection and restoration of river basins, comprehensive management of the basin of the water environment, the ecological flow of rivers and lakes to ensure that the focus of the lakes and reservoirs of eutrophication River and lake ecological flow control, river and lake ecological buffer zone restoration, natural (artificial) wetland ecosystem protection and construction, water conservation area protection, protection of drinking water sources, river outfall remediation and standardized construction.

(iii) Integrated management of priority sea areas

Focusing on the Bohai Sea, the mouth of the Yangtze River-Hangzhou Bay, and the waters adjacent to the mouth of the Pearl River, the program includes environmental remediation of mariculture, remediation of sea outfalls and sources of direct discharge of pollution into the sea, prevention and control of pollution

from ships and harbours, remediation of pro-coastal beaches, protection and restoration of marine ecosystems, and demonstration of the construction of beautiful gulfs.

(iv) Soil pollution prevention and control

These include soil pollution risk control of construction land, soil pollution remediation of construction land, remediation of industrial and mining pollution sources on agricultural land, heavy metal treatment of industrial and mining enterprises, regional treatment of historical legacy heavy metal pollution, risk control of groundwater pollution in chemical production enterprises and industrial clustering zones, comprehensive treatment of groundwater pollution in mining areas and tailing ponds, prevention and control of groundwater pollution in hazardous waste disposal sites and landfill sites, groundwater-dependent ecosystem protection, protection of groundwater-type drinking water sources, seepage prevention and renovation of key pollution sources, and sealing and backfilling of abandoned wells.

(v) Agricultural and Rural Pollution Control

Including rural sewage treatment and resource utilization, rural garbage management, rural black-smell water body remediation, waste agricultural film recycling, comprehensive utilization of straw, livestock and aquaculture pollution management and manure resource utilization, plantation surface pollution management, comprehensive rural ecological environment remediation and so on.

(vi) Solid waste treatment and disposal and comprehensive utilization of resources

Focusing on the "Zero-Waste Cities" construction project, including urban and rural living garbage collection and treatment and disposal, food waste collection and resource utilization, hazardous waste and medical waste collection and treatment and disposal, comprehensive utilization of mineral resources (including tailings), recycling of waste resources, resource utilization of agricultural solid waste, environmental risk management and control of industrial solid waste, harmless treatment and disposal and comprehensive utilization of industrial solid waste, resource utilization of construction waste and road asphalt, packaging waste recycling and treatment, etc. Management and control, harmless treatment and disposal of industrial solid waste and comprehensive utilization, resource utilization of construction waste and road asphalt, packaging waste recycling and treatment.

(vii) Ecological protection and restoration

Protection and restoration of important ecosystems, integrated protection and restoration of mountains, water, forests, fields, lakes, grasses, sand and ice, ecological protection and restoration of mining areas, comprehensive management of coal mining subsidence zones, protection of biodiversity and comprehensive management of desertification, desertification and soil erosion.

(viii) Other environmental governance

Ecological and environmental risk prevention and control, radioactive pollution prevention and control, noise and vibration pollution control, ecological and environmental monitoring and information capacity building.

EOD Project Entry Requirements

According to the Ministry of Ecology and Environment's EOD Program Entry Guidelines, the conditions for EOD program entry, mainly include:

Table 5 Requirements for entrance to EOD program

Category	Requirements
1. Total Investment	- For prefectural/municipal government-led projects: Total investment ≤ RMB 5 billion - For district/county government-led projects: Total investment ≤ RMB 3 billion
2. Number of Projects	- Clear project boundaries - Close integration between ecological/environmental management and industrial development; no bundling of unrelated projects - Maximum 5 individual subprojects in a portfolio
3. Self-Balancing Returns	- Strengthen project planning and optimize construction content - Require overall benefit-cost balance - Prohibit using land transfer income, tax refunds, or expected additional fiscal revenue as project income sources
4. Compliance with Eligibility Criteria	- Ecological/environmental management must meet entry requirements with clear improvement objectives - Industrial development must comply with national/local industrial policies and spatial control rules - Strict adherence to bidding, government procurement, debt control, and other regulations; no hidden local government debt allowed

(ii) EOD Project Entry Submission Materials

As to what materials need to be provided for filing, the Ministry of Ecology and Environment's guidelines for EOD program entry are clear and include four documents:

1. Outline of the preparation of the project implementation plan for the ecologically oriented development (EOD) model;

2. Ecological Environment Office (Bureau) on the project validation and assessment;

3. Letter of commitment for the implementation of the EOD program;

4. Basic information sheet of the ecological environment-oriented development model project.

Among them, the outline of the preparation of the project implementation plan for the ecological environment-oriented development (EOD) mode is the focus of attention. Its broad content includes general

information about the project area, construction content, project implementation mode, investment estimation and financing, financial analysis, and safeguard measures.

The funding sources of the EOD mode are diversified, including central finance, local finance, special funds, bank loans, special bonds, social capital, establishment of funds, own funds, etc. The integration of multiple funding channels provides a strong financial guarantee for the implementation of EOD mode projects. The integration of multiple funding channels provides a strong financial guarantee for the implementation of EOD projects and ensures that the projects can be successfully landed and sustained operation.

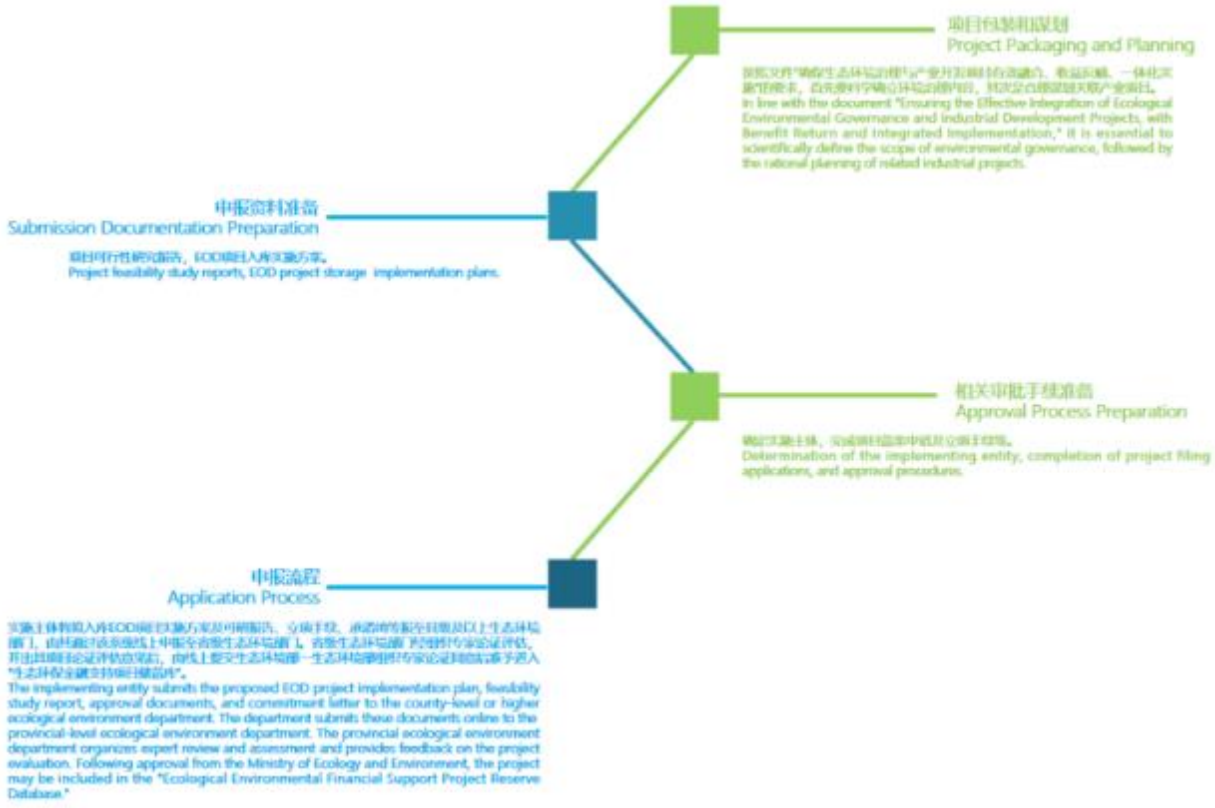


Figure 4 Process of EOD Model

The Circular on Recommending Pilot Projects for Ecology-Oriented Development Models proposes six investment and financing modes for the EOD model: government bonds, government investment funds, government-social capital partnership (PPP), formation of investment and operating companies, development finance, and environmental loans.

3.1.2.4 Opportunities and suggestions

The development of China's environmental protection market industry is a market driven by government policies, so the industry is greatly affected by policies. In general, the implementation of environmental protection projects and the upgrading of equipment in China are carried out through the following steps:

Government policy guidance and provide demonstration subsidies, and then different enterprises carry out project construction and implementation.

So we strongly recommend Netherland companies to pay attention to the implementation and dynamic trends of government policies. We recommend focusing on the following three policies: Zero-Waste Free Cities system; Emission permit management system and EOD model system.

1. Zero-Waste Free Cities system:

Technical Cooperation and Equipment Export: China's "Zero-Waste City" construction requires an increase in the accuracy of waste sorting and the efficiency of resource utilization. The Netherlands has mature experience in intelligent sorting equipment and refined sorting systems. For example, the "Urban Smart Waste Reduction Network" project in the Netherlands uses digital technology to achieve full-process tracking of waste, which can be applied to China's waste sorting demonstration cities. China generates a large amount of kitchen waste, with wet waste accounting for about 40%. The Netherlands' biological treatment technologies (such as anaerobic fermentation for biogas production and composting technology) and distributed treatment equipment can meet the needs of China. The Netherlands' technologies in the fields of industrial solid waste pyrolysis, vitrification, and recycled material preparation (such as the recycled aggregate technology for construction waste in Rotterdam) can be applied to China's " Zero-Waste City " construction.

Policy Cooperation and Project Participation: China's "Zero-Waste City" construction encourages international technological cooperation, and Dutch enterprises can participate in the "Zero-Waste City" international cooperation projects led by the Ministry of Ecology and Environment. In addition, the Netherlands' "Urban Sustainability Alliance" can cooperate with Chinese local governments to implement comprehensive solutions such as sponge cities and water-energy-urban synergy. China is currently improving its standards and certification system for recycled materials. The Netherlands' circular economy standards (such as the "Zero Waste Economy" framework) and product carbon footprint calculation methods can assist China in establishing a recycled material certification system.

Market Expansion and Localized Operations: The Netherlands' companies can shift from single-equipment supply to a comprehensive service model of "technology + operations + data." For example, they can offer value-added services such as waste sorting training, carbon footprint calculation, and circular economy consulting.

2. Emission permit management system:

China's Emission Permit Management Measures (2023 Revision) explicitly requires the inclusion of industrial solid waste in permit management, which directly drives the demand of enterprises for efficient solid waste treatment technologies. The Netherlands' technological advantages in plastic recycling technology and waste sorting can complement the Chinese market. The Netherlands circular economy incubators can provide comprehensive solutions for waste co-processing to Chinese industrial parks, helping enterprises pass the "environmental management ledger" review in their emission permits. The

emission permit requires the "lawful transfer" of hazardous waste. The Netherlands' technologies in the fields of medical waste pyrolysis and heavy metal recovery (such as the hazardous waste treatment experience in the Port of Rotterdam) can fill the market gap in China. China's Emission Permit Management Information Platform requires enterprises to "publicly disclose emission data in real time." The Netherlands' companies can provide solutions in the areas of intelligent monitoring equipment and data analysis platforms.

3. EOD model system:

The Netherlands' core technologies in waste treatment (such as biogas upgrading, CO_2 capture and utilization, and vacuum waste transportation systems) can be directly integrated into the industrial chains of China's EOD projects. China's EOD projects emphasize "ecological governance + industrial development," and the Netherlands' companies can participate in the planning and operation of eco-industrial parks. EOD projects have large funding requirements and need to combine government special bonds with social capital. Dutch companies can participate as technology providers in equipment supply and operations. In EOD projects such as key river basin governance and mine reclamation, Dutch companies can jointly apply for special bonds with Chinese companies to purchase high-end sorting equipment or build intelligent recycling systems. The Netherlands' standard systems in the fields of "zero-waste" economy and carbon footprint accounting can help standardize China's EOD projects.

3.2 Waste to Resource Segment Market Analysis

3.2.1 Industrial solid waste

According to the provisions of Chapter III, "Industrial Solid Waste," of the Solid Waste Pollution Environment Prevention and Control Law of the People's Republic of China, industrial solid waste refers to solid waste generated during industrial production activities. Entities disposing of industrial solid waste shall submit an application to the local competent ecological and environmental authority and obtain the corresponding approval before proceeding with the disposal.

3.2.1.1 China's industrial solid waste treatment industry related policies

To strengthen the management of industrial solid waste, China has successively issued numerous policies. For instance, the Opinions on Accelerating the Construction of a Circular Utilization System for Waste, released by the General Office of the State Council in 2024, explicitly proposes enhancing the refined management of industrial solid waste. It emphasizes the primary responsibility of waste-generating entities, improving the management ledger system for general industrial solid waste, and promoting the classified collection and storage of industrial solid waste to prevent mixing and improper discharge. Additionally, the opinion calls for a comprehensive investigation of historical legacy solid waste storage sites, implementing hierarchical and categorized rectification, and urging enterprises with large storage volumes to enhance resource recycling.

Furthermore, in accordance with the Solid Waste Pollution Environment Prevention and Control Law of the People's Republic of China, China strictly regulates all stages of industrial solid waste, including generation, collection, storage, transportation, utilization, and disposal. Relevant entities are required to establish and improve a full-process environmental pollution prevention responsibility system, maintain management ledgers, accurately record relevant information, and implement measures to prevent pollution.

Authorities and responsibilities for industrial solid waste management

The competent ecological and environmental authority of the State Council shall be responsible for unified supervision and administration of the prevention and control of environmental pollution caused by industrial solid waste nationwide. Together with other relevant departments, it formulates standards and procedures for identifying solid waste, as well as national technical standards for preventing and controlling environmental pollution caused by solid waste. It also establishes a national information platform for preventing and controlling environmental pollution caused by hazardous waste and other solid waste. In collaboration with the competent authorities of the State Council for development and reform, industry and information technology, and others, it defines the degree of harm and impact of industrial solid waste on public health and the ecological environment, formulates technical and policy measures for prevention and control, and promotes advanced production processes and equipment.

The competent ecological and environmental authority at the provincial level shall be responsible for unified supervision and administration of the prevention and control of environmental pollution caused by industrial solid waste within its administrative region. It registers the transfer of solid waste out of the province, autonomous region, or municipality directly under the Central Government for utilization and notifies the

counterpart authority in the receiving area of the registration information. It also approves applications for the interprovincial transfer of hazardous waste.

The competent ecological and environmental authority at the city level with districts, together with the competent authorities for housing and urban-rural development, agriculture and rural affairs, health and health, and others, regularly discloses to the public information on the types, generation volume, treatment capacity, and utilization and treatment status of solid waste.

Principles and requirements for the disposal of industrial solid waste

The disposal of industrial solid waste should adhere to the principles of reduction, resource utilization, and harmlessness, and follow the "polluter pays" principle. Enterprises are encouraged to reduce the generation of industrial solid waste through clean production audits and the adoption of advanced technologies and equipment, while improving resource utilization levels.

The management of industrial solid waste should be incorporated into the Environmental Impact Assessment system, with clear identification of the generation sources, types, quantities, and destinations of waste. A management ledger should be established to accurately record relevant information. Storage facilities must comply with environmental protection standards such as the "Pollution Control Standards for the Storage and Landfill of General Industrial Solid Waste" (GB 18599), ensuring measures against dust dispersion, loss, and leakage.

The utilization and disposal of industrial solid waste should prioritize harmless technologies to ensure compliance with relevant standards and regulations. Enterprises are also encouraged to develop large-scale utilization technologies to promote the comprehensive utilization of complex and difficult-to-use industrial solid waste.

Local governments should strengthen supervision of industrial solid waste, clarify the primary responsibility of enterprises, and implement full-process environmental management through the discharge permit system and management ledger system.

Regulations and prohibitions on disposal of industrial solid waste

It is prohibited to alter, sell, lease, lend, or illegally transfer registration documents for industrial solid waste in any other form to ensure the legality and standardization of the disposal process.

No entity or individual shall mix industrial solid waste with hazardous waste, nor shall they mix hazardous waste with industrial solid waste to prevent environmental issues caused by waste mixing.

It is prohibited to establish industrial solid waste storage or disposal facilities without authorization. Disposal must take place at facilities that meet national environmental protection standards.

Industrial solid waste storage and disposal facilities shall not accept hazardous waste, household waste, or toxic and harmful waste to prevent cross-contamination between different types of waste.

3.2.1.2 China industrial solid waste treatment market analysis

According to China's environmental statistics[2] , in 2022, China's general industrial solid waste generation will be 4.1 billion tons, general industrial solid waste comprehensive utilization will be 2.3 billion tons, and general industrial solid waste disposal will be 880 million tons.

Among them, the top 10 solid waste-generating industries contribute to a total of 3.97 billion tons of general industrial solid waste, accounting for 96.5% of China's total solid waste production ratio in 2022. The top 10 industries are:

- Mining and Washing of Coal
- Mining and Processing of Ferrous Metal Ores
- Mining and Processing of Non-ferrous Metal Ores
- Mining and Processing of Non-metal Ores
- Processing of Petroleum, Coal and Other Fuels
- Manufacture of Raw Chemical Materials and Chemical Products
- Manufacture of Non-metallic Mineral Products
- Smelting and Pressing of Ferrous Metals
- Smelting and Pressing of Non-ferrous Metals
- Production and Supply of Electric Power and Heat Powe

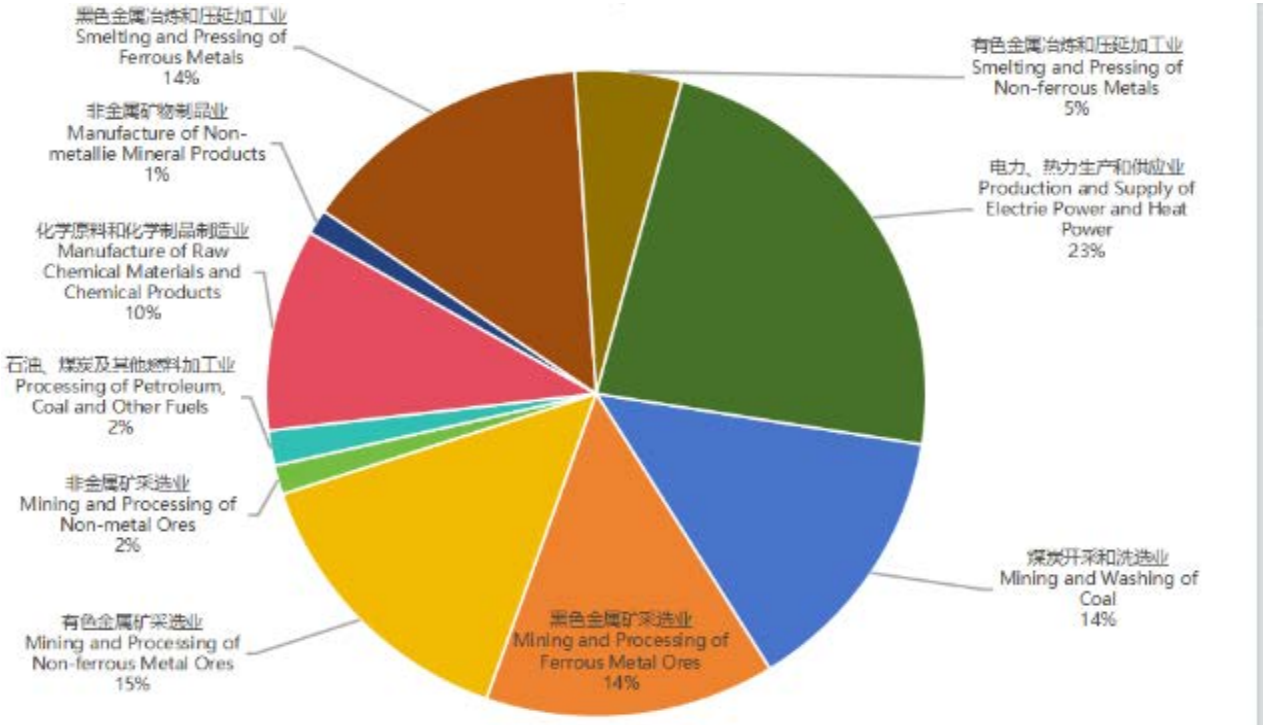


Figure 5 Top ten solid waste generating industries

In 2022, among the top ten industries contributing to the generation of solid waste in China, the production of electricity and heat production and supply industry produced 925.656 million tons, accounting for 23% of

[2] 仅含有 2022 年数据可查 The latest data currently available only for 2022

the production ratio of the top ten solid wastes; non-ferrous metal ore mining and processing industry, 578.894 million tons, accounting for 15%; ferrous metal ore mining and processing industry, 564.45 million tons, accounting for 14%; coal mining and washing industry, 543.025 million tons, accounting for 14%; ferrous metal smelting and rolling processing industry, 572.274 million tons, accounting for 14%.

From the composition of industrial solid waste, the types of industrial solid waste generated by various industries are also concentrated and relatively stable. Tailings, coal mining and burning generate the largest industrial solid waste, accounting for about 78% of the total. Among them, industrial solid wastes such as coal gangue, fly ash and slag account for about 50% of the total amount, which is closely related to the large amount of mining resources in China and the energy consumption structure dominated by coal (about 70%).

In addition, China's level of industrial solid waste resource utilization is also relatively low. For example, the total recovery rate of mineral resources is only 30%, which is 10 to 20 percentage points lower than the world average, and there is still much room for improvement.
According to the official data published by the National Bureau of Statistics and China Environmental Industry Statistical Yearbook 2023, from 2011 to 2023, China's industrial solid waste generation grew from 3.3 billion tons to 4.3 billion tons, showing the huge demand for solid waste treatment in the China market area. The national industrial solid waste generation, storage, disposal and comprehensive utilization are shown below.

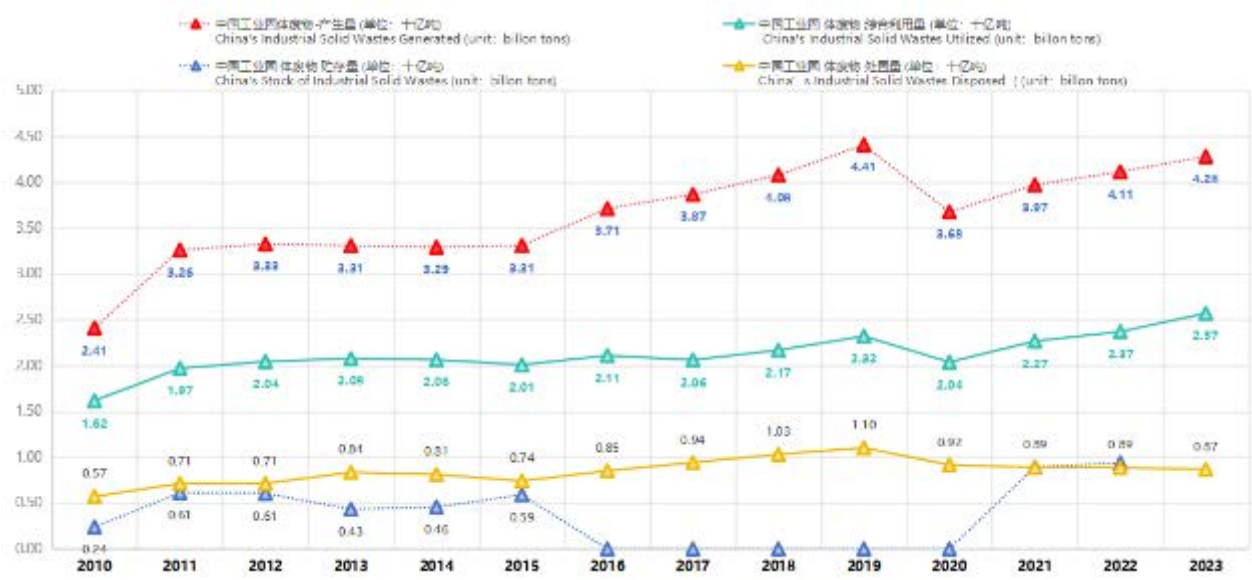


Figure 6 National industrial solid waste generation, storage, disposal and comprehensive utilization

Fundamentally, the amount of industrial solid waste generated is closely related to the economic growth and urbanization process of the country. The high economic growth and rapid urbanization will lead to a substantial increase in the amount of industrial solid waste generated, greatly promoting the development of the solid waste industry. The amount of industrial solid waste generated is correlated to a certain extent with the GDP growth rate and the urbanization rate growth rate.

Industrial solid waste generation by province in China

Figure 7 Production of industrial solid waste unit 10,000

The 2022 data show that nationally, more than 200 million tons of industrial solid waste production region is concentrated around Beijing city, such as Inner Mongolia, Liaoning, Hebei, Shanxi, and Shandong region; followed by between 100 million tons and 200 million tons range for Jiangsu, Henan, Anhui, Jiangxi, Guangxi, Yunnan, Qinghai, Sichuan and Xinjiang; the country produces the least amount of industrial solid waste are Beijing and Hainan, which are both less than 10 million tons. No statistics are available for Macao, Hong Kong, and Taiwan.

Figure 8 Central and western regions common industrial solid waste generated, utilized and disposal

Overall, the cities that generate the largest amount of industrial solid waste are basically in the central and western regions of mainland China, mainly including Lhasa, Taiyuan, Kunming, Chongqing, Jinan, and Guiyang. Compared with the eastern and central regions, the comprehensive utilization and disposal of solid waste in these five cities are far behind the amount of solid waste generated. In addition, Lhasa, Hefei, Kunming and other places have the largest solid waste output, and the amount of comprehensive utilization and disposal is relatively small, so the demand for disposal and transfer to other provinces for disposal is high, that is, there is a capacity gap for industrial solid waste disposal in the local area.

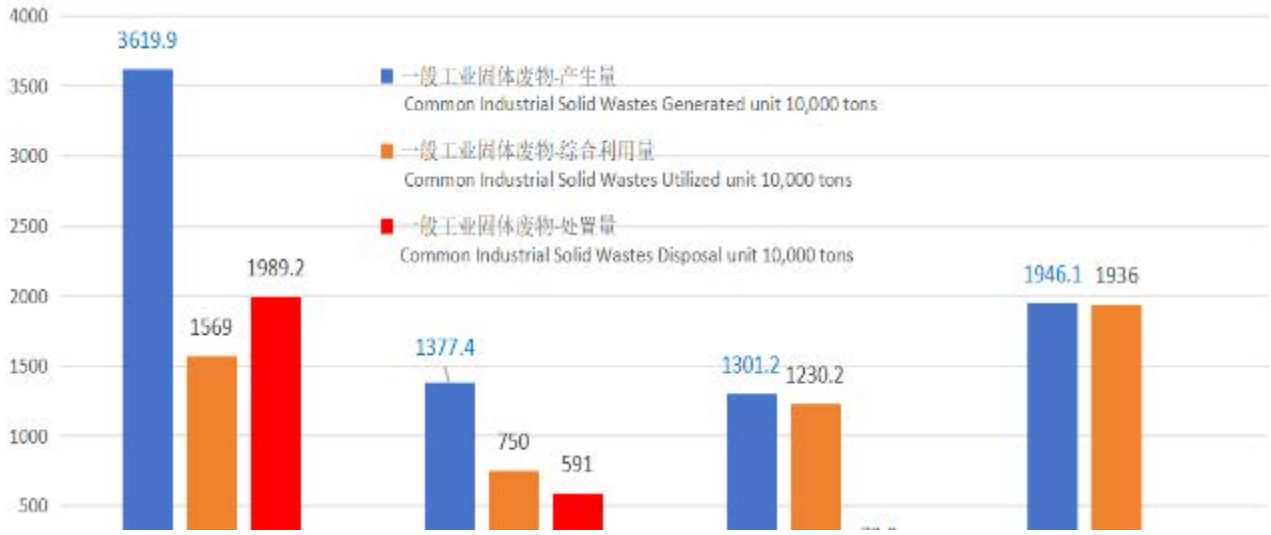


Figure 9 North China regions common industrial solid waste generated, utilized and disposal

A comparative analysis was conducted with solid waste-generating cities in North China, including Taiyuan, Hohhot, Shijiazhuang, Tianjin and Beijing. In the Beijing-Tianjin-Hebei region, except for large cities such

as Beijing and Tianjin, the comprehensive utilization volume is relatively high, while other cities such as Taiyuan and Hohhot have relatively low comprehensive utilization volumes, which ultimately leads to a relatively high volume of solid waste disposal.

Figure 10 Jiangsu Zhejiang Shanghai region common industrial solid waste generated, utilized and disposal

The cities in the Jiangsu, Zhejiang and Shanghai regions mainly include Shanghai, Hangzhou and Nanjing, which are all located in economically developed areas. Referring to the situation in the Beijing-Tianjin-Hebei region, the comprehensive utilization rate of general industrial solid waste in economically developed areas is relatively high, which leads to a small final treatment volume.

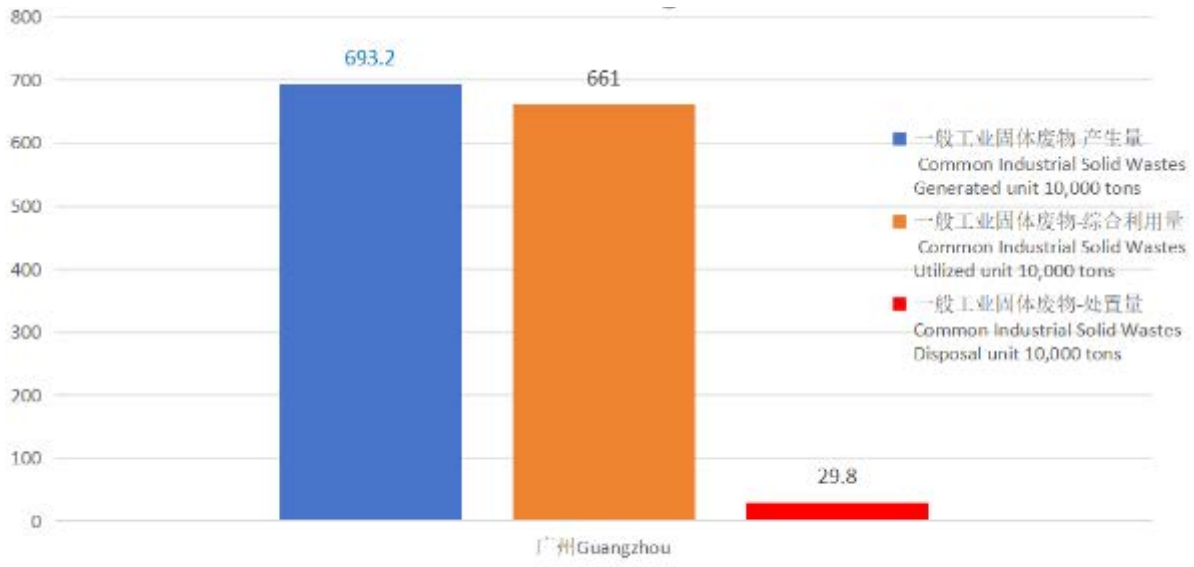


Figure 11 Guangzhou common industrial solid waste generated, utilized and disposal

There is a lack of data for cities other than Guangzhou in the Pearl River Delta region. The amount of general industrial solid waste generated in Guangzhou is relatively low and the level of economic development is high. Therefore, the comprehensive utilization and disposal volumes in Guangzhou are

relatively high, which is similar to the situation in economically developed cities such as Jiangsu, Zhejiang and Shanghai.

3.2.1.3 China's industrial waste to resource analysis

According to the solid waste generation data published by the Bureau of Statistics, the relevant solid waste comprehensive utilization rate is shown in the chart below, hovering in this range from 59.6% in 2011 to 60% in 2015. Among them, the statistical method of data from 2016 to 2020 was changed so it was not published, and it was around 56.4% and 56.8% in 2021 and 2022 respectively. According to the data released by the Ministry of Ecology and Environment in October 2024, in 2023, China's typical bulk industrial solid waste comprehensive utilization amounted to 2.258 billion tons, the comprehensive utilization rate of 53.32%, preliminary accounting, the national general industrial solid waste generation amounted to 4.28 billion tons, the comprehensive utilization amounted to 2.57 billion tons, and the disposal amounted to 870 million tons. According to the speculative data of the Double Carbon Economy Research Center, the comprehensive utilization rate of solid waste will be 60% in 2023.

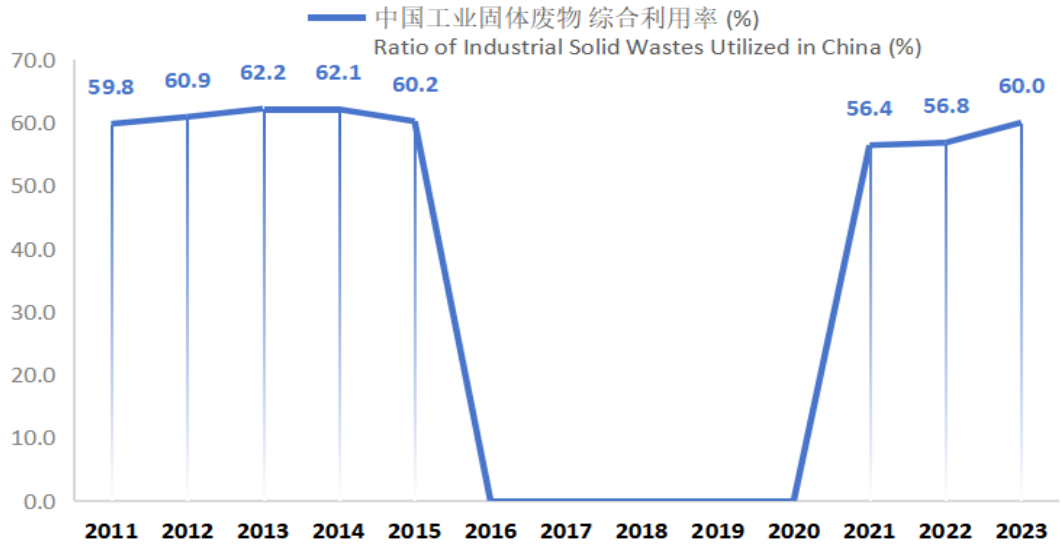


Figure 12 Ratio of industrial solid wastes utilized in China

During this period, the completed investment in China's treatment of solid waste projects showed a fluctuating growth trend, increasing from 3.1 billion RMB in 2011 to 4.7 billion RMB in 2016, reaching the maximum amount of completed investment in solid waste disposal projects, after which the market showed a sharp decline, directly reducing to 1.3 billion RMB in 2017, with growth slowing down slightly after the COVID-19 epidemic period, and the current nationally published data only shows a total of 0.6 billion RMB in 2022.

Figure 13 Completed investment in China's solid waste management project

In 2022, the top ten industries with the largest comprehensive utilization of solid waste had a total comprehensive utilization of 2.23 billion tons, accounting for 94.2% of China's total comprehensive utilization of industrial solid waste.

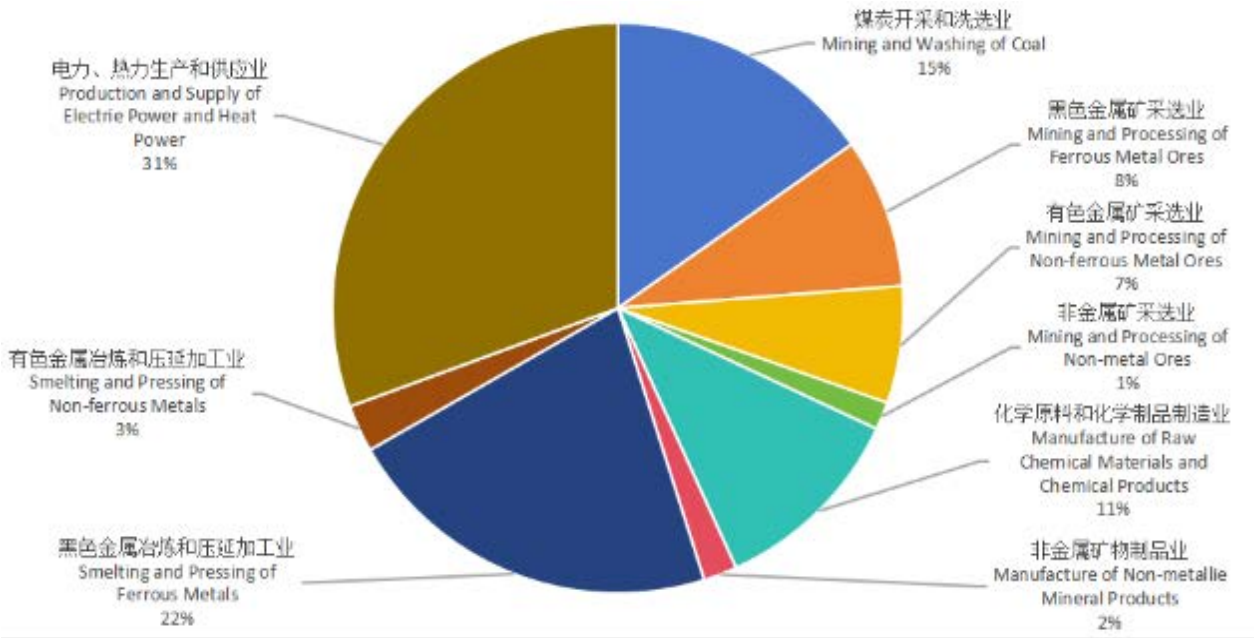


Figure 14 Top ten industries with the largest comprehensive utilization of solid waste

In 2022, among the top ten industries contributing to the comprehensive utilization of solid waste in China, the production and supply of electricity and heat industry produced 683.2 million tons, accounting for 31% of the comprehensive utilization of the top ten solid wastes; Ferrous metal smelting and Pressing industry,

482.516 million tons, accounting for 22%; Coal mining and washing industry, 340.78 million tons, accounting for 15%; chemical raw materials and Chemicals Products Industry, 251.17 million tons, accounting for 11%; Mining and Processing Industry of Ferrous Metal Ores, 189.624 million tons, accounting for 8%.

Common Industrial Solid Wastes Disposal

In 2022, among the top ten industries contributing to the disposal of solid waste, the total disposal volume was 849 million tons of general industrial solid waste, accounting for 95.6% of China's total industrial solid waste disposal volume.

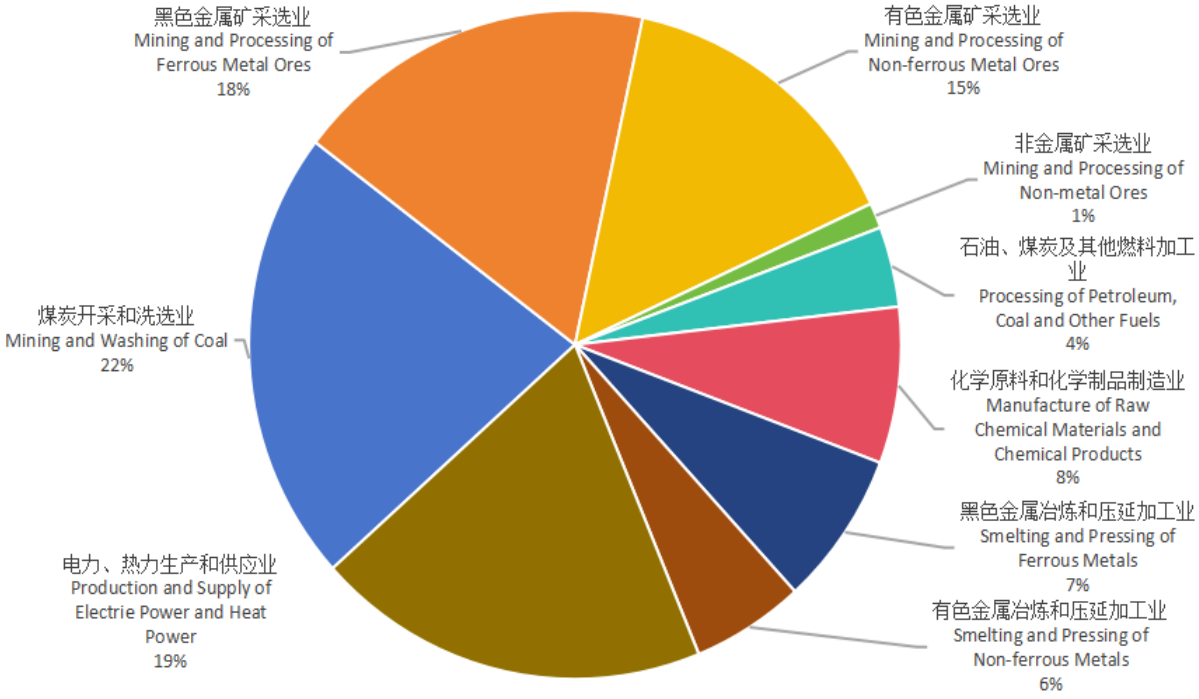


Figure 15 Top ten industries contributing to the disposal of solid waste

In 2022, among the top ten industries in China's solid waste disposal volume, coal mining and washing industry, with 186.82 million tons, accounted for 22%, ranking first; The production and supply of electricity and heat industry were 165.705 million tons, accounting for 19% of the top ten solid waste disposal volumes, ranking second; Ferrous metal mining and dressing industry, with 152.621 million tons, accounted for 18%, ranking third; Non-ferrous metal mining and dressing industry, with 125.111 million tons, accounted for 15%; Chemical raw materials and chemical products manufacturing industry, with 64.165 million tons, accounted for 8%.

Figure 16 Common industrial solid waste generated and utilized

From the general industrial solid waste generation and comprehensive utilization of the amount of view, solid waste treatment generation and comprehensive utilization of the amount of each province between the existence of a small gap between the five provinces with the highest comprehensive utilization rate: Zhejiang (99.84%), Tianjin, Shanghai, Anhui and Jiangsu (93.12%); comprehensive utilization rate of the five provinces with the lowest: Tibet 6.99%, 39.04% in Shanxi, Inner Mongolia 40.54%, Heilongjiang 40.62% and Gansu 43.94%. Therefore, from the perspective of comprehensive utilization improvement, the target provinces for project implementation are Tibet, Shanxi, Inner Mongolia and other regions.

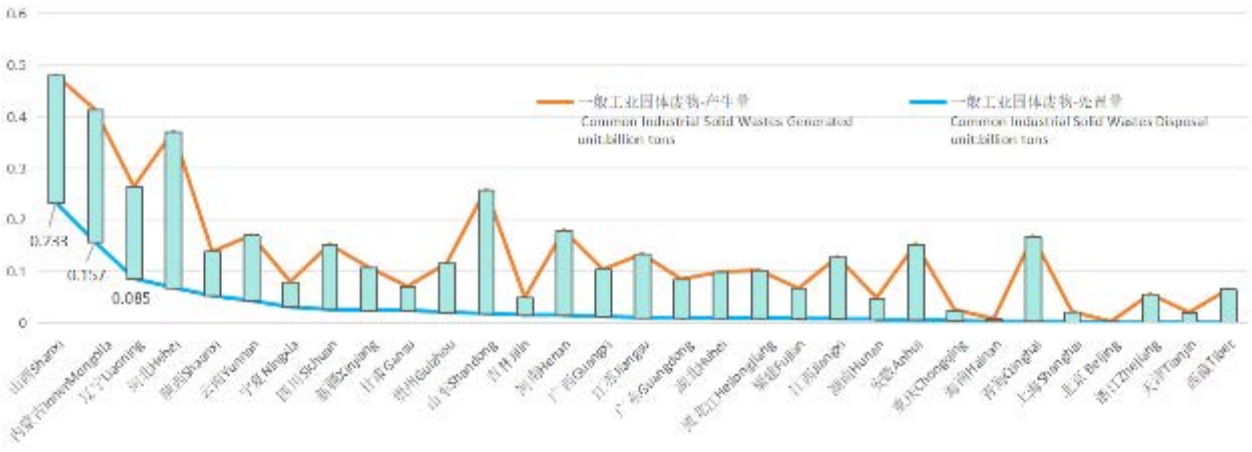


Figure 17 Common industrial solid waste generated and disposal

From the generation and disposal of general industrial solid waste, solid waste treatment industry generation and disposal of various provinces the amount a considerable gap between the disposal rate of the five provinces with the highest disposal rate: Shanxi (48.5%), Inner Mongolia, Liaoning, Shaanxi and Yunnan (24.96%); disposal rate of the five provinces with the lowest rate of 0.11% in Tibet, 0.42% in Zhejiang, Tianjin, 0.51% in Qinghai, 1.16% and Anhui, 3.47%. 1.16% and Anhui 3.47%.

Combined with the comprehensive utilization data, Tibet is a difficult region for comprehensive utilization and disposal; Qinghai Province's comprehensive utilization rate reaching 56.33%, but the disposal rate of solid waste is lower; Zhejiang Province, Tianjin, and Anhui Province have a higher comprehensive utilization rate of solid waste, resulting in a significant reduction in the final disposal rate of solid waste.

In general, China's industrialization system is huge, the industrial chain is relatively complete, and industrial enterprises in different industries generate a large amount of industrial solid waste of different categories and systems, especially in the coal mining industry, power energy production, chemical manufacturing enterprises, etc. The supervision and management of industrial solid waste/hazardous waste by the government, such as the National Development and Reform Commission, the Ministry of Industrialization and Information, and the Ministry of Ecology and Environment, is the focus of solid waste management.

China's industrial solid waste resource utilization, especially the recycling output and demand for metal waste, accounts for more than half of the world. Therefore, the recycling of solid waste is a very effective way to reduce the amount of industrial solid waste, reduce energy demand and reduce carbon emissions. Screening integrated solid waste recycling and disposal technology is an important business model direction for the future development of China's solid waste industry.

3.2.1.4 Competitive landscape of industrial solid wastes treatment in China

Upstream and downstream relationships in the industry chain

Upstream of the Industry Chain: Mainly includes raw material suppliers of industrial solid waste and solid waste treatment equipment manufacturers. Raw material suppliers provide raw materials for industrial solid waste, while equipment manufacturers provide necessary equipment support for downstream treatment enterprises to ensure the normal operation of the industry.

Midstream of the Industry Chain: Mainly composed of solid waste treatment service providers, covering the construction of treatment projects and the conduct of business. Midstream enterprises achieve profitability through service charges and recycling profits, with major demands coming from urban waste transportation and industrial waste treatment.

Downstream of the Industry Chain: Mainly includes the final disposal and resource utilization of solid waste. Downstream enterprises handle industrial solid waste through incineration, landfill, and resource regeneration, and generate revenue from resource utilization.

Industrial Solid Wastes business situation

China Everbright Environment Group Limited 光大环境

China Everbright Environment is a leading enterprise in the industrial solid waste treatment field in China, especially in hazardous waste treatment and resource recycling. The company provides comprehensive solid waste treatment solutions, including collection, transportation, treatment, and resource utilization, forming a complete industrial chain. China Everbright Environment's hazardous waste treatment facilities use advanced technologies and equipment to ensure the treatment process is efficient and environmentally

friendly. The company has set up hazardous waste treatment centers in multiple provinces, capable of handling various types of industrial solid waste, including chemical, medical, and electronic waste. In 2023, the company's industrial solid waste treatment business achieved remarkable revenue growth, with year-on-year growth exceeding 25% in the hazardous waste treatment sector.

The success of China Everbright Environment can be attributed to its strong R & D capabilities and policy support. The company continuously invests in research and development, creating efficient waste treatment technologies such as advanced incineration and resource recycling technologies. These innovations improve treatment efficiency and reduce operating costs. Additionally, China Everbright Environment actively responds to national environmental policies and participates in numerous national environmental projects, further solidifying its leading position in the industry. In 2023, the company's revenue from industrial solid waste treatment reached approximately RMB 3.5 billion, accounting for about 33% of its total revenue.

Zhejiang Weiming Environment Protection Co., Ltd. 浙江伟明环保股份有限公司

Weiming Environmental stands out in the industrial solid waste treatment field, particularly in hazardous waste treatment and resource recycling. The company offers a full-service chain, from project investment and construction to operation, and has established a leading position in the industry. Equipped with advanced technologies and facilities, Weiming Environmental ensures efficient and eco-friendly waste treatment and has set up multiple hazardous waste treatment centers across various provinces to handle different types of industrial solid waste, including chemical, medical, and electronic waste. In 2023, the company's industrial solid waste treatment business achieved significant growth, especially in resource recycling, with revenue increasing by over 30% year-on-year.

Part of Weiming Environmental's success is due to its independently developed hazardous waste treatment technologies, which enhance treatment efficiency and reduce costs. The company also actively participates in formulating national environmental standards, further consolidating its industry influence. Additionally, by establishing long-term partnerships with several large enterprises, Weiming Environmental ensures a stable supply of waste and revenue. In 2023, the company's revenue from industrial solid waste treatment reached approximately RMB 2 billion, accounting for about 33% of its total revenue.

Grandblue Environment Co.,Ltd. 瀚蓝环境

Grandblue Environmental excels in the industrial solid waste treatment sector, particularly in hazardous waste treatment and resource recycling. The company provides a full-service chain, from project investment and construction to operation, forming a comprehensive industrial chain covering the treatment of various pollution sources. Its hazardous waste treatment facilities, equipped with advanced technologies and devices, ensure efficient and eco-friendly processes. The company has established multiple treatment centers across provinces to handle diverse industrial solid wastes, including chemical, medical, and electronic waste. In 2023, Grandblue Environmental's industrial solid waste treatment business achieved stable growth, especially in resource recycling, with a year-on-year revenue increase of about 15%.

Grandblue Environmental's success is driven by continuous innovation and policy support. The company invests heavily in R & D to develop efficient waste treatment technologies, such as advanced incineration and recycling methods, which boost efficiency and cut costs. Furthermore, by collaborating with governments and businesses on multiple environmental projects, Grandblue Environmental has expanded its market share. In 2023, the company's revenue from industrial solid waste treatment reached approximately RMB 800 million, about 30% of its total revenue.

GEM Co., Ltd. 格林美

GEM Co., Ltd. excels in the industrial solid waste treatment field, particularly in waste electrical and electronic equipment (WEEE) dismantling and hazardous waste treatment. The company offers a full-service chain, from waste collection and treatment to resource utilization, establishing a strong market position. GEM's WEEE dismantling and resource recycling business holds a significant position in the domestic market, effectively reducing environmental pollution from e-waste while recycling precious metals and other valuable materials. In 2023, GEM's industrial solid waste treatment business achieved stable growth, especially in resource recycling, with a year-on-year revenue increase of about 10%.

GEM's success is partly due to its advanced resource recycling technologies, which enhance recycling rates and reduce treatment costs. The company also establishes long-term partnerships with several large electronic enterprises, ensuring a stable waste supply and revenue. Furthermore, GEM actively participates in formulating national environmental standards, further consolidating its industry influence. In 2023, the company's revenue from industrial solid waste treatment reached approximately RMB 2 billion, accounting for about 30% of its total revenue.

3.2.1.5 Market trends and opportunities

There has been a significant increase in the amount of bulk solid waste. In recent years, the rapid expansion of industrial production capacity in industries such as new energy vehicles, shipbuilding, and coal chemical industry has driven the rapid development of industries such as non-ferrous metals, precious metals, chemical raw materials, and coal in China, resulting in a rapid increase in the amount of bulk solid waste such as slag, steel slag, ferroalloy slag, coal gangue, and fly ash.

Large quantities of industrial solid waste are generated, and there is a large historical stockpile. Large quantities of solid waste have the following difficulties: complex composition, multiple technical routes, multiple comprehensive utilization products, different market demands for comprehensive utilization products, and significant information asymmetry in the industry. With the gradual introduction of policy standards and regulations and the continuous emergence of innovative technologies and demonstration projects, the main issues that need to be urgently addressed are how to select technical routes, combine multiple technical routes to form overall investment projects, accurately and systematically control the investment risks of comprehensive utilization projects, and scientifically determine the business model of the project, especially in resource-based cities and large waste-producing enterprises.

China's renewable resource industry has formed a relatively complete and structured industrial chain structure, but the overall competitiveness of the recycling and disposal industry needs to be strengthened.

The latest data shows that in 2023, the total amount of ten types of renewable resources recovered in China, including scrap iron and steel, scrap non-ferrous metals, scrap plastics, scrap paper, scrap tires, waste electrical and electronic products, scrapped motor vehicles, waste textiles, waste glass, and waste batteries (except lead-acid batteries), will be approximately 376 million tons, an increase of 1.5% over 2022. Among these, scrap iron and steel remains the largest category, accounting for more than 60% of the total amount of renewable resources recovered. The increase in the amount of scrap motor vehicles recovered was the most significant, with a year-on-year increase of 29.2%.[3]

China's "14th Five-Year Plan for Circular Economic Development" sets a target of a 60% comprehensive utilization rate for bulk solid waste by 2025, indicating a huge market potential in the industrial solid waste treatment sector. Dutch companies, equipped with advanced technologies and extensive experience, can leverage this opportunity to enter the Chinese market. They can participate in pilot projects in policy-driven cities like Beijing Economic-Technological Development Area and Wujin District, Changzhou. For instance, Dutch AVR garbage management company could offer similar waste-to-energy solutions in China, given its success in Europe.

Dutch companies excel in industrial solid waste treatment with technologies like efficient sorting, resource recycling, and energy conversion. They can enter the Chinese market through various cooperation models. First, they can authorize Chinese companies to use their patented technologies and charge licensing fees. Second, they can establish joint ventures with local firms to undertake industrial solid waste treatment projects together. Third, they can provide one-stop services, including project planning, construction, and operation. This approach can help Chinese companies enhance their technical capabilities and achieve mutual benefits.

Some Dutch companies have already entered the Chinese industrial solid waste market. For example, the Amsterdam AEB waste-to-energy plant can serve as a reference for Chinese waste incineration power generation projects with its advanced garbage incineration and resource recycling technologies. Additionally, Dutch firms have engaged in the Chinese market by participating in activities organized by industry associations. They have strengthened cooperation with government departments, research institutions, and other companies to jointly promote the development of China's industrial solid waste treatment industry.

3.2.2 Domestic waste

3.2.2.1 Domestic Waste Sorting

At present, domestic waste in China can be divided into four categories: recyclable waste, food waste, hazardous waste and other waste.

Recyclables

[3] Source: China Material Recycling Association released the "China Recycling Resources Green Supply Chain Development Report 2024" on December 6, 2024

Recyclables (renewable resources) refer to recycled items that can become raw materials for production after reprocessing or can be reused after finishing, mainly including waste paper, plastics, glass, metals, electronic waste, fabrics, etc. Main types.

Waste paper - newspapers, cardboard boards, books, magazines, all kinds of books, other clean paper, all kinds of Tetra Pak milk bags, and beverage boxes (need to be rinsed and dried).

Plastics - various plastic beverage bottles, plastic oil drums, plastic pots (boxes). Glass - glass bottles, flat glass, mirrors.

Metal - Aluminum cans, all kinds of metal kitchenware, tableware, utensils, other civilian metal products. E-waste - all kinds of household electrical products.

Fabrics - tablecloths, clothes, school bags, etc.

Food waste

Food waste in the narrow sense is a kind of organic waste, which is divided into cooked food waste including leftovers, leftover food, and vegetable leaves; raw food waste including fruit peels, egg shells, tea dregs, bones, shells; refers to the source of raw materials and finished products (cooked food) or residues that are needed for family life and diet. However, food waste in a broader sense also includes used chopsticks, food packaging materials and so on.

Hazardous waste

Definition: Toxic and hazardous waste refers to waste that contains heavy metals or toxic substances that are harmful to human health or cause actual or potential harm to the environment. It mainly includes: waste medicines, waste pesticides, waste disinfectants, waste paints, waste solvents, waste mineral oil, waste cosmetics, waste films, waste photo paper, waste fluorescent tubes, waste thermometers, waste sphygmomanometers, waste rechargeable batteries, waste button batteries, alkaline batteries, lithium batteries, gallium-cadmium batteries and so on.

Other garbage

Definition: Includes wastes other than those listed above that are difficult to recycle and are usually disposed of by incineration or landfill, depending on the characteristics of the waste.

Mainly includes: used toilet paper, copy paper, fax paper, photographs, centrifugal paper, waxed paper, transfer paper, plastic glossy waste paper, sanitary napkins for women, baby diapers, napkins, cigarette butts, ceramics, clothes, footwear, asbestos tiles, white boards, wooden toys, rainboots, wooden furniture, rubber products, tires, and so on.

Figure 18 Recycling and sorting process of waste in China

3.2.2.2 China's domestic waste treatment industry related policies

On March 18, 2017, the General Office of the State Council released the Implementation Plan for the Domestic Waste Classification System formulated by the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development, which plans to basically establish a system of laws, regulations and standards related to waste classification by the end of 2020, and to first implement the mandatory classification of domestic garbage in municipalities directly under the central government, provincial capitals, cities with single-listed cities in the planning process, and the 46 cities of the other first demonstration cities for the classification of domestic garbage. Another first batch of domestic waste classification demonstration cities include Handan City, Hebei Province, Suzhou City, Jiangsu Province, Tongling City, Anhui Province, Yichun City, Jiangxi Province, Tai'an City, Shandong Province, Yichang City, Hubei Province, Guangyuan City, Sichuan Province, Deyang City, Rikaze City, Tibet Autonomous Region, and Xianyang City, Shaanxi Province. The program requires that hazardous waste must be included as one of the categories for mandatory classification, with optional mandatory classification categories such as perishable waste and recyclables.

In June 2019, nine departments, including the Ministry of Housing and Urban-Rural Development of the People's Republic of China, issued the Notice on Comprehensively Carrying Out Classification of Domestic Waste in Prefecture-Level and Above Cities Across the Country. Among the requirements: by 2020, 46 key cities will have built a domestic waste classification and treatment system; other prefecture-level cities will realize full coverage of domestic waste classification in public institutions, and at least one street will have built a demonstration area for domestic waste classification.

On November 15, 2019, the Ministry of Housing and Urban-Rural Development (MOHURD) released a new version of the standard "Signs for Classification of Domestic Waste", which came into effect on December 1st. The new standard adjusts the categories of domestic garbage into four categories: recyclables, hazardous garbage, food waste and other garbage, and deletes the three categories of bulky garbage, combustible garbage and compostable garbage. Since this standard is recommended and non-mandatory, some cities (e.g. Shanghai) will not change the name and classification standard for the time being.

By the end of 2020, the 46 key cities where early and pilot implementation is to be carried out shall have built a waste classification and treatment system; and other prefectural-level cities shall realize full coverage of the classification of domestic waste in public institutions.

By 2022, at least one district in each level city will realize full coverage of domestic waste classification, and at least one street in each other district will have built a demonstration area for domestic waste classification; by 2025, cities at the prefecture level and above will have built a domestic waste classification and treatment system.

On May 1, 2021, the National Development and Reform Commission (NDRC) and the Ministry of Housing and Urban-Rural Development (MOHURD) issued a notice on the issuance of the "14th Five-Year Plan" for the Development of Urban Living Waste Classification and Disposal Facilities, which states that the specific targets by 2025 are as follows:

A. Utilization rate of garbage resources: By the end of 2025, the utilization rate of urban domestic garbage resources will reach about 60% nationwide;

B. Garbage classification collection and transportation capacity: by the end of 2025, the national domestic garbage classification collection and transportation capacity will reach about 700,000 tons per day, basically meeting the demand for classified collection, classified transfer and treatment of domestic garbage in prefectural-level cities and cities above; counties with the conditions are encouraged to promote the construction of facilities for classifying and treating domestic garbage;

C. Waste incineration treatment capacity: By the end of 2025, the national urban domestic waste incineration treatment capacity will reach about 800,000 tons per day, and the proportion of urban domestic waste incineration treatment capacity will be about 65%.

Table 6 China's first 46 key cities for waste classification

Municipalities	Region	Major category	Consequences of non-categorization of individuals	Implementation time	Remarks on policies introduced
Beijing	Beijing, Tianjin and Hebei	Recyclables, hazardous waste, food waste, and other waste	/	2020.5.1	Beijing Municipal Regulations the Management of Domestic Wasteon, Beijing Municipal Guidance Manual the Classification of Domestic Wasteon

Tianjin	Beijing, Tianjin and Hebei	Food waste, recyclables, hazardous waste, and other waste	Individuals who refuse to rectify the situation are subject to a fine of more than 100 RMB and less than 500 RMB.	2020.12.1	Regulations on the Management of Domestic Waste in Tianjin, Measures for the Supervision and Management of the Whole Process of Classified Placement, Collection, Transportation and Disposal of Domestic Waste in Tianjin
Hebei	Beijing, Tianjin and Hebei	Food waste, recyclables, hazardous waste, and other waste	Individuals who refuse to rectify the situation are subject to a fine lower than 100 RMB	2021.1.1	Regulations of Hebei Province on Classified Management of Urban and Rural Domestic Waste; Key Points of Classification Management of Domestic Waste in Hebei Province in 2022
Shanghai	Yangtze River Delta	Recyclables, hazardous waste, wet waste, dry waste	The fine is 200 RMB, and the maximum fine for unit mixing and transportation is 50,000 RMB.	2019.7.1	Implementation Plan for Classified Collection and Disposal of Domestic Waste in Shanghai Municipality, Circular of the Shanghai Municipal People's Government on the Issuance of Several Opinions on Further Strengthening the Management of Domestic Waste in the Municipality, Measures to Promote Classification and Reduction of Domestic Waste in Shanghai Municipality, Shanghai Municipal Domestic Waste Management Regulations
Jiangsu Province	Yangtze River Delta	Recyclables. Hazardous waste, food waste, and other waste	Impose a fine of not less than RMB 20 RMB and not more than RMB 200 RMB on an individual who refuses to make corrections	2023.5.1	Regulations on the Management of Urban Amenities and Environmental Hygiene in Jiangsu Province
Zhejiang Province	Yangtze River Delta	Recyclables, hazardous waste, perishable waste, and other waste	Individuals in serious cases are fined more than 200 RMB and less than 2,000 RMB.	2021.5.1	Regulations on the Management of Domestic Waste in Zhejiang Province, Measures for the Classification and Management of Urban Domestic Waste in Zhejiang Province

Anhui Province	Yangtze River Delta	Recyclables. Hazardous waste, food waste, and other waste	Impose a fine of not less than 50 RMB and not more than 200 RMB on an individual who refuses to rectify the situation.	2022.5.1	Regulations on the Management of Classification of Household Garbage in Anhui Province
Guangdong Province	Pearl River Delta (PRD)	Recyclables. Hazardous waste, food waste, and other waste	Impose a fine of not less than RMB 100 and not more than RMB 500 on an individual who refuses to make corrections	2021.1.1	Regulations on the Management of Urban and Rural Domestic Waste in Guangdong Province

3.2.2.3 China domestic waste treatment market analysis

According to the Statistical Yearbook of the Ministry of Housing and Urban-Rural Development of the People's Republic of China, the total amount of domestic waste removal in China (in tons) from 2010 onwards was counted, and the total amount of removal in 2024 and 2025 was forecasted, and the results are shown below. Generally speaking, with the improvement of China's economic development level and the increase in population, the amount of domestic waste removal shows a rising trend. It is predicted that the volume of domestic waste removal in China from 2024 to 2025 hovers around 250 million tons.

Figure 19 China Domestic Garbage Quantity of collected and transported

Meanwhile, according to the latest People's Republic of China Ministry of Housing and Urban-Rural Development Statistical Yearbook data 2023 China's provincial domestic waste removal volume (million tons) statistics as shown in the following chart, show that the largest volume of domestic waste removal in the province is Guangdong and Jiangsu Province in the 20 million tons or more, followed by Shandong, Liaoning, Henan, Hubei, Sichuan and Zhejiang Province.

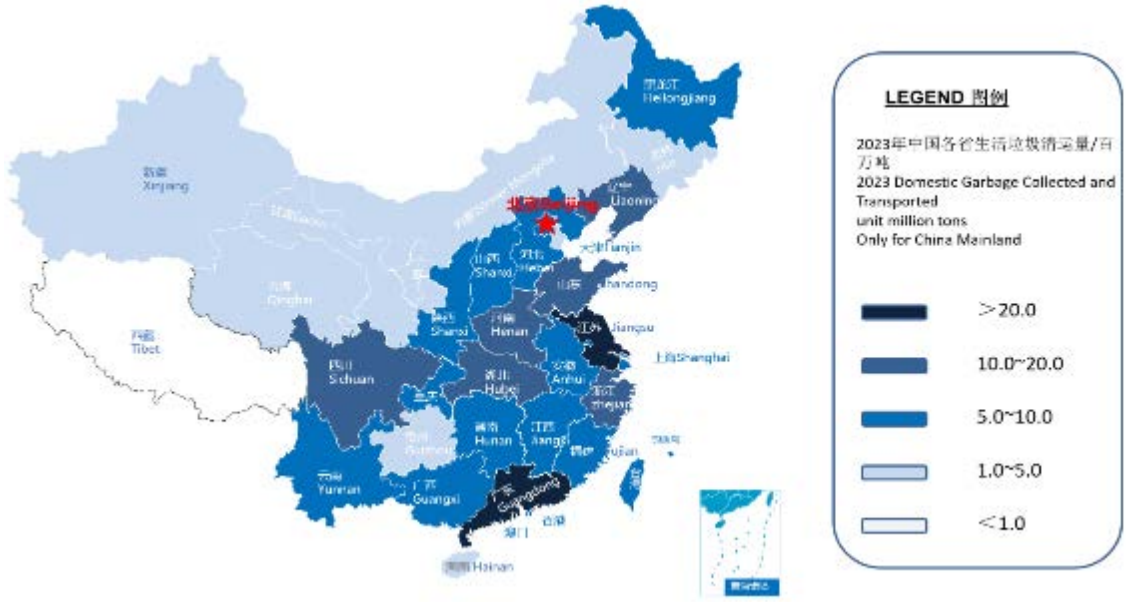


Figure 20 2023 Domestic Garbage collected and transported

Statistics on the types of household waste disposal methods in each province of China are also provided, as shown in the figure below.

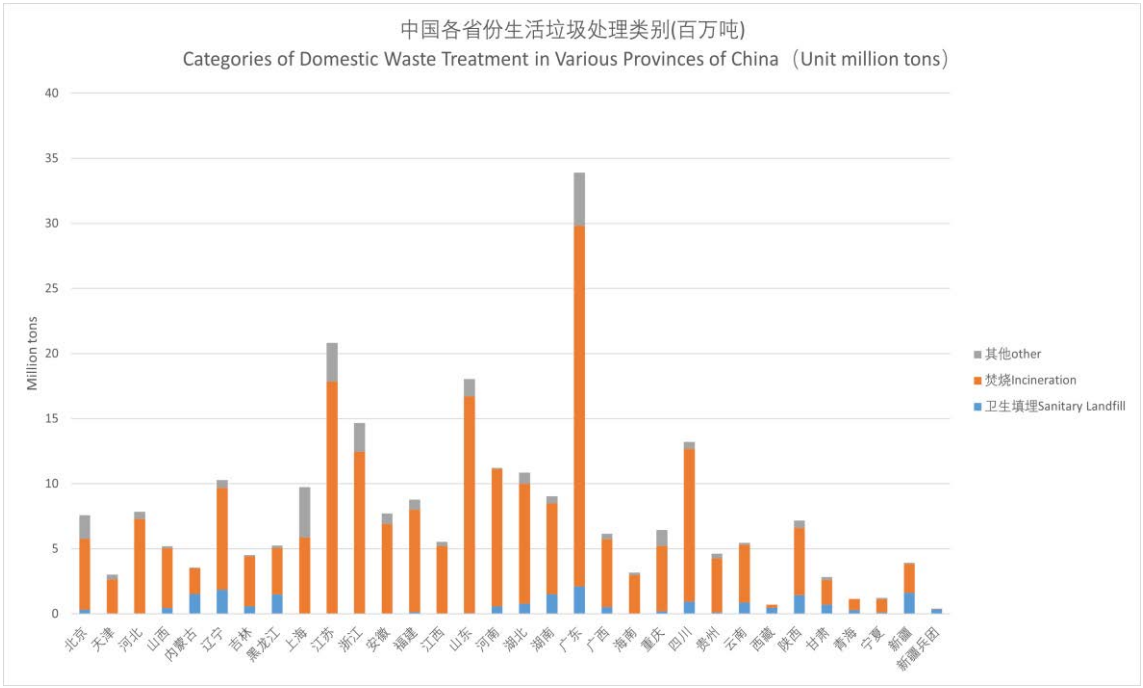


Figure 21 Categories of Domestic Waste Treatment in Various Provinces of China

Sorting and resource utilization plays a core pivot role in the upstream solid waste reduction and downstream resource reuse process, and will become the "second growth curve" of the sanitation and solid waste industry in the carbon-neutral era under its excellent economic benefits and, carbon reduction benefits, and resource substitution ability; the market space is huge, with an annual new market potential at the level of hundreds of billions of dollars, and a stock market at the level of trillions of dollars, and the

largest market in the world is in China. The market space is huge, with annual new market potential at the level of hundreds of billions of dollars and the stock market at the level of trillions of dollars, and the largest global market is in China. The chemical recycling of waste plastics provides strong economic traction and plastic waste absorption capacity for sorting, which is an important driving force for the rapid development of the industry.

(i) Sorting and resource utilization play a central role in the process of solid waste minimization and resource utilization.

In order to obtain high-quality and high-value recycled products, the recycling industry needs to meet the requirements of a single material (high purity and low impurity) in the feeding part of the production process. China's domestic waste is often a mixture of different materials, and waste plastics alone contain more than a dozen different components, so sorting has become an indispensable precursor to the resource recycling process. Sorting and resource utilization become the hub connecting upstream solid waste reduction and downstream resource regeneration.

(ii) The potential value of sorting and resourcing is extremely high, with the chemical recycling value of low-value waste plastics contributing the most.

In 2022, the domestic waste collection volume in China was 244.447 million tons. Recyclables include paper (15-20%), plastic (10-12%), metal (3-5%), glass (2-3%), and textiles (2-4%), with a combined proportion of about 31%.

In 2022, China generated 63 million tons of plastic waste, with a total of 18 million tons of plastic waste recycled. Although China's current plastic waste recycling rate is at the international leading level, reaching 30.65% in 2023, compared with the incineration or landfill rate of over 60% for plastic waste, there is still considerable room for improvement in the recycling rate. Domestic chemical recycling technologies for plastic waste achieve raw material - level regeneration by breaking down the polymer chains of plastics. The main methods include pyrolysis, catalytic cracking, solvent - based methods, and photocatalysis. Shandong Jimbo Polyolefin New Materials Co., Ltd. has partnered with Shiseido to transform waste plastics from cosmetic packaging into recycled polypropylene through pyrolysis. In April 2024, the first batch of 300 kg of chemically recycled polypropylene was delivered, achieving a closed - loop recycling process of "waste plastics - pyrolysis oil - new plastics." The recycled plastics produced by this technology meet food - contact - grade standards, with traceable carbon footprints, and have been applied to Shiseido's overseas product lines.

The following figure shows the proportion of each component of domestic waste in China.

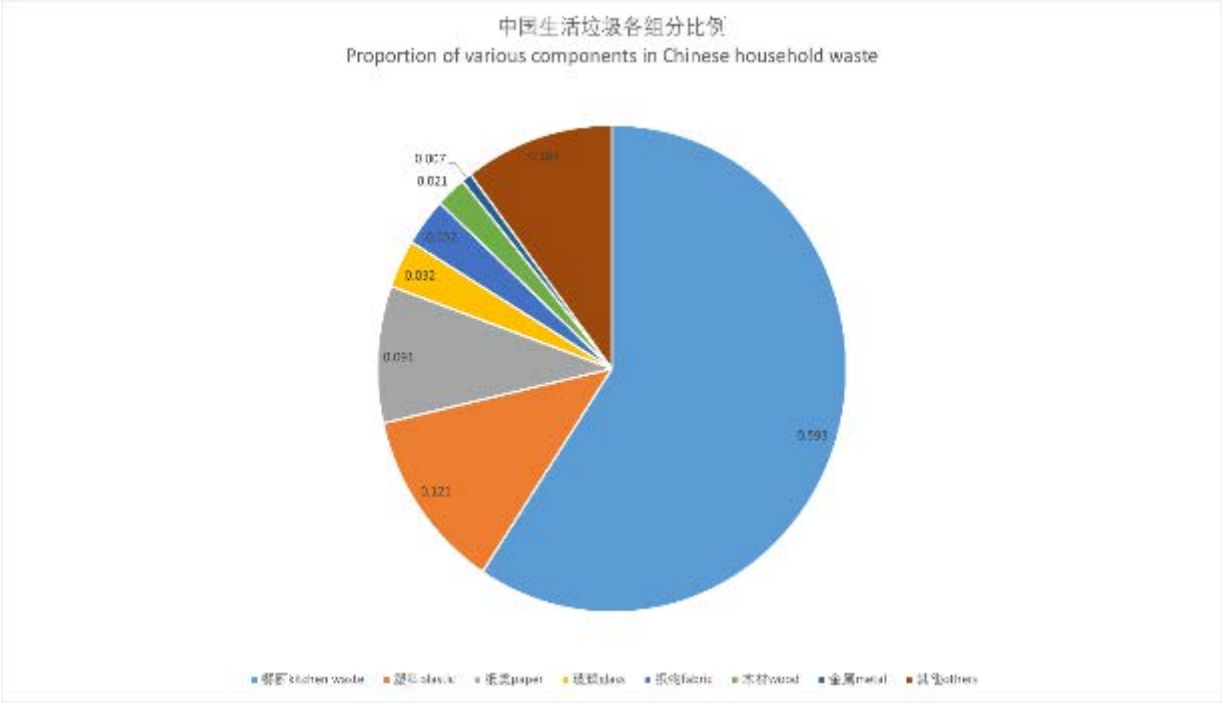


Figure 22 Proportion of various components in Chinese household waste

According to the 2011~2020 Statistical Yearbook of Urban Construction issued by the Ministry of Housing and Urban-Rural Development, statistics on China's urban domestic waste production over the past 10 years are shown below:

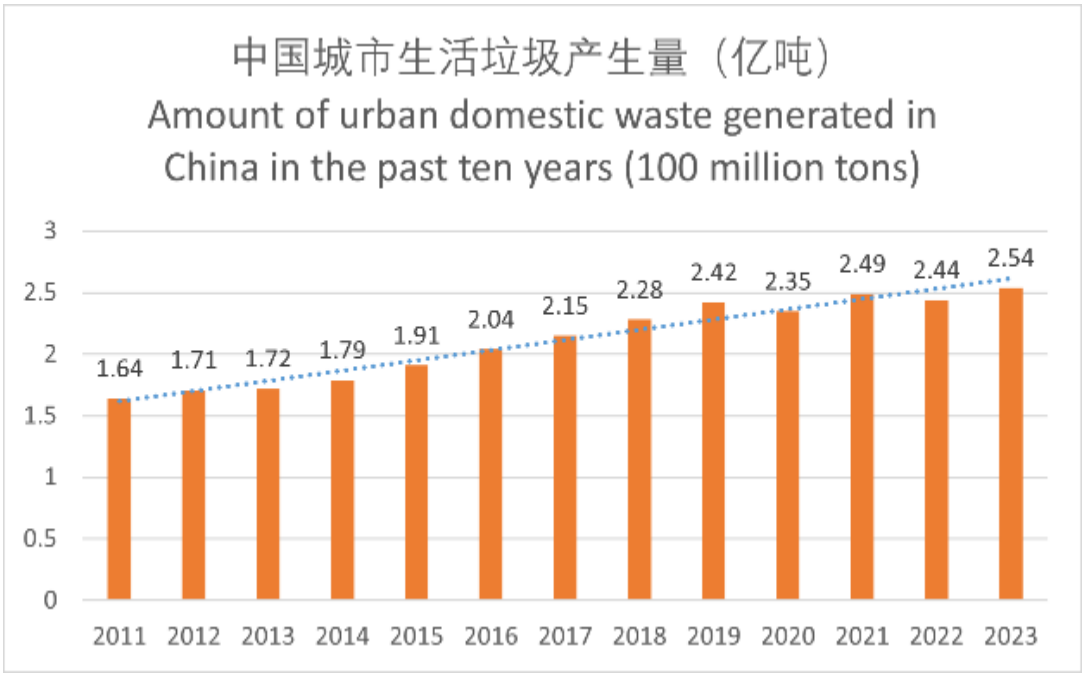


Figure 23 Amount of urban domestic waste generated in China in the past ten years

From 2011 to 2019, China's municipal domestic waste production increased year by year, with an overall linear growth trend. In 2011, the municipal domestic waste production was 164 million tons, and in 2019, it

was 242 million tons, an increase of 1.48 times, with an annual growth rate of 4.74%; In 2023, the municipal domestic waste production will be 254 million tons. The study shows that the three factors of the number of cities, GNP and urban population are positively correlated with the amount of municipal domestic waste generated, and are the main factors affecting the production of municipal domestic waste in China. The number of cities in China tends to be saturated from 2011 to 2023, which has little impact on the amount of municipal domestic waste generated in China, while the GNP is increasing, the life of urban residents is improving, and the demand for materials is In 2020, the decline of China's urban living waste may be due to the impact of the new crown pneumonia epidemic, the urban population home quarantine, and the decrease in the production of living garbage.

Reduction, resourcing and harmlessness are the basic principles of domestic waste treatment in China, of which harmlessness is the treatment of domestic waste through appropriate technology so that it does not pollute the environment or pose a hazard to human health. At present, harmless treatment of domestic waste in China includes landfilling, incineration and others (composting, resource utilization, etc.).

The number of domestic waste harmless treatment facilities in China in the past ten years is shown in the figure below, which shows that sanitary landfills and incineration are the main means of domestic waste harmless treatment in China. The number of sanitary landfills shows a rising and then falling trend, with 547 sanitary landfills in 2011, increasing year by year to a maximum of 663 in 2018, then starting to decrease, with 644 sanitary landfills in 2020. The number of incineration non-hazardous treatment facilities shows a rising trend year by year, with 109 incineration facilities in 2011, reaching 463 in 2020, a 4.2-fold increase, with an average annual growth rate of 14.8%. The number of other non-hazardous treatment facilities also shows a year-on-year upward trend, with a decline in individual years; in 2011, the number of other non-hazardous treatment facilities was 21, declining to 19 in 2013, and then increasing year by year, with the number of other non-hazardous treatment facilities standing at 180 in 2020, a 9.5-fold increase compared with 2013.

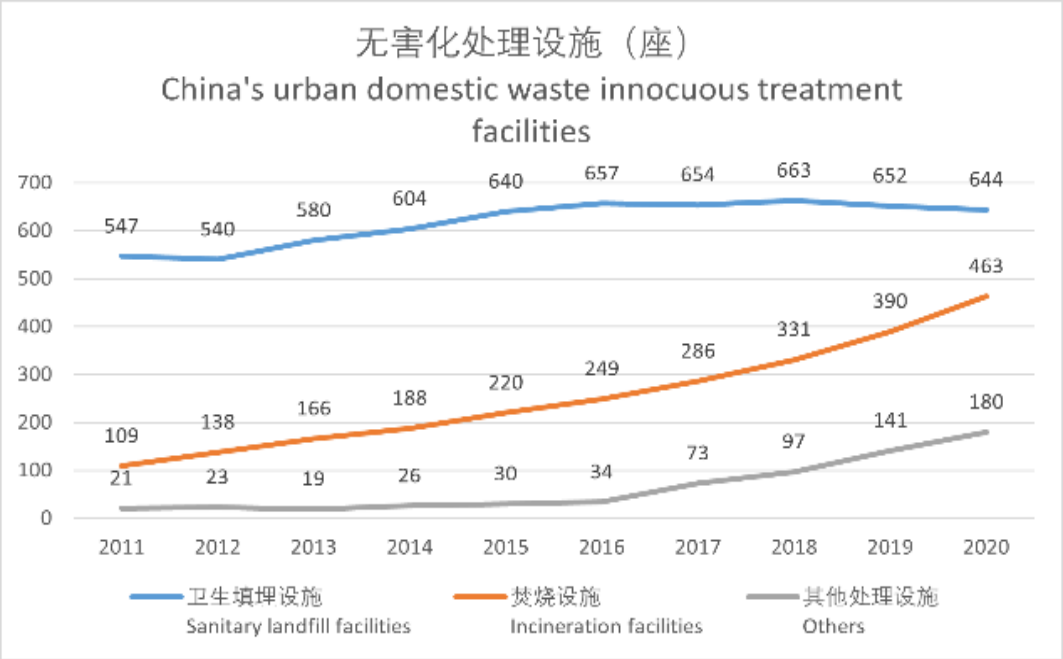


Figure 24 China’s urban domestic waste innocuous treatment facilities numbers

The following figure plots the capacity of China's domestic waste to be treated harmlessly daily using different methods. In the past ten years, the capacity of China's sanitary landfills for harmless treatment of domestic waste has shown a trend of increasing and then decreasing, with sanitary landfills treating 300,000 tons of domestic waste per day in 2011, reaching a maximum of 373,000 tons per day in 2018, and then decreasing year by year, with sanitary landfills in 2020 treating 338,000 tons of domestic waste per day. The capacity of incineration for the harmless treatment of domestic waste shows a rising trend year by year, with incineration treating 94,000 tons of domestic waste per day in 2011 and reaching 568,000 tons per day in 2020, a sixfold increase, with an average annual growth rate of 18 percent. The capacity of other harmless treatments of domestic waste from 2011 to 2016 remained stable, with a small rate of change.

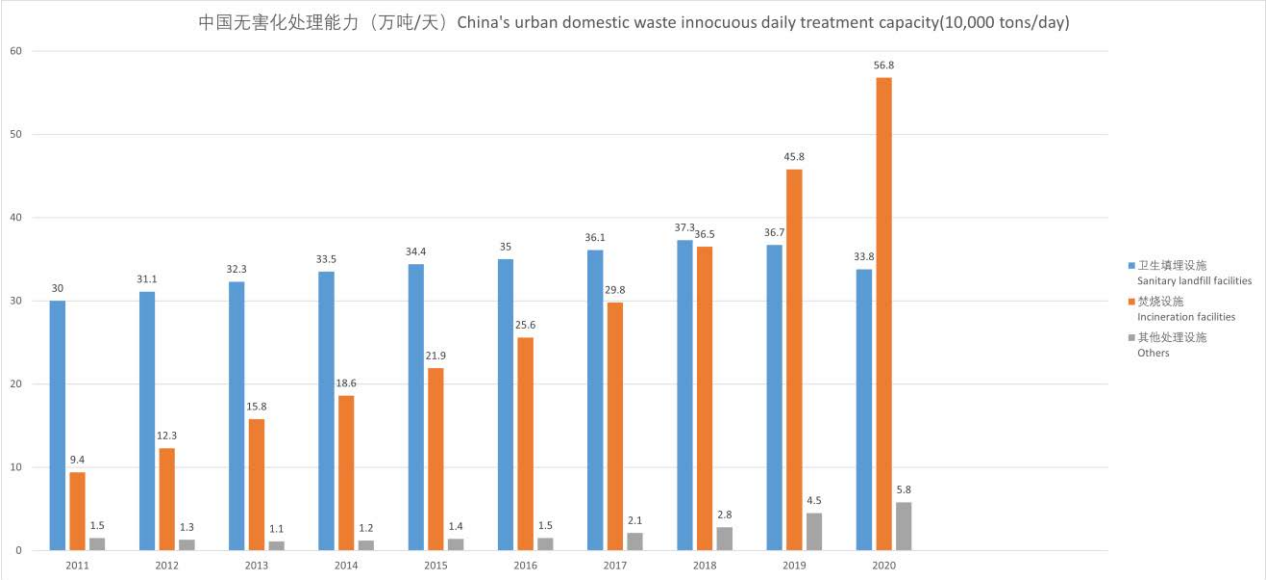


Figure 25 China’s urban domestic waste innocuous daily treatment capacity changes

As shown in the figure below, the amount of China's municipal domestic waste disposal increased year by year from 2011 to 2019, and the amount of harmless municipal waste disposal was 131 million tons in 2011, and 240 million tons in 2019, an increase of 1.83 times, with an annual growth rate of 7.29%; the amount of harmless municipal waste disposal in 2020 will be 235 million tons, a decrease of 2.33% compared with that in 2019.

From 2011 to 2020, the rate of harmless treatment of China's municipal domestic waste increased year by year, and the rate of harmless treatment of China's municipal domestic waste reached 99.7% in 2020, which is an increase of 19.9% compared with that of 2011, and the cleared municipal domestic waste can be disposed of harmlessly almost entirely.

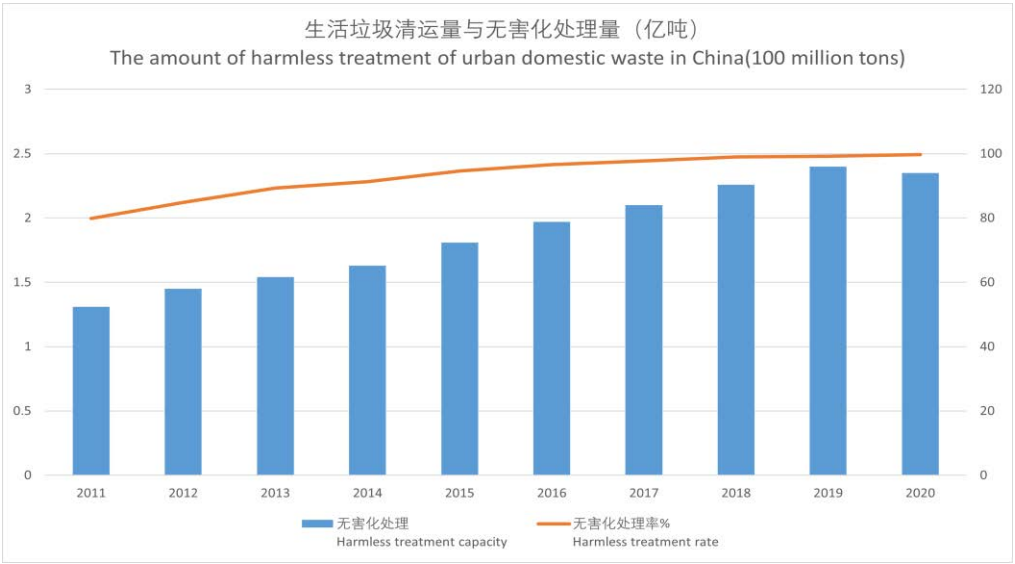


Figure 26 The amount of harmless treatment of urban domestic waste in China

The following figure plots the percentage of China's municipal domestic waste treated harmlessly by different methods in the past ten years. As shown in the figure, from 2011 to 2018, China's harmless treatment of municipal domestic waste was dominated by sanitary landfills, with the treatment volume accounting for more than 50%, but the proportion was decreasing year by year, from 77% in 2011 to 33% in 2020; the proportion of harmless incineration treatment of domestic waste increased year by year from 2011 to 2020, and in 2019 it reached 51%, exceeding sanitary landfill treatment for the first time, and reaching 62% in 2020, and also completing the "13th Five-Year Plan" national urban domestic waste harmless treatment ahead of time. More than sanitary landfill treatment, reaching 62% in 2020, and also ahead of schedule to complete the goal of the "Thirteenth Five-Year" national urban household waste harmless treatment facilities construction plan, "by the end of 2020, the household waste incineration harmless treatment capacity accounted for more than 50% of the total harmless treatment capacity,"

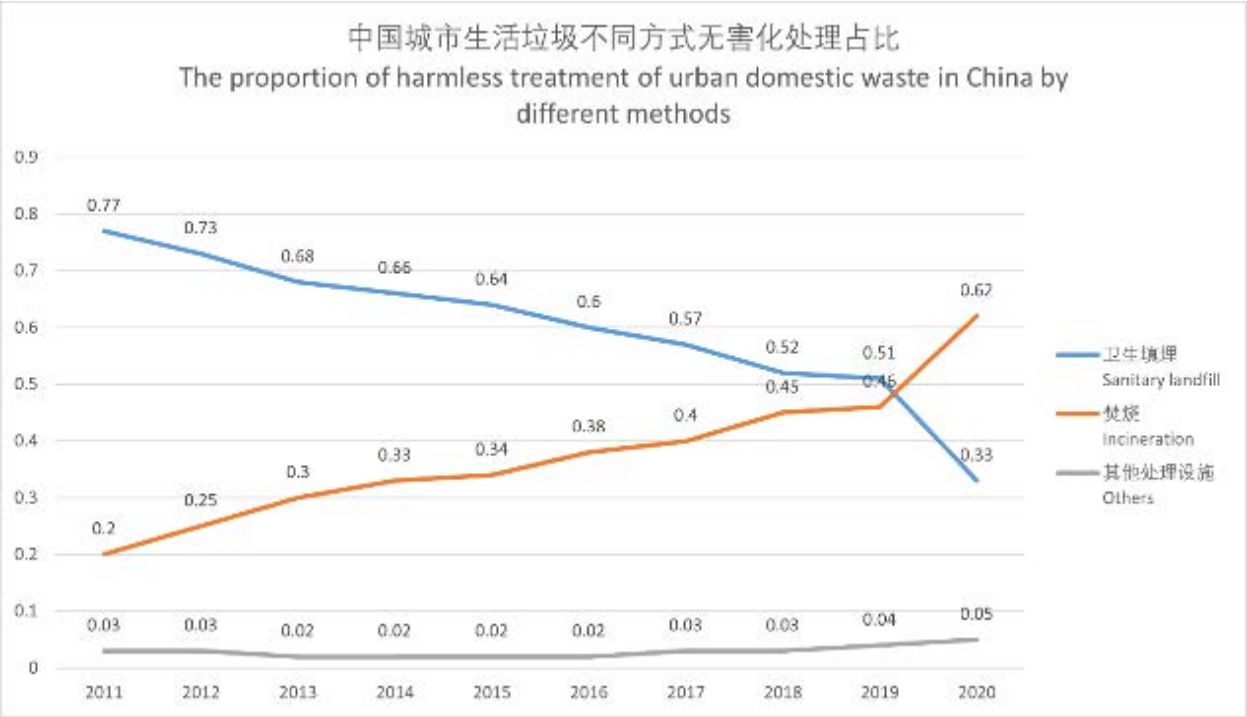


Figure 27 The proportion of harmless treatment of urban domestic waste in China by different methods

3.2.2.4 Competitive landscape of domestic waste treatment in China

End-processing enterprise industry chain forward

Back-end waste incineration enterprises expand their business to the front end and enter the front-end market for the collection and transportation of classified waste. Utilizing the absolute advantage of incineration enterprises in disposal, they can collect, transport and dispose of the whole category of regional garbage. Reference can be made to the practice of China Tianying Co，Ltd.

Back-end extension model for sanitation companies

The advantages of having a sanitation enterprise intervene in garbage classification, recyclable garbage recovery, and resource processing and utilization are that it utilizes resources such as sanitation and

cleaning manpower and site facilities to undertake garbage classification and recycling operations, and increases the function of sorting and processing recyclable garbage, which is conducive to lowering costs and improving synergistic efficiency. Reference can be made to the practices of Beijing Jinghuan Group, Hangzhou Sanitation Group, Qinglong Sanitation in Chengdu's Chenghua District, Zhejiang United Transportation and other sanitation enterprises.

Cross-border transformation mode of renewable resources enterprises

Recycling enterprises will undertake waste classification, network layout, recycling and processing of recyclable waste, and resource utilization of food waste, to realize the cross-border transformation of traditional recycling enterprises into environmental services. The advantage of this model is that the renewable resources enterprises can play to their strengths, set up online and offline recycling networks and build back-end processing and utilization chains. Reference can be made to the practices of Guiyang Gaoyuan Company, Guangzhou Supply and Marketing Bureau, Beijing Daily Clean and Chengdu Waste Treasure Network.

Vertical integration of the sanitation industry chain

In this mode of operation, one operator is responsible for waste classification, sanitation and transportation, road cleaning, resource recovery and processing, and resource utilization of food waste. The government usually adopts the PPP approach, through the purchase of services, the operating entity to provide the government with a package of solutions for domestic waste is an all-round, high-efficiency "two-network convergence". Reference can be made to the practices of Zhuhai Shifu Company, Shandong Pingdu Sanglan Company, and Beijing Sanitation's Chengdu Chongzhou project.

Government-led to create a model

Government authorities are fully involved in the layout of classification, stations, network setup, selection of main enterprises and back-end processing and utilization, with strong support from financial resources. This model is fast-acting and suitable for initial piloting. Reference can be made to the practices of Guangzhou's Yuexiu District, Shanghai's Songjiang District and Suzhou's Sanitation Department, with a more diverse range of enterprises involved, such as Suzhou Voltai, an intelligent sanitation enterprise, and Zhejiang Lianyun, a sanitation service enterprise.

IT technology companies rise to the top

Internet enterprises through a completely market-oriented means, the use of intelligent recycling machines or two-dimensional code recycling bag mode recovery of plastics, paper, metal and other recyclables, through the collection of renewable resources, transportation and disposal, to achieve a certain scale of collection and transportation to achieve market-oriented services. Reference can be made to the practice of Shandong's Dot Dot Recycling and Chengdu Aobei Environmental Protection.

Resource recovery company focuses on "two-network integration"

Establishing single-species recycling networks and specialized processing and production bases to create a whole industry chain of specialized recycling, processing, utilization and end-product manufacturing. This model is suitable for low-value recyclables such as waste textiles, waste glass and bulky garbage. Reference can be made to the practices of Beijing Yingchuang, Guangdong Everest Environment and Chengdu Hangzhou Environmental Protection.

Distributed processing model

The main body of the operation realizes wet and dry classification at the front end, and highly overlaps with the sanitation network at the middle end, utilizing the garbage compression rooms and transfer yards of the sanitation system distributed in the urban area, and carrying out renovation and upgrading to increase the equipment used for processing the food waste and recyclable garbage, to achieve the goal of "one game for two purposes". It is characterized by near and decentralized processing of food waste, small-scale processing, and changing centralized waste processing to decentralized processing. Its benefits are to reduce logistics and site costs, shorten the distance of garbage transportation, and reduce the phenomenon of leakage during transportation. Reference can be made to the practices of Shenzhen Intel Technology and Chengdu IFS.

3.2.2.5 Typical cases in China

Xiamen Low-Value Recyclables Sorting Center: Located in Haicang District of Xiamen City, Xiamen Low-Value Recyclables Sorting Center is the first low-value recyclables sorting center in China, which is invested and operated by Land & Sea Environmental Protection. The project was inaugurated on December 31, 2022, and is now in full operation. It can process 50 tons of mixed low-value recyclables (various types of rigid plastics, plastic film bags, paper-based composite packaging, etc.) per day. PP, PE and paper-based packaging will be further recycled by Luhai Environmental Protection, while the rest will be packaged and sold.

Chongqing Xajiaba Food Waste Transfer Center: Completed in November 2020, this is the first fully automated food waste sorting plant in the city. The project receives food waste from six areas in the main city of Chongqing, including Yubei District, Jiangbei District and Liangjiang New District, with a capacity of 400 tons per day. The food waste is mechanically and optically sorted to separate out mixed metals, plastics and other combustibles, and at the same time to realize the purification effect on organic matter. After dry cleaning, the sorted plastics go into the waste plastic processing plant to realize resource utilization. The purified organic matter can be used for anaerobic fermentation to produce biogas.

Suzhou "Reinventing Packaging" Project: A collaboration between GIZ, Suzhou City Recycling, Beijing Normal University, Como Environmental and other companies and organizations. GIZ and Suzhou City Recycling sorted out waste plastics from Suzhou's municipal waste, and the soft plastics were chemically recycled by Thermo Scientific to produce plastic pyrolysis oil, which led to the conclusion that "50% of all plastic waste can be chemically recycled". This project is the first time in China to explore the high-value resource utilization of low-value plastic waste through the mode of "sorting + resource utilization".

Jiangsu Haishengyuan Renewable Resources Co., Ltd. is a high-tech environmental protection enterprise engaged in the processing and crushing of scrap steel and intelligent sorting of scrap steel crushing tailings, and the comprehensive utilization of recycling. The company's project located in Jiayu County, Xianning City, Hubei Province, recycles and processes 500,000 tons of scrap steel annually and sorts 100,000 tons of crushed tailings annually. After crushing the scrap steel briquettes, the scrap steel is picked out by magnetic separation, and then the aluminum, zinc, copper, iron, stainless steel, plastic and rubber in the tailings are separated one by one by photoelectric sorting, and then finally the high calorific value substances in the residue (such as sponges, fabrics, foot mats, carpets, carpet rubber and plastic, etc.) are made into RDF, which can be supplied to the power plants and cement factories as an alternative fuel to lignite coal. The project is built as the first green, intelligent and efficient demonstration base for the separation of scrap steel crushing tailings in China.

The Xupu Two-Network Integration Distribution Center, which was built by Shanghai CITIC Environment in 2020 in conjunction with waste classification, is a demonstration project that integrates automated fine sorting, automated sorting, baling and transferring, and intelligent inbound and outbound storage, with a processing capacity of 60 tons/day of recyclables. Mixed rigid plastics collected from various collection points are classified into transparent PET, miscellaneous PET, white HDPE, miscellaneous HDPE, and other plastics and films by AUTOSORT optical sorting equipment, which greatly improves the purity and value of the sorted materials and lays the foundation for subsequent high-value recycling.

Jiuxianqiao Garbage Classification Project: Beijing Jiuxianqiao Garbage Classification Project adopts the intelligent garbage classification model - "wet and dry classification model". The wet and dry garbage classification model is a new model to simplify the garbage classification process for residents based on the experience of Beijing Microenvironmental Management Co. A new model to simplify the sorting procedure for residents' garbage. It realizes door-to-door recycling of small dry garbage (plastics, metal parts, used electronics, glass, textiles and paper, etc.), and for wet garbage (food waste), residents only need to drop it off at regular intervals. Residents will be encouraged to participate in wet and dry waste sorting through the implementation of a "reward point" system. Within 10 months, more than 63% of the residents in the districts where smart waste separation was implemented had completed the registration process, realizing a 6.2% reduction in the amount of waste at source.

3.2.2.5 Market trends and opportunities

Trends

China is currently one of the countries that produce the most domestic waste in the world, and with the urbanization process, the amount of domestic waste produced will continue to increase, and the composition will be more complex. With China's gradual attention to domestic waste management, the development of relevant policies and regulations, as well as the continuous construction of relevant supporting facilities, the environmental problems generated by domestic waste in China have gradually been controlled and improved, but it should be noted that the overall level of waste treatment in China is

still relatively backward, and there is still a large gap between the relevant waste treatment technology and equipment and professional talents.

China's urban household waste management and its management process roughly includes five stages: source reduction, reuse, recycling, regeneration and end-of-pipe treatment.In the "14th Five-Year Plan," it is clearly stated that by 2025, the incineration capacity for municipal solid waste will reach 800,000 tons per day, effectively achieving near "zero landfill" of untreated waste.

China's municipal waste management is currently in a pivotal phase transitioning from "scale-based treatment" to "refined management." This transition requires sustainable development through policy innovation, technological advancement, and societal collaboration. Over the next five years, it is anticipated that the resource utilization rate will increase to over 35%, and digital management systems will be implemented across major cities. However, rural and less developed areas will still need to focus on addressing infrastructure deficiencies.

In recent years, China's domestic waste disposal technology has been in continuous development and innovation, landfill disposal technology from the earliest simple pile and landfill, the development of impermeable full cover good safety and hygienic filling; incineration power generation technology will be in the domestic waste of combustibles into carbon dioxide and water, etc., produced by the preheating used for power generation to realize the domestic waste, "reduction, harmlessness and resourcefulness," China's incineration power generation facilities and processing capacity increases year by year, reaching 463 seats in 2020, and the proportion of domestic waste treatment reaches 62%. However, sanitary landfill leachate pollution of soil, groundwater and other issues, as well as incineration and power generation flue gas produced by dioxin, fly ash disposal and other secondary pollution of the environment, need to be solved by technological innovation and development.

Since the beginning of this century, the volume of urban domestic waste has surged, and the demand for end-of-pipe disposal has increased by leaps and bounds. However, due to the accelerated urbanization process, urban land constraints, and new landfill site selection difficulties, incineration disposal is gradually becoming the preferred option. Promoted by a series of policies and regulations, the proportion of incineration in the end-of-life waste disposal capacity has increased rapidly, from 3.7% in 2002 to nearly 80% in 2022, fully dominating the treatment of domestic waste. However, the vast majority of waste is burned, and the overall recycling rate of waste is still not high.

The existing system of collection, transportation and treatment facilities can hardly meet the requirements of classification. First, there are outstanding shortcomings in the classification and collection facilities. The amount of domestic garbage generated in cities and towns has increased considerably, and the original collection and transportation facilities can no longer meet the needs. At present, in addition to 46 key cities, most prefecture-level cities and counties have yet to set up facilities for separate collection and transportation of domestic waste. Secondly, there is still a large gap in waste incineration capacity, about 50% of the cities (including prefectural-level cities and county-level cities) have not yet built incineration facilities, and there is a large gap in incineration capacity in most counties. Third, the utilization rate of

resource utilization needs to be further improved. At present, China's domestic garbage disposal by landfill is still a large proportion of domestic garbage recycling enterprises, "small, scattered, chaotic" and low recycling level is still prevalent, the utilization rate of urban domestic garbage resource utilization rate of about 50%, there is more room for improvement. Fourth, food waste classification and treatment channels are not smooth. The classification of food waste is ineffective, and there are obstacles to the consumption of treated fertilizer, as well as difficulties in the stable operation of facilities and high treatment costs.

The imbalance in regional development remains prominent. First, the harmless treatment capacity in the central and western regions is still insufficient, with the harmless treatment rate of domestic waste in established towns in the western and some parts of the northeastern regions being less than 30%, which is far lower than the target of 70% put forward in the relevant plan under the "13th Five-Year Plan". Secondly, the progress of promoting waste classification varies from place to place, with the eastern region in general making relatively fast progress, and key cities having achieved positive results, while most of the central and western regions are in the preliminary exploration stage, except for key cities. Third, the level of waste incineration treatment in the central and western regions is lower than that in the east, the incineration treatment rate of the southeastern coastal cities is more than 60%, and the incineration treatment rate of the central and western regions is less than 50%, especially in the western sparsely populated, remote and other special areas, subject to the limitations of the economic conditions, the number of people, the conditions of transportation and other constraints, and has not yet explored a mature, efficient, and economically feasible incineration treatment mode that is appropriate to the level of local economic development. Foreign companies can focus more on those regions that are lack of capability, and needs more development on domestic waste treatment and have more space for market.

Opportunities

The Netherlands has significant technological advantages in the field of waste recycling, such as microbial treatment of organic waste (which can convert kitchen waste into high - efficiency organic fertilizer) and high - value recycling technologies (such as plastic regeneration). Currently, incineration accounts for 79.9% of waste treatment in China, but the capacity for kitchen waste treatment is insufficient. Dutch companies can target this demand and promote organic waste recycling technologies. For example, they can cooperate with local governments to build kitchen waste treatment centers and provide full - chain solutions from sorting and collection to end - of - line treatment.

The Netherlands has significant technological advantages in the waste recycling sector, such as microbial organic waste treatment technology (which can convert food waste into high-efficiency organic fertilizer) and high-value recycling technologies (e.g., plastic recycling). Currently, incineration accounts for 79.9% of waste treatment in China, but there is insufficient capacity for food waste treatment. Dutch enterprises can target this demand by promoting organic waste recycling technologies—for example, collaborating with local governments to build food waste treatment centers and providing full-chain solutions from classified collection to terminal processing.

China has introduced multiple green financial support measures, such as green bond interest subsidies and PPP project subsidies. Dutch enterprises can collaborate with local partners to apply for green bond financing or participate in government-led PPP projects. Establishing joint ventures with Chinese local enterprises is an effective way to mitigate risks. For example, Dutch companies can cooperate with leading Chinese firms like China Everbright International and Capital Environmental Protection to jointly invest in building waste incineration plants or recycling projects. Technology licensing models can rapidly expand market coverage. Participating in government-led PPP projects allows for stable revenue through long-term operations.

In addition to green financial policies, Dutch enterprises can seek support from international capital, such as green loans from the European Investment Bank (EIB) or funding through Sino-Dutch bilateral funds. As a leader in the circular economy, the Netherlands can enhance its brand image by promoting the "zero-waste" concept and successful cases (such as the AEB waste incineration plant), and strengthen public trust by investing in community environmental protection projects in China.

3.2.3 Agricultural waste

Agricultural solid waste in China refers to solid waste generated during agricultural production activities. It mainly comes from plant cultivation, animal breeding (residues generated in the process of livestock and poultry breeding) and agricultural plastic residual film. Contains waste generated in agricultural production and livestock and poultry farming, mainly referring to crop residues and livestock and poultry manure.

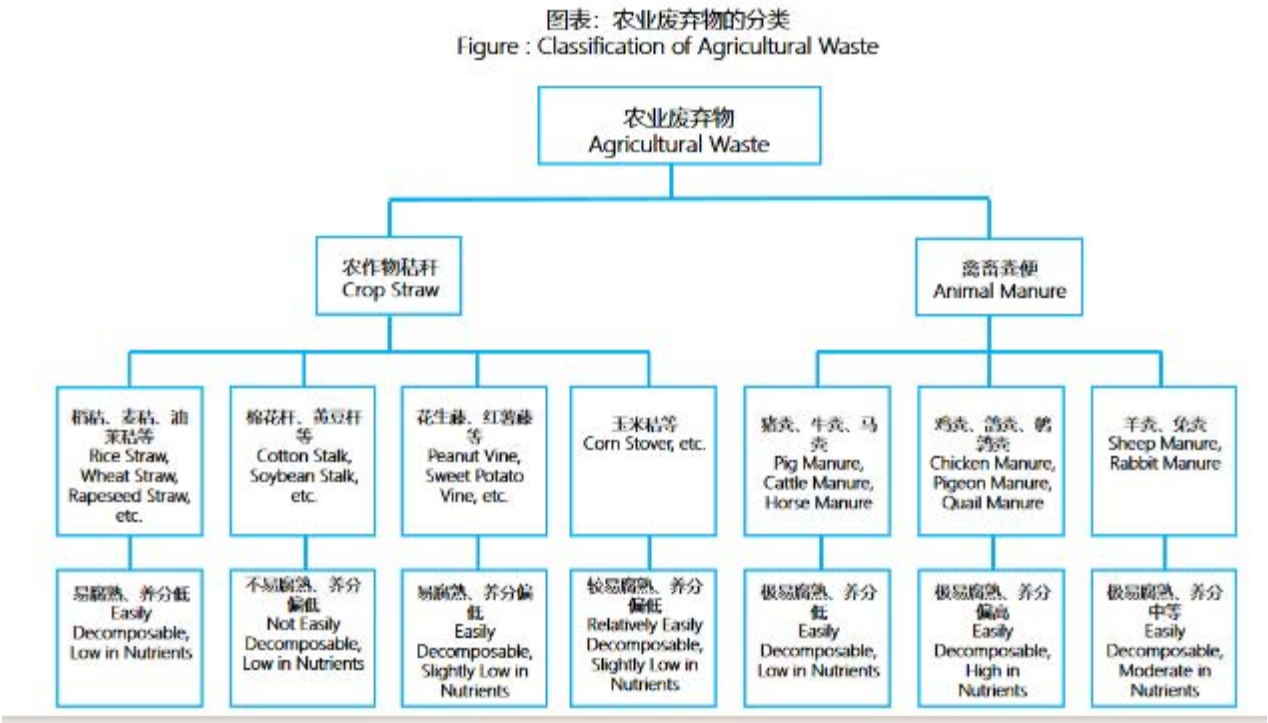


Figure 28 Classification of Agricultural Waste

3.2.3.1 China's agricultural waste treatment industry related policies

In order to enhance the management of agricultural waste, China has successively promulgated a number of policies. For instance, the "Opinions of the General Office of the State Council on Accelerating the Construction of a Waste Circulation and Utilization System" issued by the General Office of the State Council in 2024 proposes to accelerate the improvement of the agricultural waste collection system. It calls for the establishment and improvement of a collection, treatment, and utilization system for livestock and poultry manure, and the construction of supporting facilities for centralized collection and treatment of livestock and poultry manure, as well as storage and utilization of biogas residues and liquids in a location-specific manner. It also calls for the improvement of the straw collection, storage, and transportation system, guiding major straw producers to collect and store straw locally and cultivating third-party service providers for collection, storage, and transportation. In addition, it guides localities to strengthen the recycling of old agricultural materials such as agricultural films, pesticide and fertilizer packaging, agricultural machinery, and fishing nets, and to actively leverage the role of the supply and marketing cooperative system's recycling network.

At the same time, the "Action Plan for the Battle against Agricultural and Rural Pollution (2021–2025)" has also set out relevant requirements, proposing that by 2025, the level of rural environmental remediation will be significantly improved, agricultural non-point source pollution will be initially controlled, and the rural ecological environment will continue to improve. Among them, the recovery rate of agricultural films will reach 85%, and the comprehensive utilization rate of livestock and poultry manure will exceed 80%. These policies provide clear guidance and targets for the scientific treatment and resource utilization of agricultural waste, promoting the agricultural waste treatment industry to develop in a more standardized and efficient direction.

Authorities and responsibilities for agricultural waste management

The Ministry of Agriculture and Rural Affairs of the People’s Republic of China is responsible for guiding the recycling and utilization of agricultural solid waste nationwide. It takes the lead in promoting the prevention and control of agricultural solid waste pollution and works with the Ministry of Ecology and Environment and other relevant departments to establish and improve the recycling and utilization system for agricultural solid waste

The agricultural and rural affairs departments of provinces, autonomous regions, and municipalities directly under the central government are responsible for managing agricultural solid waste within their administrative regions and supervising and guiding the disposal of agricultural solid waste at the local level. This includes the management of four types of agricultural solid waste: livestock and poultry manure, crop straw, waste agricultural films, and pesticide packaging waste.

The agricultural and rural affairs departments of local people’s governments at or above the county level are responsible for the supervision and administration of the duties of pesticide producers, operators, and users in the recovery and treatment of pesticide packaging waste within their administrative regions. Meanwhile, the ecological environment departments of local people’s governments at or above the county level are responsible for the supervision and administration of environmental pollution prevention and

control in the activities of recovery and treatment of pesticide packaging waste within their administrative regions.

Principles and requirements for the disposal of agricultural waste

Agricultural waste disposal in China should follow the principles of reduction, resource utilization, and harmlessness, and encourage agricultural producers to prioritize the use of agricultural waste comprehensive utilization products to promote the recycling of waste in agricultural production.

The construction of agricultural waste collection, processing, and comprehensive utilization facilities should be incorporated into rural infrastructure planning, improve the recovery system for straw, livestock and poultry manure, agricultural films, etc., build supporting facilities as appropriate, and ensure that waste has a suitable disposal site.

The agricultural and rural authorities should formulate agricultural waste disposal plans based on the regional agricultural production situation, reasonably arrange straw returning to the field, manure resource utilization, agricultural film recycling, etc., strengthen monitoring, evaluation, and law enforcement inspections, and promote the development of the agricultural waste resource utilization industry.

Regulations and prohibitions on disposal of agricultural waste

The collection, storage, transportation, utilization, and disposal of agricultural waste should comply with relevant national laws and regulations, ensuring harmless treatment and resource utilization. County-level and above people's government agricultural and rural authorities are responsible for guiding the construction of agricultural solid waste recycling systems, and encouraging and guiding relevant units to legally collect, store, transport, utilize, and dispose of agricultural solid waste.

No unit or individual shall dump, pile up, or discard agricultural waste at will, nor shall they mix hazardous waste with agricultural waste. Open burning of straw is prohibited in densely populated areas, around airports, and near transportation routes.

Entities engaged in the production, sale, and use of pesticides shall fulfill their obligations to recycle pesticide packaging waste and must not discard or scatter it. Users of agricultural films shall take effective measures to recycle and utilize them and are prohibited from using non-degradable agricultural films.

Violations of agricultural waste disposal regulations will be punished in accordance with relevant laws and regulations, including being ordered to correct the behavior and being subject to fines.

3.2.3.2 China agricultural waste treatment market analysis

Crop Straw

According to data released by China's Government[4] , in 2019, the country's livestock and poultry manure production of 3.05 billion tons, crop straw production of 870 million tons, 2.465 million tons of agricultural film for use, and about 3.5 billion pieces of discarded pesticide packaging waste. According to the average annual growth rate of 0.3% of the sown area of grain crops in 2024 and the information of the Ministry of Agriculture and Rural Affairs' straw account data, China's theoretical straw production in 2025 will be 897 million tons, and the amount that can be collected and disposed of will be 880 million tons.

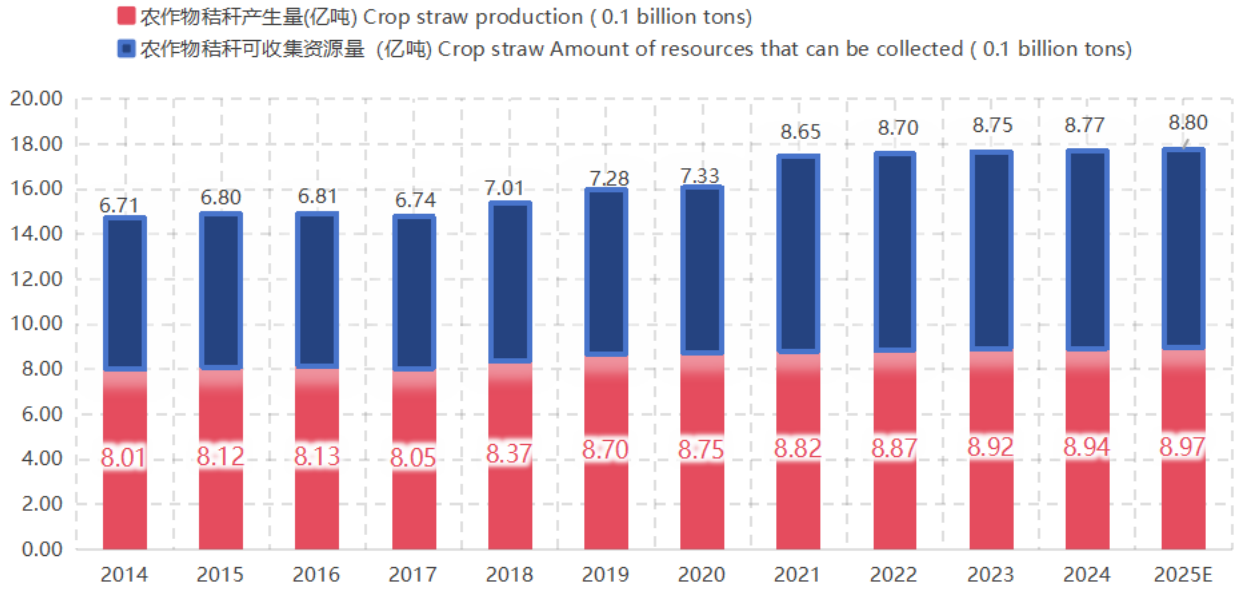


Figure 29 Crop straw production and resources can be collected

The basic data for calculating China's straw production come from the production of major agricultural products in China published in the China Statistical Yearbook and the statistical data of China's sub-districted arable land area, including the arable land area of the country's 31 provinces (autonomous regions and municipalities excluding Hong Kong, Macao, and Taiwan) and the economic production of major crops from 2009 to 2018. Major crops include 16 categories of crops such as rice, wheat, corn, other cereals, beans, potatoes, rapeseed, cotton, hemp, sugar, sugar beet, sugarcane and tobacco.

[4] Opinions of the Ministry of Agriculture and Rural Affairs on the Implementation of the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste

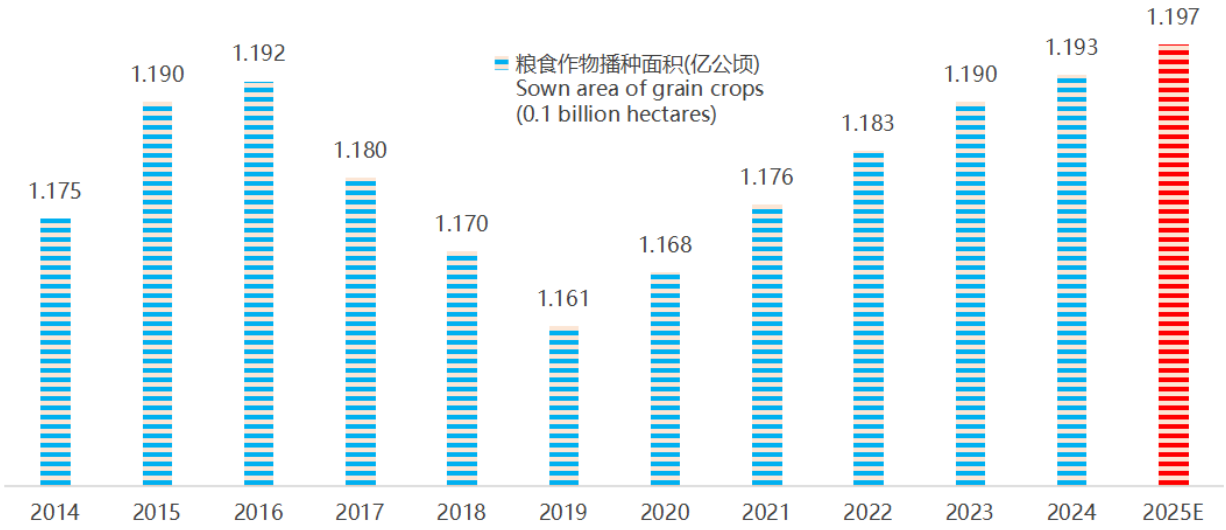


Figure 30 Sown area of grain crops

From 2014 to 2024, China's overall grain crop planting area showed a trend of first increasing, then decreasing, and finally increasing again. According to data released by the National Bureau of Statistics, China's grain crop planting area in 2024 will be 119.3 million hectares.

According to the data published in the Second National Pollution Source Census Bulletin, in 2017, the national straw production was 805 million tons, the amount of straw collectible resources was 674 million tons, and the amount of straw utilization was 585 million tons.

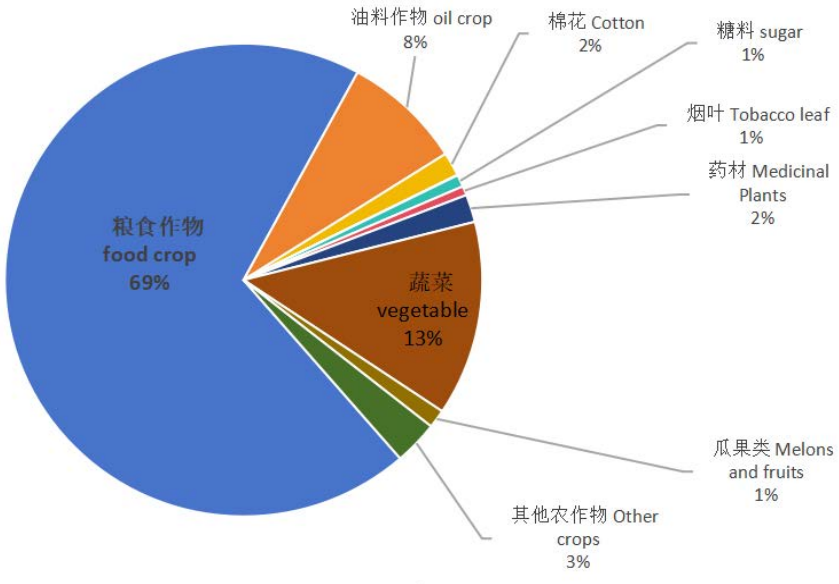


Figure 31 Planting structure of crops in China in 2023

In the planting structure of crops in China in 2023, grain crop planting accounted for 69%, followed by vegetables at 13%, and then oil crops at 8%. In the structure of grain crop cultivation, grains accounted for 58.22%, corn 25.76%, rice 16.87%, and wheat 13.77%.

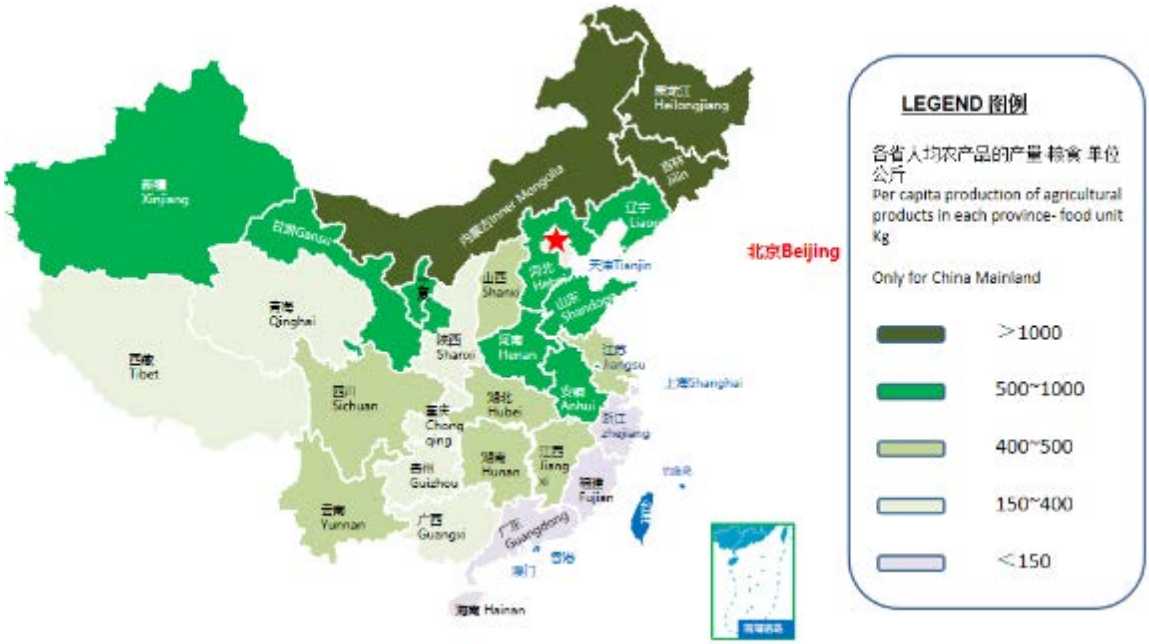


Figure 32 Per capita production of agricultural products in each province-food

The per capita agricultural product data of each province shows that Heilongjiang, Jilin and Inner Mongolia have the highest per capita agricultural product - grain and cereals. Xinjiang's per capita cotton agricultural product data ranks first in the country, at 197 kilograms per person.

Agricultural plastic films

Agricultural plastic films are mainly shed films and ground films, in addition to shade nets, insect nets, films for forage, and agricultural non-woven fabrics, etc. In 2022, the national use of agricultural plastic films was 2.37 million tons, and the use of ground films was 1.34 million tons.

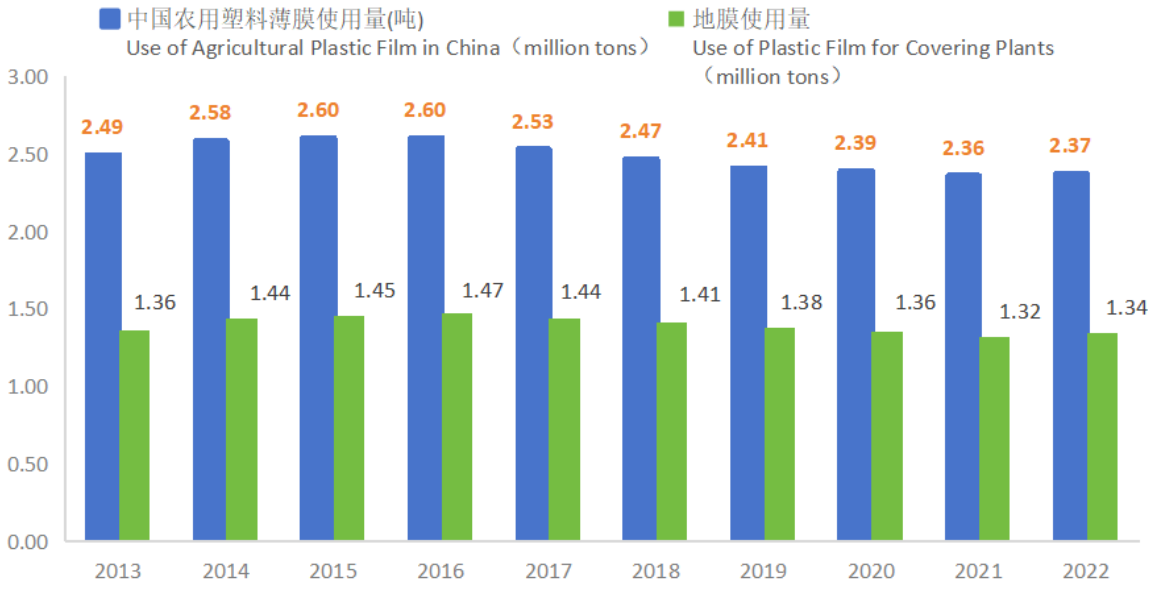


Figure 33 Use of Agriculture Plastic film and plastic film in China

As can be seen from the figure, the use of agricultural plastic film and ground film both show a trend of first slightly increasing and then slowly decreasing with the increase of years. Current data shows that in 2022, China's use of agricultural plastic film will stabilize at around 2.37 million tons, with ground film accounting for about 56.5%.

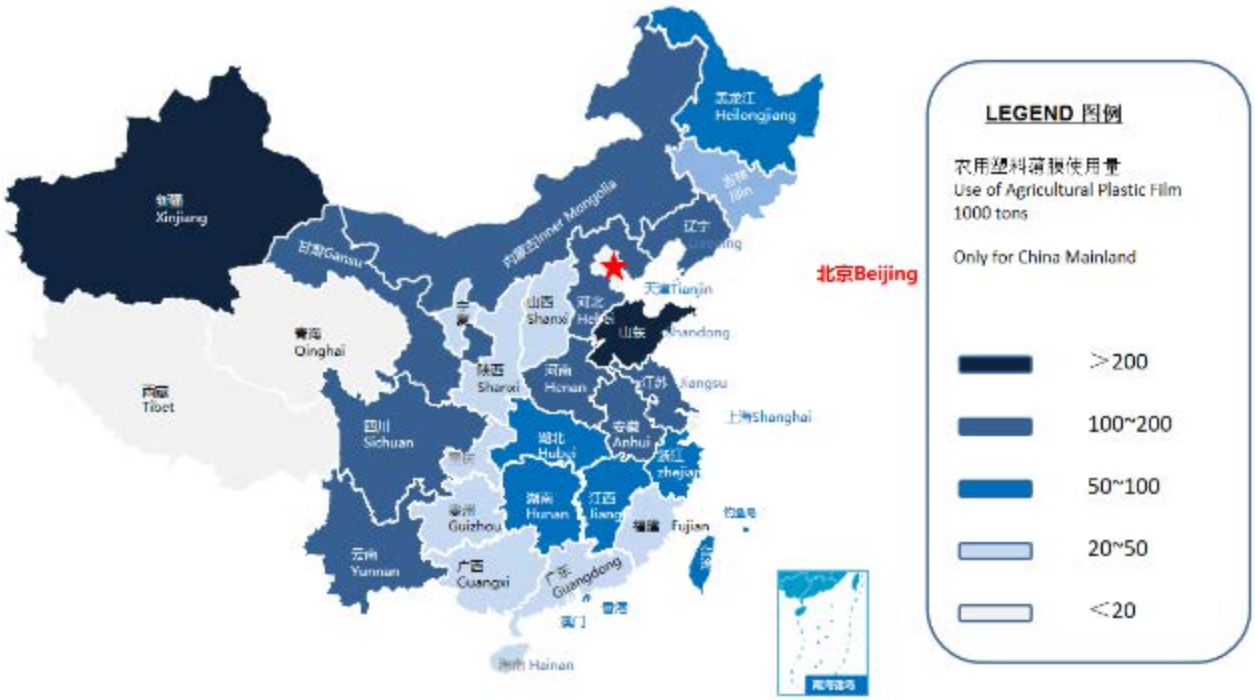


Figure 34 Use of agricultural plastic film in China

The regions with the largest use of agricultural plastic films are Xinjiang and Shandong regions, followed by Inner Mongolia, Gansu, Sichuan, Yunnan, Liaoning, Hebei, Henan, Anhui and Jiangsu regions.

Figure 35 Use ofplastic film in China

The region with the largest usage of plastic film is Xinjiang, followed by Inner Mongolia and Gansu; Sichuan, Yunnan, Henan and Shandong are also provinces with relatively large usage.

Livestock and poultry wastes

The livestock industry is traditional, but also a dynamic and vibrant industry. With the sustained and stable growth of China's economy and the continuous improvement of residents' income levels, the demand for animal products has increased rapidly. At this stage, China has formed a more perfect industrial chain and more adequate supply capacity and has become one of the two pillars of the agricultural industry alongside the planting industry.

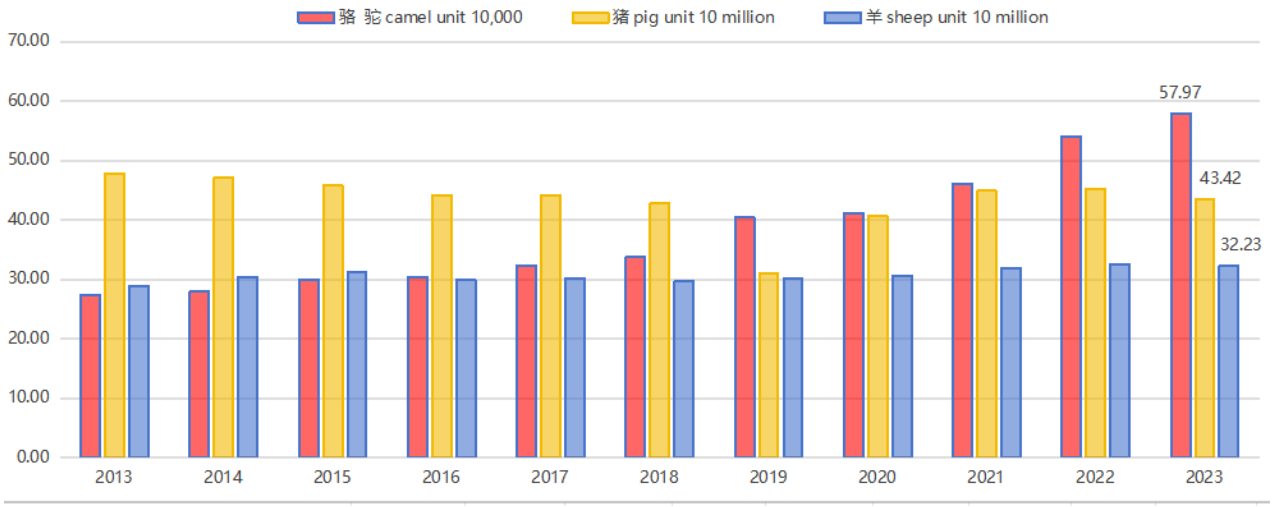


Figure 36 Production of livestock industry in China

With the growth of China's population and the continuous improvement of residents' consumption level, the demand for poultry and livestock products continues to grow year by year. In 2019, due to the impact of African swine fever, the scale of pig farming in the Chinese market declined sharply. In 2020, against the background of a sharp decline in the scale of global pig farming, China's pig farming scale has recovered under the guidance and support of relevant national policies. Overall, driven by the growth of demand for poultry and livestock, the scale of poultry and livestock farming in China has shown an overall growth trend.

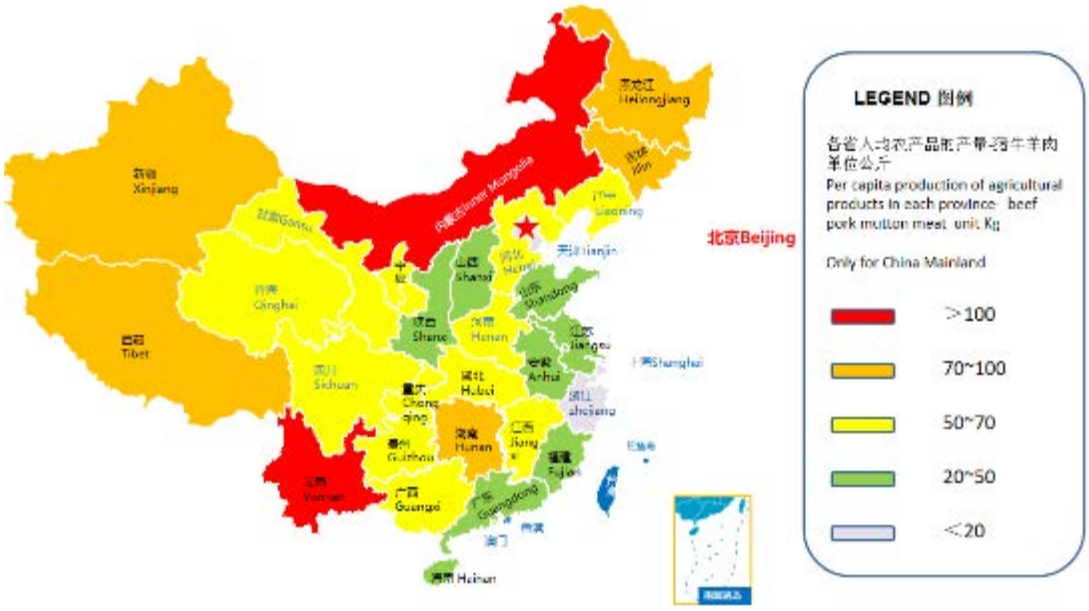


Figure 37 Per capita production of agricultural products in each province-beef pork mutton meat

Per capita agricultural product data for each province showed that Inner Mongolia and Yunnan provinces had the highest per capita agricultural product output - pork, beef and mutton, reaching 100 kilograms per person.

In terms of pig inventory, at the end of 2023, China's pig inventory was 434.2227 million, a year-on-year decrease of 18.3346 million, a year-on-year growth rate of -4.1%, and a compound growth rate of -0.26% compared with 2016; the number of sows with breeding capacity at the end of the year was 41.42 million, a decrease of 2.48 million from the end of the previous year, a decrease of 5.7%.

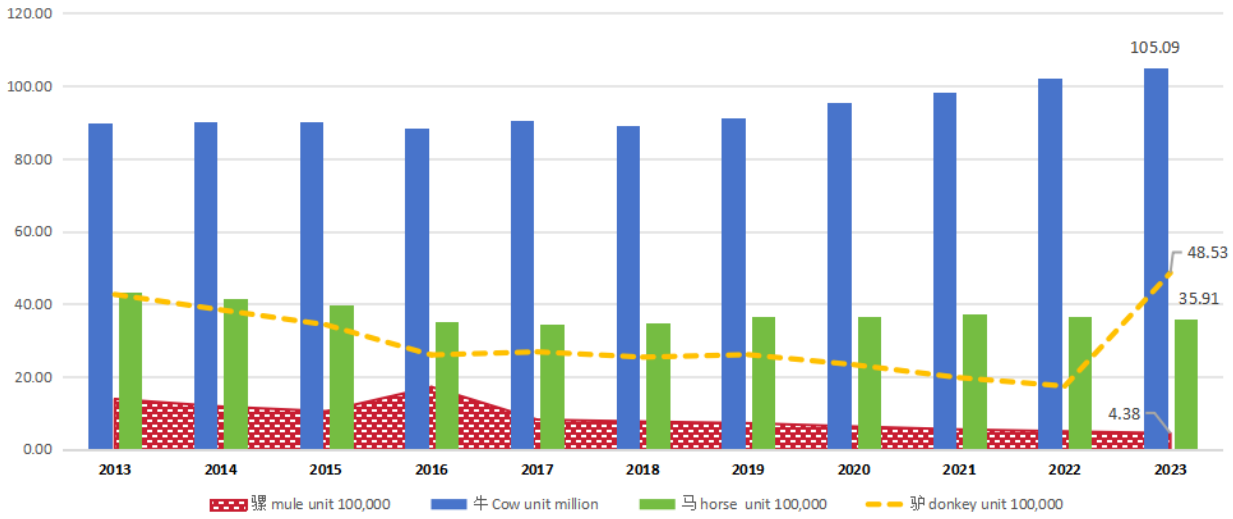


Figure 38 Production of livestock industry in China

In terms of animal inventory, at the end of 2023, China's cattle inventory will be 105.09 million, an increase of 2.93 million from the end of the previous year, an increase of 2.9%, the highest inventory since 2019, and a compound growth of 2.51% over 2014; the sheep inventory will be 322.33 million, a decrease of 3.95 million from the end of the previous year, a year-on-year decrease of 1.2%, and a compound growth of 1.06% over 2014. At the end of June 2024, the national cattle inventory will be 102.04 million, an increase of 2.9% over the previous year; the sheep inventory will be 320.74 million, a decrease of 2.8% over the previous year, ending four consecutive years of growth.

In terms of animal slaughter volume, in 2023, China's cattle and sheep slaughtered amounted to 50.2348 million and 338.64 million, respectively, an increase of 1.8357 million and 2.4 million with a year-on-year change rate of 3.8% and 0.7%, and a compound growth rate of 2.01% and 2.11%, compared with that in 2014. In the first half of 2024, the country's cattle slaughter volume amounted to 21.5 million, an increase of 2.4% over the previous year; the total sheep slaughter volume amounted to 140.84 million, a decrease of 3.1% over the previous year. Overall, with the increase in residents' demand for cattle and sheep consumption, the scale of domestic cattle and sheep breeding is showing a growing trend.

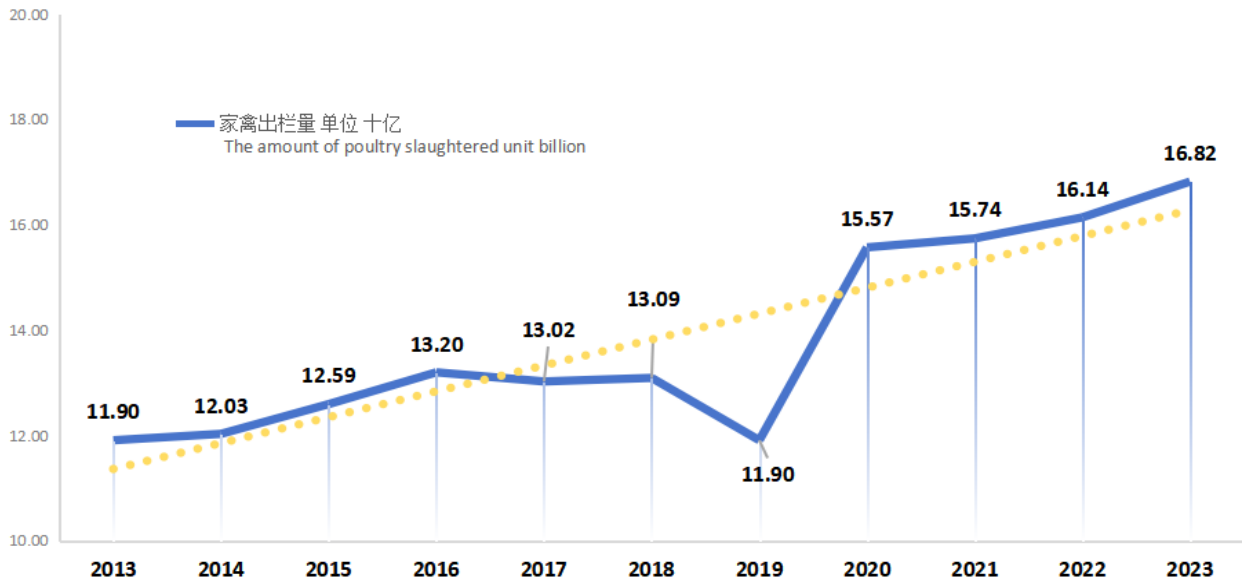


Figure 39 The amount of poultry slaughtered

In terms of poultry slaughter volume: the poultry slaughter volume from 2016 to 2023 showed an upward trend. Data showed that at the end of 2023, China's poultry slaughter volume was 16.82 billion, an increase of 680 million from the end of the previous year, an increase of 0.2%. The poultry inventory at the end of 2020-2023 was relatively stable, basically stable at more than 6.8 billion RMB. At the end of 2023, China's poultry inventory was 6.78 billion RMB, a year-on-year increase of 0.2%.

Different livestock produce different amounts of manure, according to the livestock manure excretion coefficients, combined with the livestock feeding cycle and the amount of feeding to estimate the amount of national livestock manure production, take 2023 China's livestock and poultry breeding stock data for example

Table 7 The value of the excretion value of the excretion coefficient in China

Category	Value（Kg/day）	Raising cycle: Day	Animal Number Calculate Basis
Sheep	2.51	＞365	Breeding Stock at the end of 2023
Horse	16.16	＞365	Breeding Stock at the end of 2023
Donkey Mule	13.9	＞365	Breeding Stock at the end of 2023
Camel	17	＞365	Breeding Stock at the end of 2023
Pig	7.65	199	slaughtered number at the end of 2023
Beef cattle	33.05	＞365	slaughtered number at the end of 2023

Category	Value（Kg/day）	Raising cycle: Day	Animal Number Calculate Basis
Dairy cattle	41.1	＞365	Breeding Stock at the end of 2023
Poultry	0.125	＜365	Breeding Stock at the end of 2023

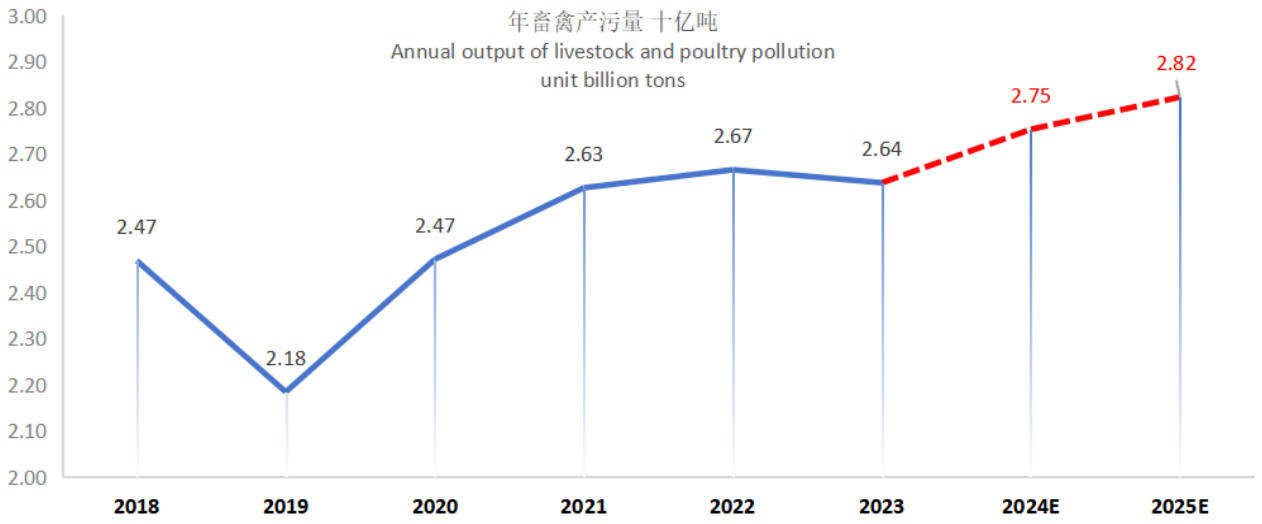


Figure 40 Annual output of livestock and poultry pollution

With the rapid development of China's livestock industry, the current output of livestock and poultry manure has reached more than 2.8 billion tons per year and is continuing to increase. Based on the availability of data, the statistical scope of the above estimate of the amount of livestock manure produced does not include all livestock species and the actual amount of livestock manure produced is greater than the above estimate.

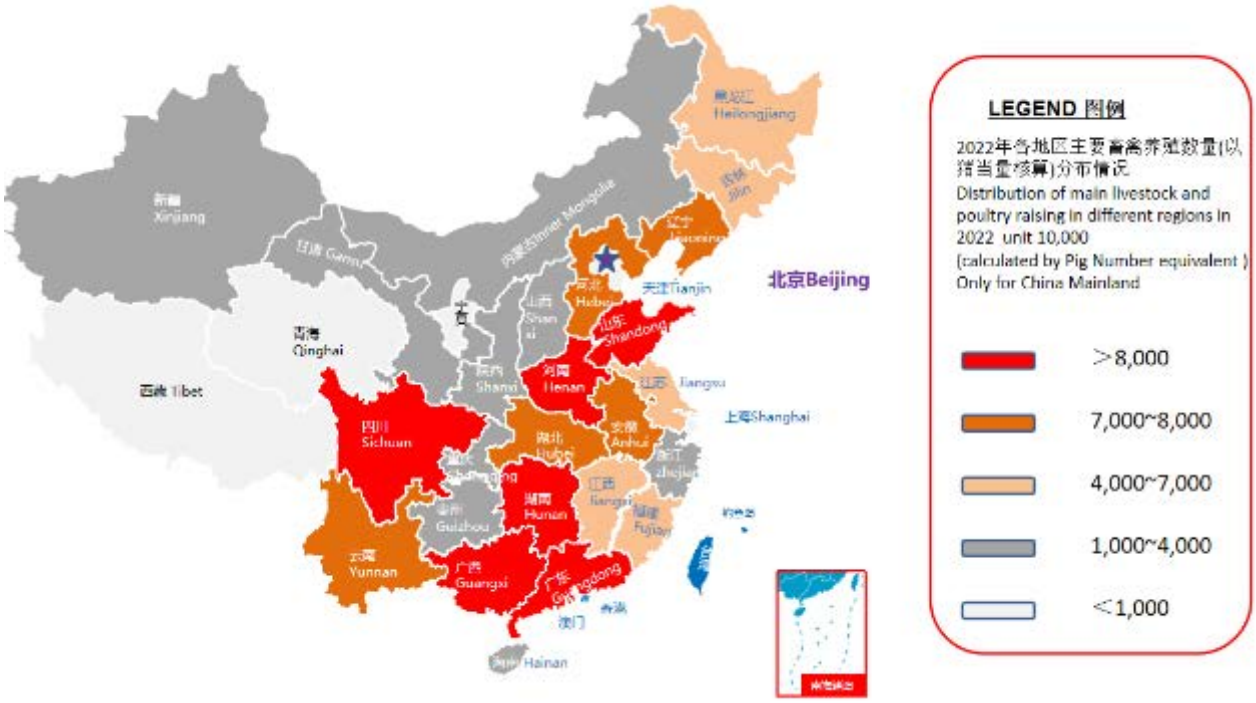


Figure 41 Distribution of main livestock and poultry raising in different regions in 2022

Livestock and poultry farming in China is mainly concentrated in the provinces of Shandong, Hunan, Henan, Guangdong, Guangxi and Sichuan, etc. The northwestern region of China is the sparse area of livestock and poultry farming in China, while the east-central region is the intensive area of livestock and poultry farming.

Statistical data analysis shows that China's southwestern region developed an herbivorous livestock industry, mainly raising cattle and sheep, based on its grassland advantages. The top provinces in the cattle industry are Inner Mongolia, Yunnan, Hebei, and Heilongjiang; the top provinces in the sheep industry are Inner Mongolia, Xinjiang, Hebei, Shandong, Henan and Gansu; the top provinces in the pig industry are Sichuan, Hunan, Henan, Yunnan and Shandong; the top provinces in the poultry and egg industry are Shandong, Guangdong, Henan, Anhui, Fujian and Guangxi.

3.2.3.3 China's agriculture waste treatment resource analysis

According to data released by China's Ministry of Agriculture and Rural Affairs and the "Bulletin on the Status of China's Ecological Environment" released by the Ministry of Ecology and Environment, China's comprehensive utilization rate of livestock and poultry manure and straw has increased year by year, from 75% and 86% in 2019 to 79% and 88% in 2024, respectively. The recycling rate of agricultural film remains stable at 80%. According to the 14th Five-Year Plan released by the Chinese government, by 2025, China's comprehensive utilization rate of poultry manure and straw will reach 80% and 89% respectively, and the recycling rate of agricultural film will also be increased to 85%.

Table 8 Straw factors of different crops in China

SN:	Category	Straw factors	SN:	Category	Straw factors
1	Rice	1.00	9	Potato	0.57
2	Wheat	1.17	10	Peanut	1. 14
3	Corn	1.04	11	Rapeseed	2.87
4	Other cereal	1.60	12	Gingili	2.01
5	Beans	1.60	13	Jute and kenaf	1.90
6	Cotton	3.00	14	Other hemp	1.70
7	Beet	0.10	15	Other oil seeds	2.00
8	Sugar cane	0.43	16	Tobacco	0.71

The production and utilization of straw are closely related to regional topography, natural resource conditions, agricultural activities, and economic characteristics. Therefore, the distribution of straw production in China has wide regional differences. According to the statistics of straw resources in major agricultural areas across the country:

A. In 2021, the national collectible straw volume is 865 million tons, and the direct return of straw to the field is 402 million tons, accounting for 54.7% of the collectible volume; among them, the corn, rice, wheat, rapeseed and soybean straw return volumes are 126 million tons, 113 million tons, 104 million tons, 12 million tons and 10 million tons, respectively, accounting for 42.6%, 66.5%, 73.7%, 51.4% and 55.6% of the collectible straw volume of these crops;

B. The amount of straw produced is ranked from largest to smallest in North China, Northeast China, the middle and lower reaches of the Yangtze River, Southwest China, Northwest China, and South China, accounting for 27.18%, 24.47%, 24.35%, 9.19%, 8.87%, and 5.95% of the total amount of straw in the country, respectively. In terms of straw return to the field, the direct straw return rate in North China was 70.1%, ranking first among all regions; followed by South China and the middle and lower reaches of the Yangtze River, with a direct straw return rate of 63.7% and 60.5%, respectively; and the direct straw return rates in Northwest, Southwest and Northeast China were 37.8%, 38.9% and 43.0%, respectively;

C. The utilization rates of straw as fertilizer, feed, fuel, base material and raw material are 60%, 18%, 8.5%, 0.7% and 0.9% respectively, forming a situation of comprehensive straw utilization in which agricultural use of straw is the main mode and other utilization modes coexist.

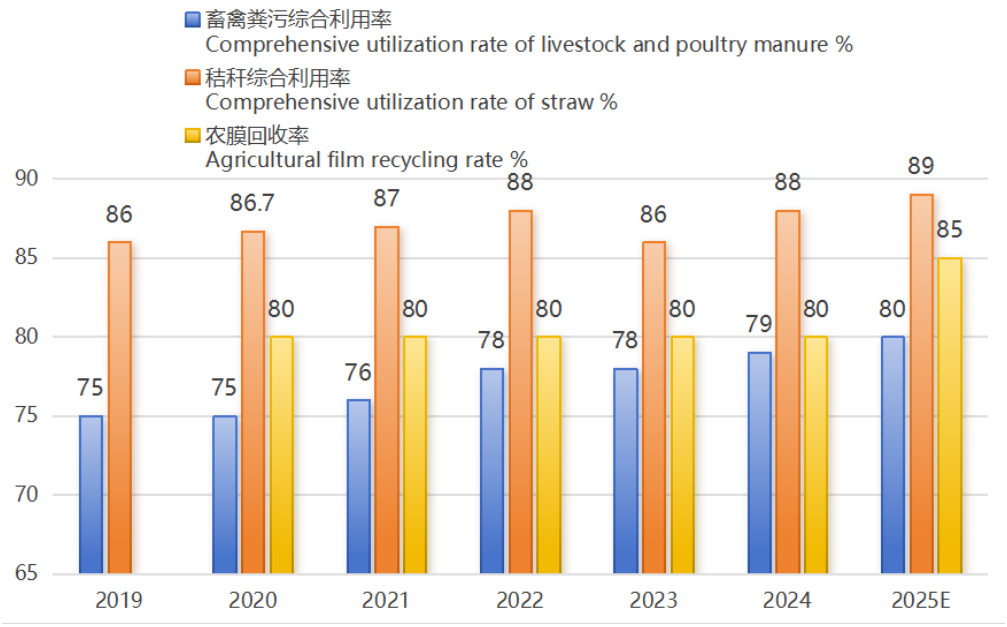


Figure 42 Comprehensive utilization rate of livestock and poultry manure , straw and agricultural film recycling rate

3.2.3.4 Competitive landscape of agriculture waste treatment in China

Upstream and downstream relationships in the industry chain

The upstream of the agricultural waste treatment industry chain mainly includes agricultural waste treatment equipment manufacturers and raw material collection enterprises. These enterprises provide the necessary equipment and technical support, such as straw balers, shredders, and anaerobic digestion equipment, which are used for the collection and pretreatment of agricultural waste.

The midstream mainly consists of system solution providers for agricultural waste treatment and resource utilization. These enterprises provide overall solutions for agricultural waste treatment, including technical solution design, equipment supply and integration, equipment installation and commissioning, and after-sales services.

The downstream project investors and operators are usually responsible for investing in the construction of projects. After the project is completed, they charge corresponding treatment fees from users through project operation and maintenance, and generate income from the sale of 再生 products. These enterprises convert treated waste into products such as organic fertilizers and biogas, achieving the resource utilization of waste.

Agriculture waste treatment industry players

Hubei Renewable Resources Group Co., Ltd. 湖北再生资源集团

Hubei Renewable Resources Group Co., Ltd. excels in agricultural waste management, covering collection, sorting, processing, and recycling. By collaborating with local governments and agricultural cooperatives, it has established a broad recycling network, promoting resource utilization of agricultural waste.

Leveraging national policy support like tax incentives and subsidies, the group expanded its market and partnered with fertilizer companies to convert waste into organic fertilizers, achieving high-value utilization. Continuously innovating and adopting advanced processing technologies, it enhanced efficiency and product quality.

In 2022, Hubei Renewable Resources Group Co., Ltd. generated approximately 300 million yuan (60% of its total revenue) from agricultural waste processing, a 15% year-on-year growth. This growth stems from sustained investment in the agricultural waste processing sector, market expansion, and ongoing exploration of new technologies.

GEM Co., Ltd. 格林美股份有限公司

GEM has a notable presence in resource recycling and environmental services, with agricultural waste processing being a key part of its diversified strategy. GEM uses resource utilization technologies to transform agricultural waste into high-value products like biochar and organic fertilizers, which are competitive in the market.

With multiple independent intellectual property rights in resource recycling and processing technologies, it efficiently converts agricultural waste into useful resources, earning a high brand reputation in resource recycling. By integrating the upstream and downstream industrial chain, GEM has formed a closed loop from waste collection to product sales, improving resource efficiency and market competitiveness.

In 2022, GEM generated approximately 2 billion yuan (10% of its total revenue) from agricultural waste processing, a 12% year-on-year increase. This achievement is attributed to continuous efforts in technological innovation, market expansion, and industrial chain integration.

China Resource And Environment Co.,Ltd. 中再资源环境集团股份有限公司

China Resource And Environment Co.,Ltd. has a significant technological edge in agricultural waste processing, with services spanning waste collection, transportation, processing, and product sales. Using composting and anaerobic fermentation technologies, it converts agricultural waste into organic fertilizers and biogas, which have good market potential.

Benefiting from national emphasis on resource recycling and environmental governance, the group has gained policy support like tax incentives and subsidies, ensuring robust business expansion. By collaborating with multiple local governments and enterprises, it has expanded its business scope and increased market share. Additionally, China Resource And Environment Co.,Ltd. keeps enhancing its processing technologies to improve waste resource utilization rates, strengthening market competitiveness.

In 2022, it generated approximately 800 million yuan (16% of its total revenue) from agricultural waste processing, a 10% year-on-year increase, reflecting sustained investment and market expansion in this field.

3.2.3.6 Market trends and opportunities

Agricultural production waste and rural domestic waste are its main components, which are scattered, complex and diverse, and difficult to collect, treat and recycle. Rural solid waste is the main source of agricultural non-point source pollution, including fertilizers, pesticides and agricultural films used in agricultural production, as well as livestock and poultry manure, vegetable waste, straw, domestic waste, etc.

Rural solid waste is different from urban solid waste. It is significantly affected by factors such as regional characteristics, economic development, local people's lifestyles and policy measures. Therefore, rural solid waste has the characteristics of huge output, wide area, difficult treatment and high environmental risks. China produces a large amount of waste such as agricultural film, pesticide and fertilizer packaging, and rural residents' feces every year. With the continuous growth of population and the continuous improvement of people's living standards, the output of rural solid waste in China will continue to growth.

In China's rural areas, farming and breeding are separated, villagers have weak environmental awareness, and solid waste resource utilization on a household basis faces problems such as insufficient policy publicity, technology, funds, and unsatisfactory project implementation results, which has put rural solid waste in an embarrassing situation.

The resource utilization of straw and livestock and poultry manure is the focus of the Ministry of Agriculture and Rural Affairs of China on rural solid waste management and work. At present, the resource recovery methods of straw include fertilizer, feed, fuel, base material, raw material, etc., and the resource utilization methods of manure include fertilizer and feed. At present, the more common and mature methods of straw and livestock and poultry manure resource utilization in China include returning to the field and improving the soil, anaerobic fermentation, and aerobic composting. The treatment methods of rural domestic waste are the same as those of urban domestic waste, mainly including incineration power generation, sanitary landfill and composting.

At present, the comprehensive utilization rate of livestock manure in China is 72%, the comprehensive utilization of livestock manure is mainly divided into three categories: fertilizer, feed and energy, of which fertilizer is the main comprehensive utilization, accounting for about 58%, livestock manure fertilizer treatment, composting treatment accounts for the majority of the livestock manure fertilizer treatment, mainly since livestock excreta contains a large amount of organic matter and mineral components, after composting and fermentation, The organic matter contained in the waste is degraded so that the organic matter is transformed into humus state; and the high temperature generated during the fermentation process can also remove the harmful substances in the manure.

In addition, to further increase the effectiveness of fertilizers and reduce the emission of malodorous substances, microbial technology can also be used to sterilize and deodorize these wastes. After a series of fermentation, sterilization and deodorization of livestock waste, combined with the appropriate amount of composite micronutrient fertilizer, it can also be made into a composite organic fertilizer.

At present, the research direction of agricultural waste resource utilization in China is mainly to return it directly to the field, apply it to farmland as organic fertilizer after composting, or use it in livestock and

poultry breeding after processing. Foreign research focuses on the use of waste as biomass adsorbent and energy (such as producing methane, biogas, bioethanol, organic acid, etc.).

Figure 43 Agricultural Waste Resource Utilization

Overall, driven by the growth of livestock demand, the overall scale of livestock breeding in China has shown a growing trend.

China's agricultural waste treatment market presents significant opportunities for Dutch enterprises. As an agricultural giant, China generates large amounts of agricultural waste like straw and livestock manure annually. The government is highly committed to promoting resource utilization of agricultural waste and has introduced supportive policies, such as subsidies for straw utilization, creating a favorable policy environment for Dutch companies. With its advanced technologies and extensive experience in agricultural waste treatment, the Netherlands is well-positioned to offer efficient and eco-friendly solutions to Chinese enterprises.

Dutch companies can enter China's agricultural waste market through various approaches. One effective way is technology licensing and cooperation, where Dutch firms can authorize Chinese companies to use their patented technologies in exchange for licensing fees, thereby enhancing the technical capabilities of Chinese enterprises. Establishing joint ventures with local companies is another viable option, enabling Dutch businesses to leverage synergies and adapt better to the Chinese market. Additionally, Dutch companies can provide comprehensive solutions, offering one-stop services from project planning and construction to operation, covering the entire process of agricultural waste collection, transportation, treatment, and resource utilization.

Several Dutch companies have already made successful inroads into China's agricultural waste market. For example, Dumilco Global Agritech, part of the Dutch Dumilco Management Group, has been active in

multiple Chinese cities, including Beijing, Qingdao, Shanghai, Fuzhou, Xiamen, and Wuhan, over the past seven years. Collaborating with local governments, the company has registered its technologies as standard technologies and provided subsidies to farmers. Another example is Sino Dutch Agri Exchange, an organization dedicated to facilitating the participation of Dutch agricultural businesses in Chinese agricultural projects. It offers reliable and timely information to help farmers achieve sustainable growth in yields and income while reducing the costs and usage of pesticides, fertilizers, and water.

3.2.4 Construction waste

According to the Provisions on the Management of Urban Construction Waste, published by the Ministry of Housing and Construction in 2005, construction waste refers to the discarded soil, materials and other wastes generated by construction units, construction units in the process of constructing, altering, expanding and dismantling various types of buildings, structures, pipeline networks, etc., as well as by residents in the process of decorating and renovating their houses. Units disposing of construction waste shall apply to the competent department of urban environmental sanitation of the city people's government and obtain approval for the disposal of construction waste in the city before disposing of it.

3.2.4.1 China's construction waste treatment industry related policies

To strengthen the treatment of construction waste, China has issued many policies, such as the General Administration of Market Supervision in 2024, the Central Office of the Internet Information Office and other departments issued the "implementation of the national standardization development program" Action Plan (2024-2025)" proposed the development and revision of standards for the resource utilization of construction waste. Accelerating the improvement of green procurement, green circulation, green assessment and other green supply chain evaluation standards. National Industry Policy on Construction Waste Disposal shown in Appendix 1 Table 16. Policies related to construction waste disposal industry in some provinces and cities are shown in Appendix Table 17.

Table 9 Major policies and regulations in Urban Construction Waste Management Regulations

Category	Core Content
Administrative Authorities and Responsibilities	- **Central Level**: The construction department of the State Council coordinates national urban construction waste management to ensure uniform compliance with disposal standards. - **Provincial/Autonomous Regional Level**: Construction authorities at the provincial/autonomous regional level supervise and guide waste management within their administrative regions, implement central policies, and formulate local regulations. - **Municipal Level**: The municipal department in charge of urban environment and sanitation manages day-to-day operations, including formulating disposal plans, overseeing the entire process of collection, transportation, and disposal, and ensuring the planning and supervision of disposal facilities.

Principles and Requirements for Disposal	- **Guiding Principles**: Reduction (source control), resource utilization (priority for recycling), harmless treatment (safe disposal), and "polluter pays" (waste producers assume disposal responsibility). - **Facility Planning**: Disposal sites and recycling facilities for construction waste must be integrated into urban infrastructure planning to ensure compliant disposal locations. - **Disposal Planning**: Municipal departments formulate plans based on construction schedules to rationally allocate construction waste for backfilling in projects, reducing the pressure of off-site transportation and landfilling.
Regulations and Prohibited Acts	- **Document Management**: Prohibited from altering, selling, renting, or illegally transferring construction waste disposal approval documents to ensure legal 资质 (qualifications). - **Waste Mixing**: Strictly forbidden to mix construction waste with domestic waste or hazardous waste to prevent environmental risks. - **Site Management**: Unauthorized disposal sites are prohibited; construction waste must be disposed of at government-designated locations. - **Acceptance Restrictions**: Disposal sites must not accept industrial waste, domestic waste, or toxic/hazardous waste to avoid cross-contamination between waste types.

3.2.4.2 China’s construction waste treatment market analysis

The generation of construction waste mainly comes from the demolition of old buildings, the construction of new buildings and the decoration of buildings. The research object is the production of construction waste in 30 provinces in China from 2005 to 2023, excluding Tibet, Hong Kong, Macao and Taiwan. The data on the construction area of houses, the gross output value of the construction industry and the number of employees required for the study are all from the "China Construction Industry Statistical Yearbook" of the corresponding years, and the regional gross product, the population at the end of the year and the per capita GDP of each province are from the "China Statistical Yearbook".

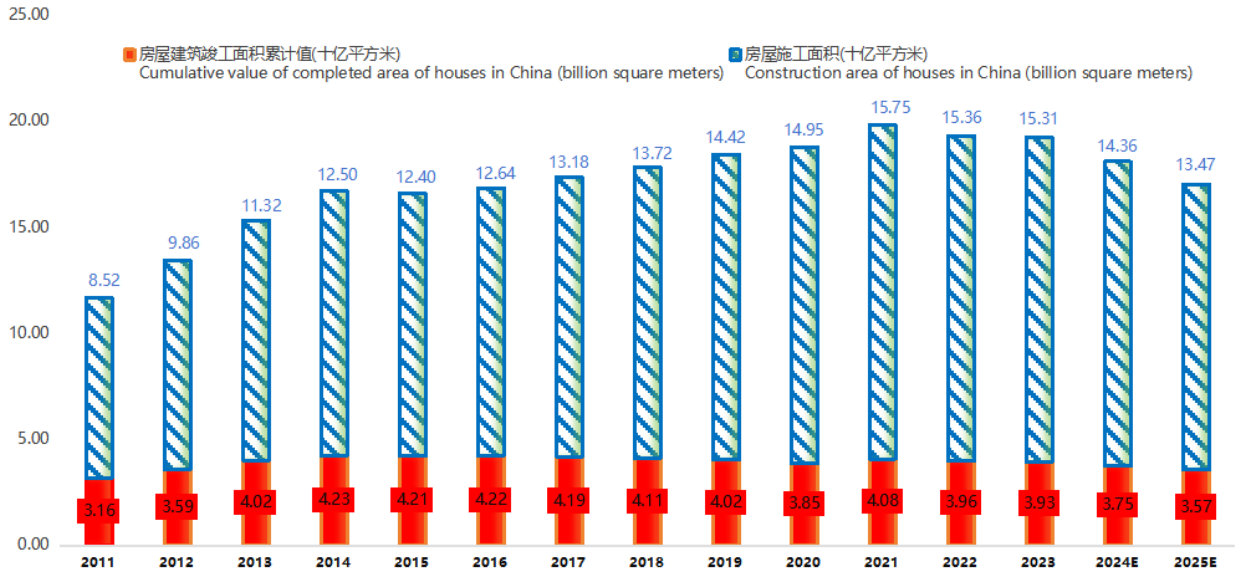


Figure 44 Cumulative value of completed area of hours in China

Data show that China's housing construction in the first half of 2024, a housing construction area of 11.039 billion square meters, a year-on-year decrease of 6.2%, of which, the new construction area of 1.518 billion square meters, a year-on-year decrease of 14.2%. Housing completion area of 1.351 billion square meters, down 4.8% year-on-year. It is estimated that in 2024, China's housing construction area will be about 14.36 billion square meters, and the completed housing area will be 3.75 billion square meters.

From the composition of the completed housing area of construction enterprises across the country, the completed area of residential housing accounts for the largest proportion, which is 59.06%; the completed area of factories and buildings accounts for 19.81%; the completed area of commercial and service housing accounts for 6.43%; and the completed area of other types of housing accounts for less than 5%.

The following figure shows the estimated output of construction waste using the area estimation method. The data shows that from 2013 to 2023, the annual output of construction waste has remained at more than 2 billion tons per year. Among them, the annual output in 2021 was the largest at 2.96 billion tons. After 2022, due to the delayed impact of the epidemic on the economy, the annual output of construction waste has slightly decreased. It is found that the output of construction waste shows a downward trend year by year.

Figure 45 Amount of construction waste in China

From 2011 to 2023, the regional differences in the production of construction waste are significant, and the overall distribution shows the characteristics of "east high and west low".

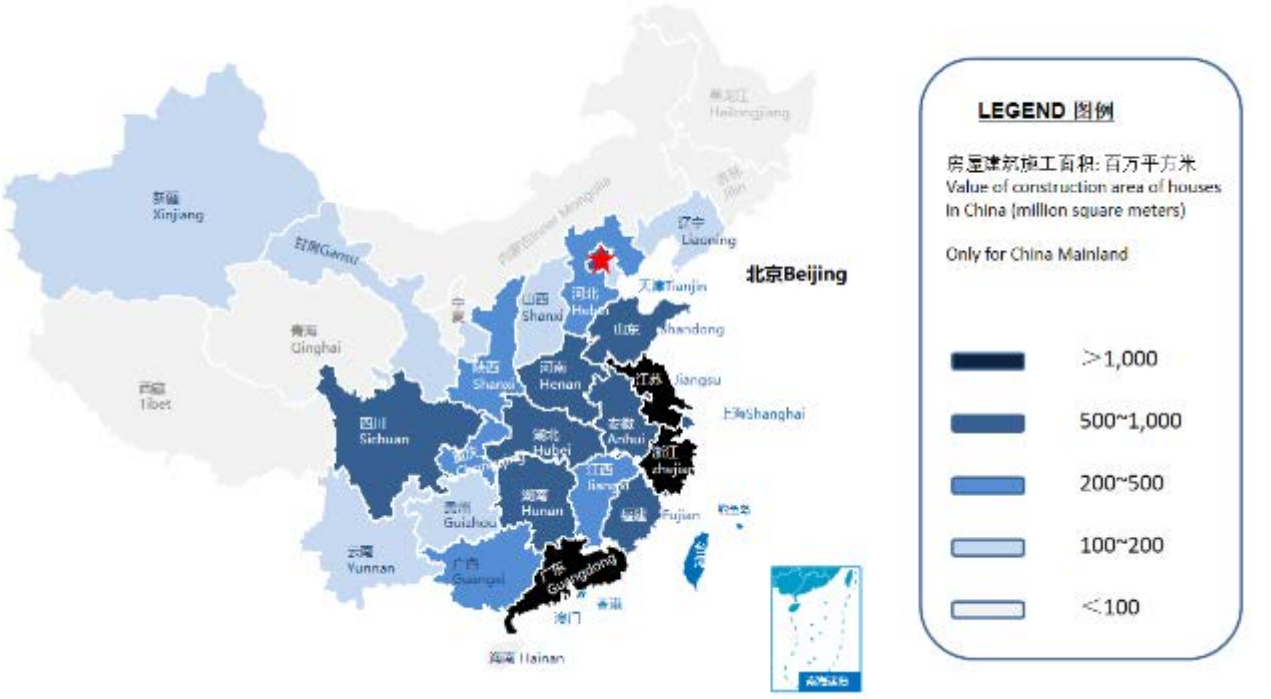


Figure 46 Value of construction area of houses in China

Most of the provinces with higher construction waste production are concentrated in the coastal areas in the southeast of China, such as Shandong, Jiangsu, Zhejiang, Fujian, and Guangdong. This reason is mainly due to the differences in population size and economic development level of each province, which lead to different growth rates of construction waste production. Coastal areas have superior geographic

location, convenient transportation, faster economic development, high population density, and high urbanization rate, and the production of construction waste has also increased.

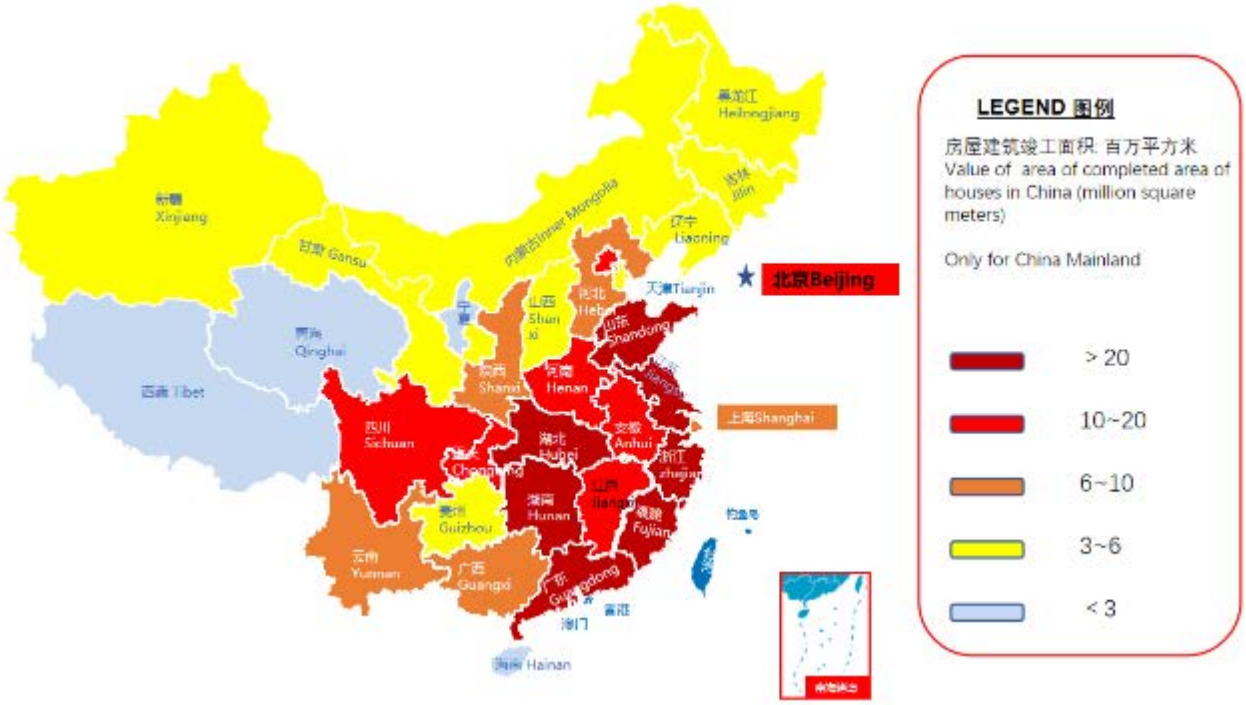


Figure 47 Value of area of completed area of houses in China

In the annual output distribution chart, it can be seen that Guangdong, Jiangsu, and Zhejiang occupy a leading position in the production of construction waste in China. They are located in the Yangtze River Delta region, which region with rapid economic development, strong urban innovation vitality, and a continuous increase in population inflow. These factors have led to an increase in the production of construction waste. From 2007 to 2013, in the process of continuous advancement of the overall regional development strategy, the location characteristics of China's economic industries generally showed a trend of shifting from the east to the central and western regions, and the share of construction waste production in the central region also increased accordingly.

Figure 48 Amount of construction waste by province in 2023

Most of the construction waste production in the northern China areas is at a relatively low level. These regions have inconvenient transportation and a relatively small population. In particular, the population in the northeast has experienced negative growth, the construction waste production is low, and the annual changes are small.

The output of construction waste in Jiangsu, Zhejiang and Guangdong accounts for a relatively large proportion of the national total, and they all maintain a relatively high growth rate from 2019 to 2023. The growth rates of Jiangsu and Zhejiang provinces show a trend of first rising and then falling, both reaching their maximum amount in 2022, 516 million tons in Jiangsu Province and 322 million tons in Zhejiang Province, respectively. The output of construction waste in Guangdong, Fujian and Hunan provinces all show a trend of continuous increase, reaching their maximum number in 2023.

Shandong's construction waste production ranks ahead of the remaining provinces, showing a sustained growth trend. The growth rate of Hubei's construction waste production has increased significantly in 2021, and its construction waste production value has gradually surpassed Shandong. Ningxia, Hainan, Qinghai and other provinces have a relatively low proportion of construction waste production in China. The construction waste production of each province is closely related to the local economy and the level of development of the construction industry. Provinces with developed construction industries are more likely to produce more construction waste.

3.2.4.3 China's construction waste to resource market analysis

Construction waste recycling

The recycling of construction waste concrete is to crush and process construction waste concrete into recycled products such as recycled bone (powder) that meet the standard requirements, and then use the recycled bone(powder) and other materials in finished or semi-finished products such as concrete, premixed mortar, wall materials, roadbed, etc. in construction.

The resource utilization of construction waste is a systematic project. The entire process from waste source control to terminal management involves multiple entities, such as building demolition contractors, construction waste transportation fleets, landfills, and waste resource utilization centers.

Material flow: After old buildings are demolished, some valuable waste materials such as metals are directly recycled, and other waste materials (such as waste concrete) are transported to landfills for direct disposal, or transported to comprehensive waste disposal centers. Some waste materials with potential value are recycled and processed into construction products and sold in the construction market, thus entering the building construction process.

Capital flow: Owners of old buildings select demolition contractors or demolition companies from the market and pay demolition fees; demolition contractors or demolition companies select appropriate garbage transport fleets to transport demolition waste, and the garbage transport fleets choose the destination of the waste (landfill or integrated disposal center) based on the amount of transportation fees paid by the demolition contractors or demolition companies; resource-based construction waste is transformed into construction products and flows into the market, and owners of new buildings obtain resource-based recycled products through market transactions.

Information flow: Owners of old buildings obtain information about demolition contractors or demolition companies through the construction market, and then choose appropriate demolition enterprises; demolition contractors, demolition companies and waste transportation fleets also obtain their information through the market; owners of new buildings learn about the performance, price and other information of waste recycling products through the construction market, and then decide whether or not to purchase recycled products.

In recent years, due to the continuous implementation of favorable environmental policies in China, the market size of the construction waste resource utilization industry in China has increased rapidly, from 1.27 billion yuan in 2018 to 12.414 billion yuan in 2023, with a compound annual growth rate of 57.77% during this period. In 2023, the amount of construction waste utilized in China reached 271 million tons. However, the degree of resourceful recycling and reuse of construction waste in China is relatively low. In 2021, the utilization rate of urban construction waste resources is about 40%, which is a huge gap compared with more than 70% in Europe and the United States, and nearly 100% in Japan.

Upstream and downstream relationships in the industry chain

The upstream of the construction waste resource utilization industry chain mainly includes construction waste export companies and construction waste treatment equipment/facility manufacturers;

The midstream enterprises in the construction waste resource utilization industry chain are mainly providers of construction waste treatment and resource utilization system solutions and can provide overall solutions for construction waste treatment, including technology and solution design, equipment supply and integration, equipment installation and commissioning, after-sales service, etc.

The downstream enterprises in the construction waste resource utilization industry chain are Investors and operators, usually responsible for investment and project operation and maintenance, charging users corresponding construction waste disposal fees and obtaining income from the sale of recycled products.

Policy-driven

In 2019, the Ministry of Housing and Urban-Rural Development promulgated the industry standard "Technical Standard for Construction Waste Treatment" (CJT134), requiring that construction waste should be classified from the source, and should be collected, transported, treated and disposed of according to construction debris, construction mud, construction waste, demolition waste and decoration waste. It is encouraged to adopt local utilization, decentralized treatment, centralized treatment and other modes of resource utilization of construction waste, and local utilization is encouraged first.

In the "14th Five-Year" Circular Economy Development Plan issued in 2021, the National Development and Reform Commission proposed that the comprehensive utilization rate of construction waste should reach 60% by 2025 and that it should carry out the demonstration project of resource utilization of construction waste and build 50 demonstration cities for resource utilization of construction waste.

In January 2022, the General Office of the State Council forwarded the Circular of the National Development and Reform Commission and other departments on the Guidance Opinions on Accelerating the Construction of Environmental Infrastructure in Cities and Towns (State Council Letter (2022) No. 7), which states that it is necessary to "strengthen the fine classification of construction wastes and their resourceful utilization, improve the quality of the products of resourceful and recycled construction wastes, expand the scope of their use, and regulate the construction waste collection, storage, transportation, utilization and disposal".

In June 2022, the Ministry of Housing and Construction and the National Development and Reform Commission jointly issued the Carbon Peak Implementation Plan for Urban and Rural Construction, proposing that during the "14th Five-Year Plan" period, cities across the country will have a new capacity of 400 million tons/year of construction waste elimination and 250 million tons/year of capacity of construction waste resource utilization.

3.2.4.4 Competitive landscape of construction waste treatment in China

Construction waste treatment industry players

The current market of China's construction waste disposal industry is characterized by high regional concentration and dispersed national concentration. For example, in economically developed regions such as Beijing, Shanghai, and Jiangsu, local governments attach great importance to the resource disposal of construction waste and have issued a series of management policies and requirements. Therefore, several regionally renowned companies have gradually emerged. The following lists some of the leading companies in the domestic construction waste disposal industry.

Table 10 Major industry players in construction waste treatment

Company Name	Founded	Core Business	Technical/Model Advantages	Market Position & Regional Coverage	Other information

Henan Xuchang Jinke Resources Co., Ltd.	2001	Full industrial chain of construction waste management (collection, transportation, disposal, recycled product production)	- **Franchised Operation Model**: First company in Henan Province to obtain exclusive rights for construction waste disposal, pioneering the "Xuchang Model" of government-led and market-driven operations - **Product Portfolio**: 8 categories and over 100 recycled products, including aggregates, wall materials, and imitation stone	- **Regional Focus**: Concentrated in Xuchang City, radiating Henan Province - **Policy Benchmark**: Supported Xuchang's "zero-waste city" pilot, with annual treatment capacity exceeding 3 million tons	- **Policy Support**: Received local government subsidies and green financial support
Shanghai Environment Group Co., Ltd.	2004	Solid waste resource utilization (including construction waste), domestic waste treatment, water environment management, hazardous medical waste disposal	- **Full-process Service Capability**: Provides one-stop solutions from planning to operation - **Technology Integration**: AI sorting, 3D-printed recycled building materials applied in Shanghai and Jiangsu projects	- **National Presence**: Operates in the Yangtze River Delta, Pearl River Delta, and central-western regions - **Industry Leadership**: 2023 revenue of 6.381 billion RMB, leading enterprise in solid waste treatment	**Revenue and Profit:** In 2023, the revenue reached 6.381 billion yuan, an increase of 1.51% year-on-year. In the first three quarters of 2024, the company's total operating income was 4.28 billion yuan, a decrease of 0.91% year-on-year, while its net profit reached 502 million yuan, an increase of 6.08% year-on-year.

Beijing Greenuse Co., Ltd.	2006	Stockpile waste treatment, construction waste resource utilization, primary waste comprehensive disposal	- **Stockpile Treatment Expertise**: Treated 15 million tons of stockpiled waste, responsible for informal landfill remediation in Beijing - **Technology Integration**: "Equipment manufacturing + process integration" model for waste reduction and resource utilization	- **Regional Deepening**: Focused on Beijing and surrounding areas, participated in major projects like Xiong'an New Area - **Certifications**: Holds multiple patents and qualifications in solid waste treatment	- **Project Case**: Ecological restoration of informal landfills in Beijing's Changping District
Beijing GeoEnviron Engineering & Technology, Inc.	1992	Solid and hazardous waste resource utilization (61% of revenue), domestic waste treatment, environmental remediation	- **Technological R&D**: Over 700 patents covering heavy metal pollution control and industrial solid waste co-treatment - **Diversified Business**: Expanded into new energy materials (e.g., lithium battery recycling) and ecological restoration	- **National Network**: Over 100 subsidiaries, with Central and Northwest China as core markets, East China accounting for 21% - **Industry Status**: Total assets exceeding 20 billion RMB in 2023, leading enterprise in environmental protection	- **Core Business Share**: 61% revenue from solid/hazardous waste resource utilization

3.2.4.5 Market trends and opportunities

Market trends

China's annual construction waste output has exceeded 2 billion tons, accounting for nearly 40% of the total municipal solid waste, making it the largest and most concentrated single type of solid waste in cities. The field of construction waste is gradually showing an inclination towards market opportunities. Compared

to other solid waste treatment industries, the construction waste treatment industry is still in the early stages of industrial development.

The recycling rates of construction waste vary significantly among countries worldwide. Some developed countries have relatively high resource utilization rates. For example, South Korea, Germany, and Japan have a waste resource utilization rate of over 90%. In China, the comprehensive utilization rate of construction waste reached 50% in 2020. However, compared with developed countries in Europe and America, there is still a considerable gap and a lot of room for improvement.

Comparing with advanced countries, the disposal of construction waste in China's cities presents the following problems:

The degree of separate collection of construction waste is not high, and at present, the vast majority can only be collected in a mixed manner.

The recycling rate of construction waste is low. In most parts of China, the utilization rate of construction waste resources is less than 10%, and there is still significant room for improvement. There are about 800 fixed construction waste production lines that have been built or are planned to be built across the country, but they are far from being able to meet current demand.

The business model for construction waste disposal is flawed The characteristics of the construction waste disposal business, which is driven by policies in the front end and the market in the back end, have brought great hidden dangers and pressure to the development of the business. Recycled products are mainly construction raw materials such as concrete, mortar, recycled bricks, and aggregates. The sales targets are mainly construction companies. Affected by the downturn in the real estate industry, the number of projects started by construction companies has shown a trend of significant reduction.

Although the technical aspects of construction waste disposal are relatively mature, the construction of a business model is the key to its development. To improve the level of resource utilization of urban waste in China and promote green, low-carbon, circular development, the Ministry of Ecology and Environment has included the issue of construction waste as a key direction for disposal in the construction of national zero-waste cities in the “Zero-Waste City” construction plan. This strategy focuses on reducing the generation of construction waste at the source and improving resource utilization efficiency, providing solid policy support for the development of the construction waste recycling industry.

Opportunities

China's "14th Five-Year Plan for Circular Economy Development" proposes that the comprehensive utilization rate of construction waste should reach 60% by 2025, indicating a huge market gap. Dutch companies can leverage their experience with a 96% construction waste resource utilization rate to participate in projects in China's policy pilot cities, such as the Beijing Economic-Technological Development Area and Wujin District in Changzhou. For example, a project in Wujin District, Changzhou, which introduced Dutch AI sorting equipment, processes 300,000 tons of renovation waste annually with a resource recovery rate of over 90%, becoming a national demonstration project.

China's "Solid Waste Law" strengthens the responsibility of producers. In places like Chongqing and Jiangsu, it is required that government projects prioritize the use of recycled products. The Netherlands' waste resource management system fits the domestic legal framework of "the polluter pays,". Dutch companies can fully plan for resource recycling, carry out effective cooperation between government departments (i.e. through the activities held by the governments), and actively involve the waste management industry to promote the establishment of similar economic adjustment mechanisms in China.

The competitive landscape of China's construction waste disposal industry is relatively fragmented, with small and micro enterprises being the main participants. Dutch companies can collaborate with local enterprises to jointly explore the market by leveraging their technological and managerial expertise. Dutch companies can also license their core technologies, such as AI sorting and 3D printing, to Chinese companies through technology licensing and charge patent fees. For example, Circular Hotspot from the Netherlands has collaborated with Chinese companies to promote the concept of circular construction. In addition, the PPP model promoted by the government also provides foreign companies with opportunities to cooperate with the government.

3.2.5 Hazardous waste

According to the "Solid Waste Law" (2020 revised edition), hazardous waste refers to solid waste listed in the National Catalogue of Hazardous Wastes or identified as such according to the national identification standards and methods. This includes solid waste that has characteristics such as toxicity, corrosivity, flammability, reactivity, or infectivity, as well as solid waste that cannot be ruled out as having hazardous characteristics and may cause harmful effects on the ecological environment or human health, and thus needs to be managed as hazardous waste. The generation of hazardous waste covers industrial production, medical waste, and social sources. Units disposing of hazardous waste must obtain a hazardous waste operation permit, strictly follow the transfer manifest system, and are prohibited from dumping, piling up, or transferring illegally.

3.2.5.1 China's hazardous waste disposal industry related policies

China's hazardous waste treatment industry policies focus on the core aspects of full - process supervision, resource utilization, and environmental risk prevention. In recent years, the industry's standardized development has been promoted through several top - level designs. The "Guiding Opinions on Further Strengthening the Environmental Management of Hazardous Waste and Strictly Preventing Environmental Risks" released by the Ministry of Ecology and Environment in 2025 put forward three - stage goals:

- In 2026: Full - process information - based supervision will be fully covered among all key - regulated units for hazardous waste in the country;
- In 2027: Full - process information - based supervision will be basically realized among all units related to hazardous waste nationwide, and the proportion of hazardous waste landfill disposal will remain stable or decrease;

- In 2030: The Full - process information - based supervision system for hazardous waste will be further improved, the proportion of landfill disposal will be controlled within 10%, and environmental risks will be effectively prevented.

The core content of hazardous waste management policies is shown in the table below:

Table 11 Key content of hazardous waste management policies

Category	Core Content
Administrative Authorities and Responsibilities	- **Central Level**: The ecological and environmental authorities of the State Council coordinate national hazardous waste management, formulate the national hazardous waste list, identification standards, and technical specifications. - **Provincial/Autonomous Regional Level**: Local ecological and environmental authorities are responsible for supervising and managing hazardous waste pollution prevention and control within their administrative regions, and approving hazardous waste business licenses. - **Municipal Level**: Ecological and environmental authorities at or above the county level implement specific supervision, establish an information management platform for hazardous waste, and oversee the entire process of collection, transportation, and disposal.
Principles and Requirements for Disposal	- **Guiding Principles**: Source reduction, full-process control, priority for resource utilization, risk prevention and control, and the "polluter pays" principle. - **Facility Planning**: Hazardous waste disposal facilities shall be incorporated into local environmental protection plans to ensure regional disposal capacity matches waste generation needs. - **Transfer Management**: Cross-provincial/municipal transfers require processing transfer documents and obtaining approval from ecological and environmental authorities in both regions; unauthorized transfers are prohibited.
Regulations and Prohibited Acts	- **Document Management**: Forging, altering, or transferring hazardous waste business licenses or transfer documents is prohibited. - **Classification Management**: Mixing hazardous waste with general industrial solid waste or domestic waste for collection and disposal is strictly prohibited. - **Illegal Disposal**: Unauthorized dumping or landfilling of hazardous waste is prohibited; hazardous waste must not be provided to unqualified units for disposal.

3.2.5.2 China's hazardous waste disposal industry market analysis

Hazardous waste primarily originates from three major sources: industrial sources, medical sources, and social sources. Among these, industrial hazardous waste is the predominant category in the hazardous waste treatment industry, accounting for the highest proportion and characterized by complex components. It is mainly generated during the manufacturing process and involves numerous industries, such as chemical industry, electronic component manufacturing, petroleum refining, and metal smelting. Industrial

hazardous waste includes waste acids and alkalis, pesticide waste, distillation residues, waste mineral oils, metal - containing waste, and so on. Medical hazardous waste is mainly produced in medical institutions, such as hospitals and clinics, and includes medical waste, discarded pharmaceuticals, infusion bottles (bags), and so on. Social hazardous waste comprises waste engine oil from vehicle maintenance, waste lead - acid batteries, discarded fluorescent lamps, laboratory waste, and so on.

In 2022, China's hazardous waste generated 950 million tons and hazardous waste utilization and disposal will be 944 million tons. Among them, the top 10 hazardous waste-generating industries contribute to a total of 87.6 million tons of hazardous waste, accounting for 92.1% of China's total hazardous waste production ratio in 2022. The top 10 industries contributing to the utilization and disposal of hazardous waste disposed of a total of 88.4 million tons of hazardous waste, accounting for 93.6% of China's total hazardous waste utilization and disposal in 2022.

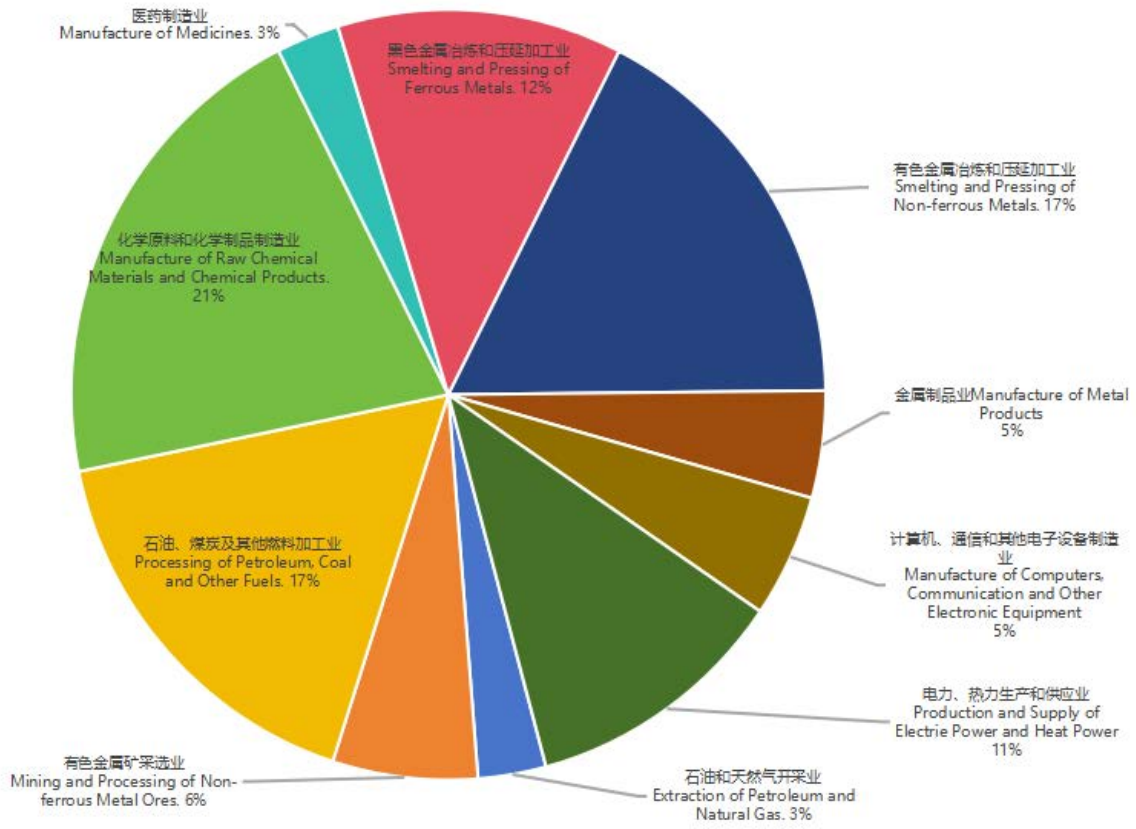


Figure 49 Top ten hazardous waste-generating industries

In 2022, among the top 10 industries contributing to the generation of hazardous waste in China, the chemical raw materials and chemical products manufacturing industry, 18.194 million tons, accounting for 20.8%; non-ferrous metal smelting and rolling processing industry, 15.209 million tons, accounting for about 17.4%; petroleum, coal and other fuels processing industry, 14.767 million tons, accounting for 16.9%; electric power and heat production and supply industry, generated 9.92 million tons, accounting for 11.3 %.

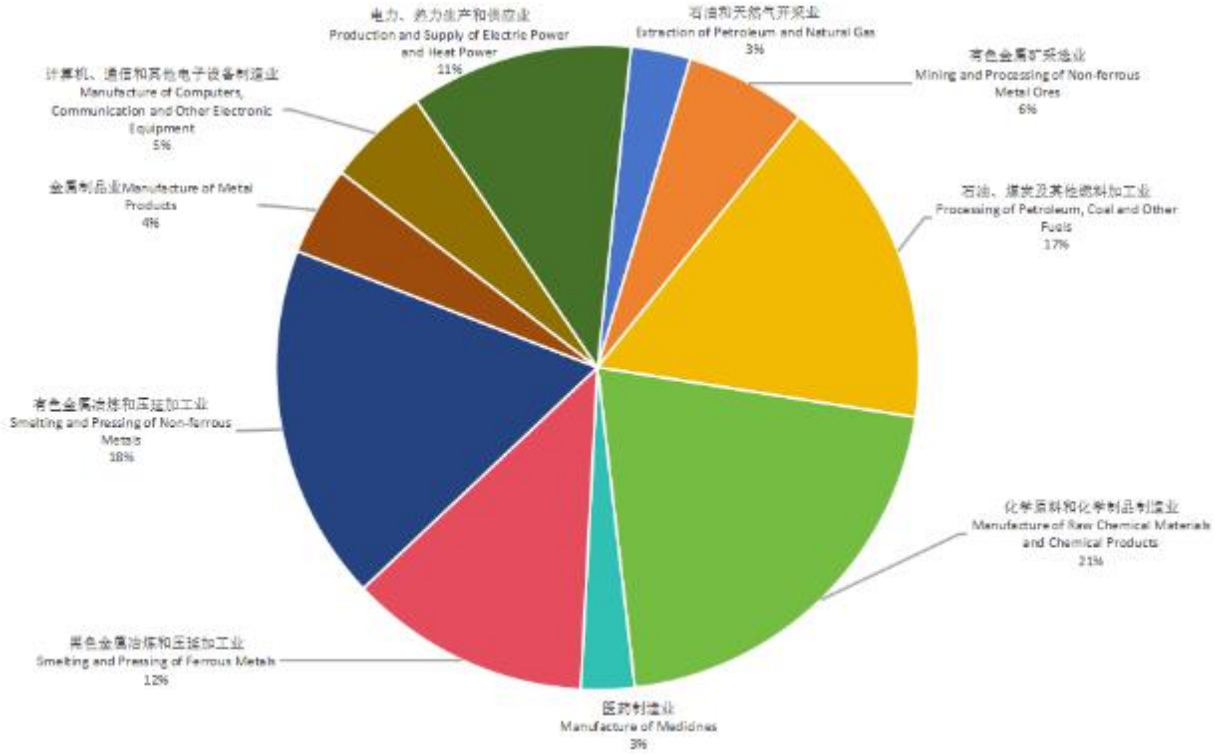


Figure 50 Top ten industries contributing to the utilization and disposal of hazardous waste

In 2022, among the top 10 industries contributing to the utilization and disposal volume of hazardous waste in China, the chemical raw materials and chemical products manufacturing industry, 18.288 million tons, accounting for 21%; the non-ferrous metal smelting and rolling processing industry, 15.826 million tons, accounting for about 18%; the petroleum, coal and other fuels processing industry, 14.737 million tons, accounting for 17%; the ferrous metal smelting and rolling processing industry 10.74 million tons, accounting for about 12%; electricity and heat production and supply industry, 9.886 million tons, accounting for 11%.

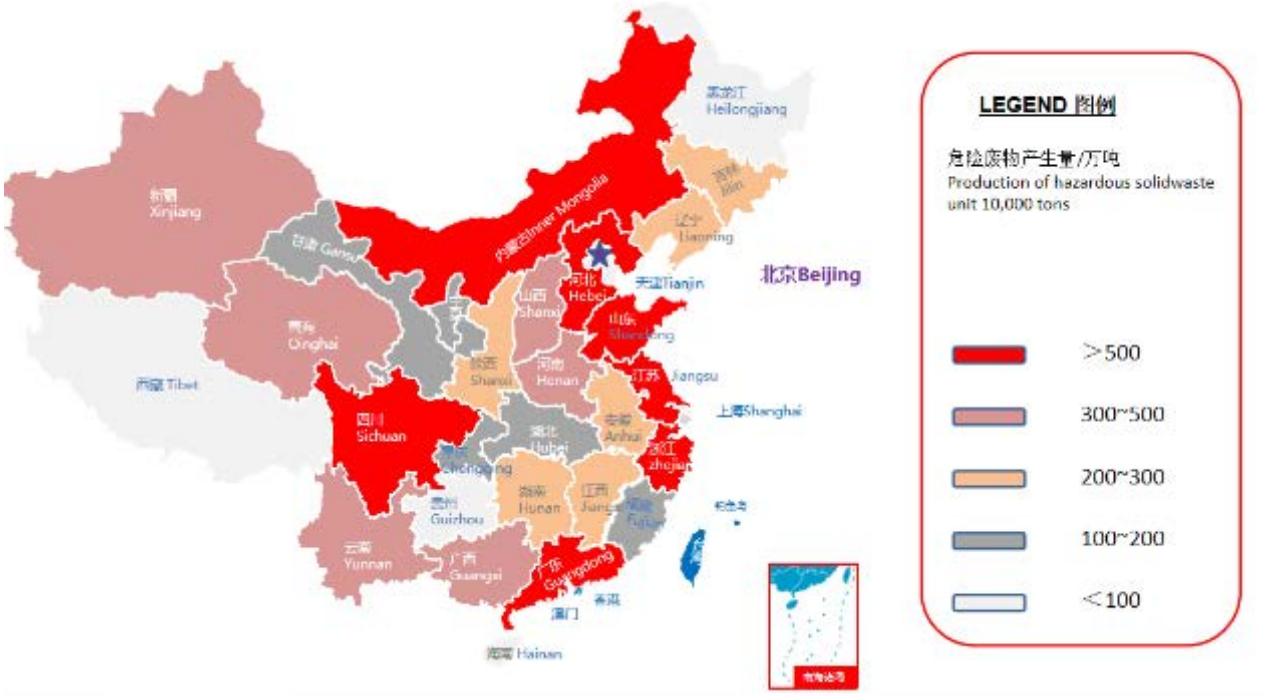


Figure 51 Production of hazardous solid waste

In 2022, China's hazardous waste generation was 95.148 million tons, and hazardous waste disposal and utilization was 94.439 million tons. In terms of the distribution of provinces in the country, the region with the largest generation is Shandong Province with 11.09 million tons, followed by Inner Mongolia with 6.785 million tons, Jiangsu Province generating 6.465 million tons, Zhejiang with 5.946 million tons and Guangdong with 5.464 million tons. No statistics are available for Macao, Hong Kong, and Taiwan.

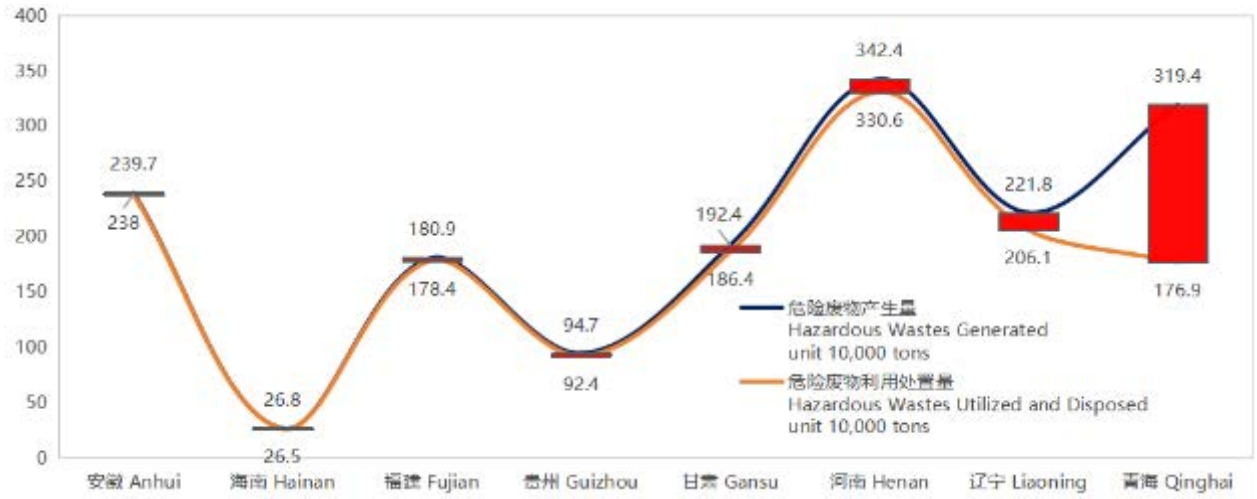


Figure 52 Hazardous waste generated and disposal

The provinces with the largest gap between the amount of hazardous waste generated and the amount of hazardous waste utilized and disposed of are the three provinces of Qinghai, Liaoning, and Henan, so the growth opportunities for the hazardous waste disposal industry are likely to occur in these three provinces.

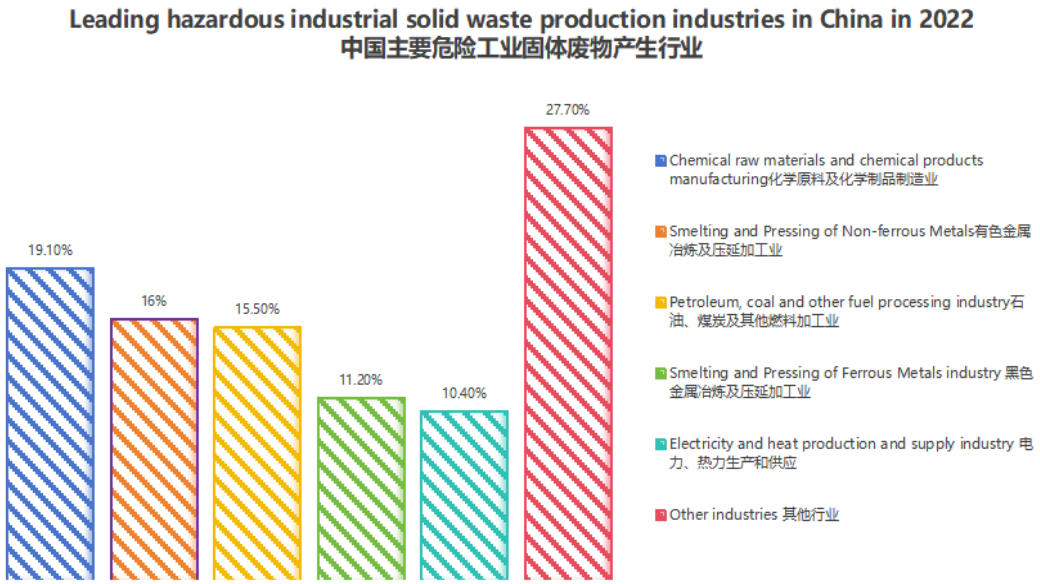


Figure 53 Leading hazardous industrial solid waste production industries in China in 2022

The top three industries that produce the most hazardous waste are the chemical raw materials and chemical products manufacturing industry, accounting for 19.1%, followed by the non-ferrous metal smelting and pressing industry, accounting for 16%, and the petroleum, coal, and other fuel processing industry, accounting for 15.5%.

3.2.5.3 China's hazardous waste to resource market analysis

Hazardous Waste Resource Utilization

The resource utilization of hazardous waste refers to the process of extracting valuable elements from hazardous waste through physical or chemical treatment processes such as smelting, extraction, electrolysis, and purification, and further processing them into products. The treatment of hazardous waste can be broadly divided into two categories: one is the resource utilization of hazardous waste, for example, electroplating sludge containing precious metals can be processed through multiple procedures such as dewatering, thickening, smelting, and purification to extract the metals, which can then be sold for use in building materials; the other is harmless treatment, which mainly involves reducing the volume of hazardous waste and eliminating its polluting properties through methods such as incineration, landfilling, and hydrometallurgical processes. There are three main smelting methods for the resource utilization of hazardous waste: hydrometallurgical smelting, pyrometallurgical smelting, and combined pyrometallurgical - hydrometallurgical smelting.

Under the guidance of the "dual - carbon" goals, the Chinese government has in recent years continuously promoted the development of the solid and hazardous waste resource utilization industry and improved resource utilization efficiency. With the continuous increase in the resource utilization rate of solid and hazardous waste, the market size of China's solid and hazardous waste comprehensive utilization and disposal industry continues to expand. In 2023, it increased to around 435.697 billion yuan, a year - on -

year increase of 12.58%. In 2017, the resource utilization volume of China's industrial solid and hazardous waste was about 1.852 billion tons, and in 2023, China's solid and hazardous waste resource utilization volume reached 2.66 billion tons.

Upstream to downstream industry chain

The upstream of the hazardous waste treatment project industry chain centers on industrial, medical, and social waste - generating units that legally and compliantly produce and report hazardous waste. It also relies on environmental protection equipment manufacturers and research institutions to provide technical and equipment support, and is subject to strict supervision by government departments such as the Ministry of Ecology and Environment.

The midstream consolidates dispersed hazardous waste through qualified collection and transportation companies, relying on comprehensive treatment enterprises or specialized disposal institutions. It employs harmless technologies such as incineration and landfill, as well as resource - utilization processes like waste acid regeneration and metal extraction, to reduce the volume of hazardous waste and transform its value (e.g., recycling new energy battery materials).

The downstream supplies recycled resources (such as precious metals and regenerated acids and alkalis) to industrial fields like chemical, metallurgy, and new energy, forming a recycling loop. Meanwhile, secondary products generated from harmless treatment (such as incineration fly ash) require further specialized disposal.

Policy-driven

The "Implementation Plan for Reforming and Strengthening the Supervision and Utilization and Disposal Capacity of Hazardous Waste" released in 2021 proposed to promote the construction of regional special hazardous waste centralized disposal centers (such as waste acid, waste salt, fly ash, etc.); and encouraged enterprises to equip themselves with high - standard resource utilization facilities.

The "Overall Implementation Plan for Major Hazardous Waste Engineering Projects (2023 - 2025)" released in 2023 proposed to coordinate the layout of 1 national technology center, 6 regional technology centers, and 20 regional disposal centers, focusing on solving the treatment difficulties of special hazardous wastes such as fly ash and waste salt; and supported the research and development and demonstration application of high - end technologies such as plasma melting and bio - leaching.

In the "Guiding Opinions on Accelerating the Resource Utilization of Hazardous Waste" issued by the General Office of the State Council in 2024, it was proposed to allow cross - regional trading of "regenerated resource vouchers" and to include metal recovery rates and carbon emission intensity in the trading system. The opinions also encouraged "point - to - point" directional utilization, simplified the transfer approval process, and promoted the high - value utilization of waste activated carbon, waste resin, and other categories through market incentives and strengthened supervision, reducing the risk of secondary pollution.

In 2025, the National Development and Reform Commission and the Ministry of Ecology and Environment jointly issued the "Special Plan for the Resource Utilization of Hazardous Waste". It was proposed that by 2025, the national comprehensive utilization rate of hazardous waste would be increased from 52% in 2020 to 60%, with the utilization rate of waste mineral oil, waste lead - acid batteries and other categories reaching over 90%. Central and western provinces would add 120 million tons/year of hazardous waste resource utilization capacity, focusing on filling the treatment gap for special categories such as waste salt and fly ash, and narrowing the regional disparities.

3.2.5.4 Competitive landscape of Hazardous waste treatment in China

Hazardous waste treatment industry players

China's hazardous waste treatment industry is still in its nascent stage, with a broad market space but a large number of participants that are highly fragmented. Most enterprises are relatively small in scale and have weaker capabilities in technology, funding, and research and development, with single - type qualifications. In terms of larger - scale enterprises with in - depth resource utilization capabilities, the number is relatively small. The following lists some of the leading enterprises in China's hazardous waste treatment industry.

Table 12 Major industry players in hazardous waste treatment market

Company Name	Founded	Core Business	Technical/Model Advantages	Market Position & Regional Coverage	Revenue
Dongjiang Environmental	1999	Industrial and municipal hazardous waste harmless treatment and resource utilization, covering incineration, landfilling, and physico-chemical processes, with supporting water treatment and environmental testing services.	Cross-provincial collaborative disposal capacity (e.g., inter-regional allocation of waste acid/salt), plasma melting + biological leaching process (heavy metal recovery rate from fly ash >95%), holding 44 types of hazardous waste operation qualifications.	National hazardous waste treatment capacity exceeds 2.8 million tons/year, covering core regions such as Pearl River Delta, Yangtze River Delta, and Beijing-Tianjin-Hebei, with a market share of over 15%, and >20% in	2023 revenue: ~RMB 10 billion, CAGR >10%.

				Guangdong and Jiangsu.	
GeoEnviron Engineering	1992	Resource utilization of heavy metal-containing hazardous waste (copper, nickel, lead), focusing on the closed-loop of "hazardous waste collection-preprocessing-metal purification," with supporting environmental engineering and operation services.	Pyrometallurgical melting technology (electrolytic nickel extraction from nickel-containing waste, annual metal recovery >20,000 tons), recycled products included in the *Green Product Government Procurement List*, with value-added 3x higher than traditional landfilling.	Regional leader in Jinchang (Gansu), Fuzhou (Jiangxi), serving large industrial enterprises like Jinchuan Group, with local market share of 25%-30%, national resource utilization capacity >1.026 million tons/year.	2023 revenue: ~RMB 8 billion, 5-year net profit CAGR 32.65%.
Shenneng Environmental (Hangzhou Fuyang)	2004	Resource utilization of copper-containing multi-metal hazardous waste, annual treatment capacity 400,000 tons, mainly recycling copper alloys and precious metals.	Fire smelting + residual pole fuel substitution technology (copper recovery rate 98%, annual CO_2 reduction 35,000 tons), recognized by the Basel Convention as a "zero-waste city" model, replicated in 6 provinces including Jiangsu and Anhui.	Leading copper-containing hazardous waste processor in East China, with copper alloy annual output value >RMB 1 billion, profit margin 20% higher than traditional landfilling, technology applied in Yangtze River Delta and central provinces.	2013 revenue: RMB 2.053 billion (recent data undisclosed).

Dalian Yishun Green Technology	2017	Plasma melting technology application, specializing in complex hazardous waste treatment (incineration fly ash, industrial aluminum ash), equipment service life up to 8,000 hours/year.	DC plasma melting furnace (leaching toxicity <10% of national standard, metal recovery rate >90%), operation cost 30% lower than traditional processes, holding 25 patents.	Technology applied in Liaoning, Shandong, filling regional fly ash treatment gaps, equipment orders growing 30% annually, improving hazardous waste collection efficiency for SMEs by 60%.	Revenue data not disclosed.
Halan Environment	1992	Integrated urban environmental services, integrating hazardous waste treatment, municipal solid waste, water supply/drainage, providing "collection-treatment-resource utilization" one-stop solutions.	Digital management system (full-life-cycle traceability, service cost 15% lower than industry average), deep 绑定 industrial clients (e.g., Midea Group), 300,000 tons/year hazardous waste treatment base in Foshan as regional benchmark.	Market share >30% in Foshan (Guangdong), operating in 35 cities nationwide, ranked 5th in China's Top 10 Environmental Enterprises (2023), leading in solid waste treatment capacity.	2023 revenue: ~RMB 12 billion, total assets RMB 33.288 billion.
Hailuo Environmental Protection	2020	Cement kiln co-processing of hazardous waste, annual treatment capacity >2 million tons, covering fly ash, waste catalysts, with supporting sludge drying and soil remediation.	Cement kiln co-processing technology (1.2 tons CO_2 reduction per ton of hazardous waste, 5%-8% energy cost reduction for cement kilns), technology exported to 3	Relying on Hailuo Group's national cement kiln network, forming regional advantages in Anhui, Jiangxi, listed in Hong Kong in 2022, becoming one of the largest cement kiln co-	2022 revenue: RMB 1.73 billion, projected treatment capacity >3 million tons/year by 2025.

	projects in Southeast Asia.	processing service providers.

3.2.5.5 Market trends and opportunities

Market trends and space

China's hazardous waste treatment industry is undergoing profound changes, with market trends showing multi - dimensional structural adjustments and a broad development space in the future. Industry integration and increased concentration driven by policies have become the core logic. The Ministry of Ecology and Environment has explicitly required that by 2030, the proportion of hazardous waste landfill disposal should be controlled at less than 10%, which will push enterprises to optimize their production capacity structure through mergers and acquisitions.

At present, although there are many participants in China's hazardous waste disposal industry, the overall scale and production capacity of the industry are relatively small and still in the development stage. This industry situation leads to the fact that most hazardous waste disposal companies are relatively weak in technology, funding, and R & D capabilities. Many enterprises have single disposal qualifications, mainly limited to the treatment of one or several types of hazardous waste, and lack comprehensive and integrated disposal capabilities. In the future, industry mergers and acquisitions will replace new construction projects. Leading enterprises will occupy more market share through cross - regional integration. Small and medium - sized enterprises need to survive through technological barriers or regional specialization.

Technological innovation accelerates the transformation towards high - value resource utilization and low - carbonization. Plasma melting technology enables a metal recovery rate of over 90% from fly ash, and co - processing of hazardous waste in cement kilns can reduce carbon dioxide emissions by 1.2 tons per ton of hazardous waste. Meanwhile, intelligent management has become a key to enhancing competitiveness. For example, the "Hazardous Waste Intelligent Management Platform" in Hangzhou has achieved digital - based supervision of the entire chain, reducing the error rate of enterprise reporting by 100% and increasing the supervision efficiency by 60%.

Therefore, the future development of China's hazardous waste treatment industry will focus on three major directions:

1. **Increasing Market Concentration:** The market concentration ratio (CR5) is expected to increase from the current 12% to 20% by 2025. Leading enterprises will consolidate their advantages through technology output and regional integration.
2. **Resource Utilization and Low Carbonization:** High - value resource utilization projects (such as precious metal recovery and recycled metals) will account for more than 50%, and carbon trading income will contribute 10% - 15% of profits.

3. **Intelligent and Digital Deepening:** The adoption rate of technologies such as blockchain traceability and AI early warning will exceed 70%, and the full lifecycle management costs will be reduced by more than 30%.

Opportunities

Reduction of foreign investment barriers: China's 2025 action plan to stabilize foreign investment clearly cancels foreign investment access restrictions in the manufacturing industry, allows foreign investment to participate in pilot segmented production of biological products, and optimizes foreign investment merger and acquisition rules. As a key area of the environmental protection industry, hazardous waste treatment is accessible to foreign investment in the form of sole proprietorship or joint venture. For example, Dutch companies can learn from the successful model of Tialoc Group in China - - participating in hazardous waste disposal projects in chemical parks through technology output and engineering general contracting.

The Ministry of Ecology and Environment requires that the proportion of landfill disposal be reduced to less than 10% by 2030, promoting the application of high - value resource utilization technologies such as plasma melting and bio - leaching. The Netherlands' experience in the circular economy (such as soil remediation technology in the Kempens area) can be directly connected with China's needs.

China is advancing the digital - based supervision of the entire life cycle of hazardous waste. The Netherlands' experience in the Internet of Things and blockchain traceability technology can help Chinese enterprises improve supervision efficiency.

The Netherlands' technological accumulation in the field of hazardous waste resource utilization (such as waste acid recycling and precious metal purification) can fill the gap in China's special hazardous waste treatment. The "technology licensing + operation service" model can be adopted to jointly build demonstration projects with Chinese local governments or leading enterprises, reducing market entry risks.

3.2.6 Sludge

According to the "Technical Policy on Sludge Treatment and Disposal and Pollution Prevention and Control for Urban Wastewater Treatment Plants (Trial)", sludge is a semi - solid or solid waste generated in the process of wastewater treatment..

3.2.6.1 China's sludge disposal industry related policies

China's hazardous waste treatment industry policies focus on the core aspects of full - process supervision, resource utilization, and environmental risk prevention. In recent years, the industry's standardized development has been promoted through several top - level designs. The "Guiding Opinions on Further Strengthening the Environmental Management of Hazardous Waste and Strictly Preventing Environmental Risks" released by the Ministry of Ecology and Environment in 2025 put forward three - stage goals:

China's sludge treatment industry policies focus on harmless disposal, resource utilization, and full - chain supervision. The top - level design promotes the standardized development of the industry. In 2022, the National Development and Reform Commission, the Ministry of Housing and Urban - Rural Development,

and the Ministry of Ecology and Environment jointly issued the "Implementation Plan for the Harmless Treatment and Resource Utilization of Sludge", which proposed::

- In 2025: The national capacity for the harmless treatment of newly - added sludge (wet sludge with a moisture content of 80%) should be no less than 20,000 tons per day. The harmless treatment rate of urban sludge should reach more than 90%, and cities at or above the prefecture level should achieve a rate of over 95%. A basically complete, green - low - carbon, and effectively - supervised treatment system will be formed.
- In 2030: The proportion of sludge landfill will be significantly reduced, and resource utilization (such as land application and building material manufacturing) will become mainstream. A full - chain governance model of "reduction, stabilization, harmlessness, and resource utilization" will be formed.

The core content of sludge management policies is shown in the table below:

Table 13 Key content of sludge management policies

Category	Core Content
Competent Authorities and Responsibilities	- **Central Level**: The ecological and environmental authorities and housing and urban-rural development authorities of the State Council coordinate national management of sludge pollution prevention and resource utilization, and formulate technical standards and norms at the national level. - **Provincial/Autonomous Region Level**: Ecological and environmental authorities and housing and urban-rural development authorities at the provincial/autonomous region level supervise and guide sludge management within their jurisdictions, implement central policies, and formulate local implementation rules. - **Municipal Level**: Drainage authorities of city governments are specifically responsible for supervising the collection, transportation, treatment, and disposal of sludge within their administrative regions, formulating annual plans, and implementing the sludge transfer manifest system.
Principles and Requirements for Disposal	- **Guiding Principles**: Adhere to the principles of reduction (source control), resource utilization (priority for recycling), harmless treatment (safe disposal), and "polluter-pays" (liability of waste-producing entities). Prioritize sludge reduction through technologies such as anaerobic digestion and drying-incineration, and promote resource utilization paths such as land application and building material production. - **Facility Planning**: Integrate sludge treatment and disposal facilities into special urban environmental sanitation plans and sewage governance plans. New sewage treatment plants must be equipped with supporting sludge treatment facilities in parallel. - **Transfer Management**: Implement a sludge transfer manifest system to record details such as sludge generation volume, destination, and disposal methods. Cross-provincial/municipal transfers require manifest processing and approval from ecological and environmental authorities of both regions.

Regulations and Prohibited Acts	- **Document Management**: Prohibit altering, reselling, leasing, lending, or illegally transferring licenses and permits related to sludge disposal. Disposal entities must obtain environmental impact assessment approval from ecological and environmental authorities and be included in pollution discharge permit management. - **Classification Management**: Strictly prohibit mixing sludge with hazardous waste or municipal solid waste. Industrial sludge and municipal sludge must be collected and disposed of separately; sludge with excessive heavy metals shall not be directly applied to land. - **Illegal Disposal**: Prohibit unauthorized establishment of sludge disposal sites or temporary storage points. Sludge must be disposed of in venues designated or approved by the government. Dumping sludge in non-designated areas such as rivers and lakes is prohibited.

3.2.6.2 China's sludge disposal industry market analysis

Sludge mainly comes from municipal sludge, industrial sludge, and other sources. Municipal sludge refers to the excess sludge generated from the treatment of domestic sewage in urban wastewater treatment plants, accounting for more than 70%. Industrial sludge accounts for about 25%, including sludge containing heavy metals or toxic and harmful substances generated from wastewater treatment in industries such as chemical, electroplating, and paper - making, such as electroplating sludge and printing and dyeing sludge. Other - sourced sludge includes river dredging sludge, construction slurry, etc., accounting for about 5%.

The continuous accumulation of sludge production has provided a foundation for the development of China's sludge treatment and disposal industry. From the point of view of sludge generation, sludge is generally generated when treating sewage. While China's sewage is divided into two parts, industrial and urban life, China's industrial sewage discharge remained at about 19 billion tons per year from 2014 to 2021, and urban life sewage discharge grew from 51.03 billion tons to about 57.0 billion tons.

Generally speaking, a sewage treatment plant can produce 5-8 tons of sludge with a water content of 80% for every 10,000 tons of domestic sewage it treats, and 10-30 tons of sludge for every 10,000 tons of industrial sewage. Based on the unit output of 6.5 tons and 20 tons respectively, China's annual sludge production will remain above 70 million tons/year between 2014 and 2021.

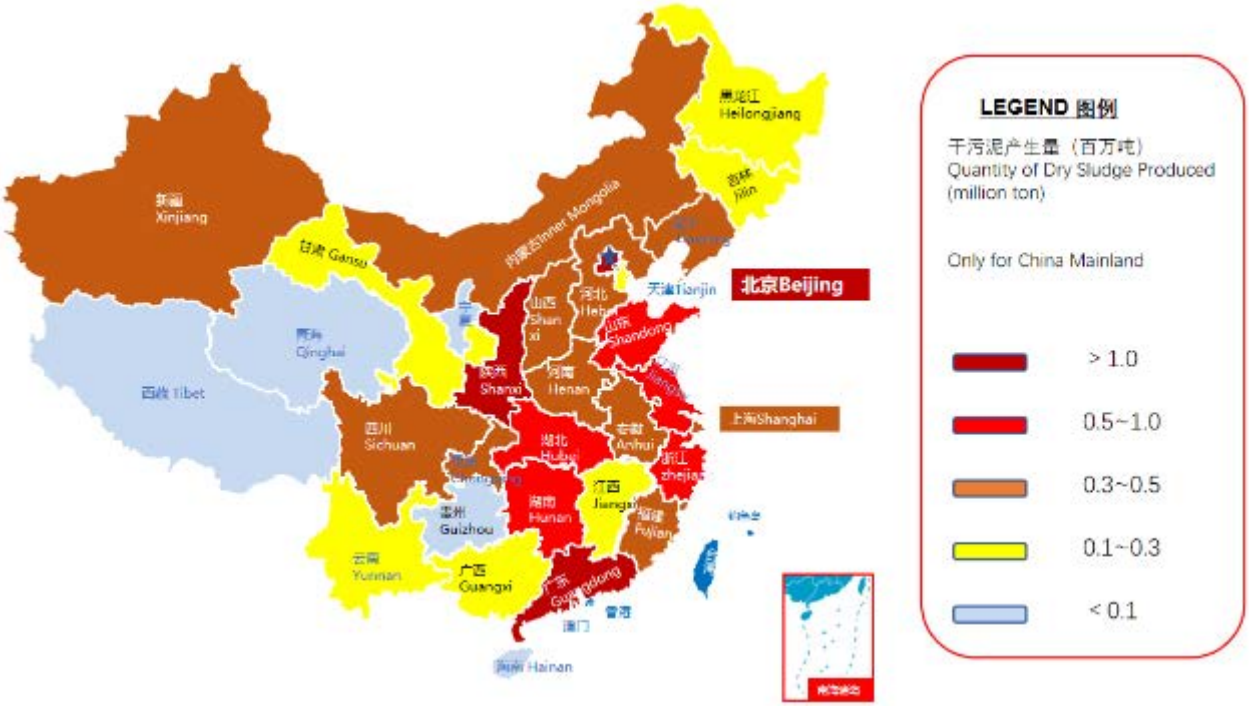


Figure 54 Quantity of dry sludge produced

From the dry mud production statistics, relatively the most production provinces are Guangdong, Beijing and Shaanxi provinces, of which Beijing has 1.86 million tons, Shaanxi 1.42 million tons, Guangdong Province output 1.41 million tons, Jiangsu 1.34 million tons, Zhejiang 1.04 million tons, Shandong Province 870 thousand tons, Hunan Province 860 thousand tons, Hubei 550 thousand tons.

Figure 55 Quantity of dry sludge treated by regions

From the dry mud disposal volume statistics, of which a total of 1.856 million tons in Beijing, 1.415 million tons in Shaanxi, 1.38 million tons in Guangdong Province, 1.34 million tons in Jiangsu, 1.03 million tons in Zhejiang, 871 thousand tons in Shandong Province, 854 thousand tons in Hunan Province and 549 thousand tons in Hubei.

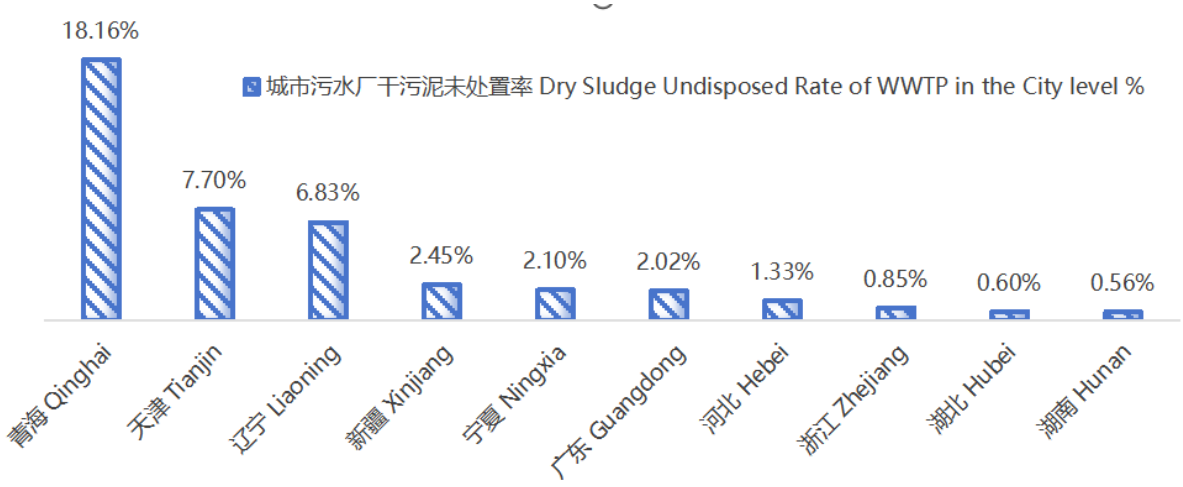


Figure 56 Dry sludge undisposed rate of WWTP in the city level

According to the statistical data, it was found that in the ratio of undisposed urban dry sludge to the amount of dry sludge generated in each province, the undisposed rate of Qinghai accounted for the highest proportion of 18.15%; followed by Tianjin at 7.7% and Liaoning at 6.8%. The highest disposal rates were in Tibet, Jilin, Guizhou, Heilongjiang and Shanghai, reaching 100% disposal.

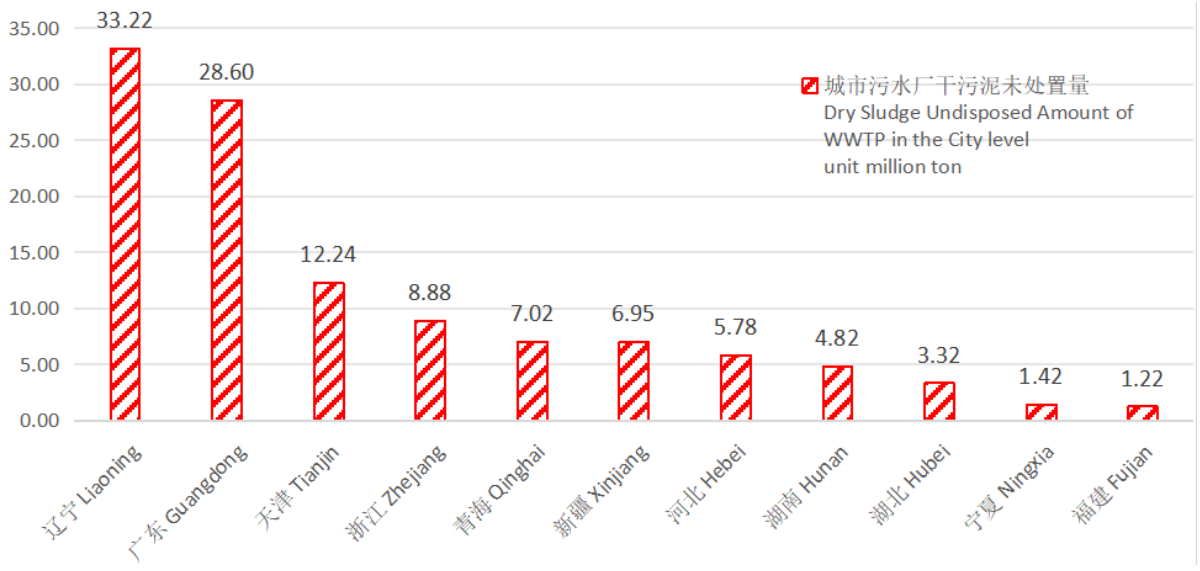


Figure 57 Dry sludge undisposed amount of WWTP in the city level

The provinces with relatively large amounts of undisposed dry mud are Liaoning, with a total of 33.22 million tons, Guangdong with 28.6 million tons, and Tianjin with 12.24 million tons.

3.2.6.3 China's sludge to resource market analysis

Sludge Resource Utilization

Sludge treatment and disposal refers to the process of reducing, stabilizing, harmlessly treating, and resource - utilizing the sludge generated in the wastewater treatment process. The aim is to lower the moisture content of sludge, reduce its volume, remove harmful substances, and transform it into usable resources as much as possible through physical, chemical, or biological methods. Sludge treatment mainly includes incineration, landfill, land application, or other resource - utilization methods.

The market size and utilization volume of sludge resource utilization in China are growing rapidly. In 2023, China's sludge production has exceeded 65 million tons/year (with a moisture content of 80%), and the sludge treatment market size is around 30 - 40 billion yuan, of which resource utilization treatment accounts for about 30% - 40%. By 2025, with the realization of the harmless disposal rate target (over 90%), the sludge treatment market size is expected to exceed 100 billion yuan, and the sludge resource utilization market size is expected to exceed 50 billion yuan..

Industrial chain

The industrial chain structure of China's sludge treatment and disposal industry covers the entire process from sludge generation, treatment, and disposal to resource utilization. Specifically, the upstream of the industry chain mainly includes sludge - generating sources such as wastewater treatment plants and industrial enterprises, as well as the manufacturing of sludge treatment equipment and the supply of engineering materials.

The midstream focuses on the harmless treatment and resource - utilization transformation of sludge, with professional sludge treatment enterprises as the core entities. They convert sludge into products such as biogas, organic fertilizer, and building material raw materials through technical routes like dewatering, anaerobic digestion, and drying and incineration. This involves multiple aspects including municipal operation and maintenance, energy supply, and urban management.

The downstream includes the final disposal and resource utilization of sludge, such as sludge composting, incineration, and building material utilization, as well as related transportation services and industrial chemical applications.

Policy-driven

In 2021, the National Development and Reform Commission and the Ministry of Housing and Urban - Rural Development issued the "14th Five - Year Plan for Urban Wastewater Treatment and Resource Utilization". It was clearly stated that by 2025, the harmless disposal rate of urban sludge would reach more than 90%, an increase of 15 percentage points compared with 2020, and by 2035, the harmless disposal of sludge would be fully realized.

In 2022, the National Development and Reform Commission and three other departments jointly issued the "Implementation Plan for the Harmless Treatment and Resource Utilization of Sludge", proposing that by 2025, the national capacity for the harmless treatment of newly - added sludge (wet sludge with a moisture

content of 80%) should be no less than 20,000 tons per day. The harmless treatment rate of urban sludge should reach more than 90%, and cities at or above the prefecture level should achieve a rate of over 95%.

In 2023, the "Implementation Opinions on Promoting the Synergistic Reduction of Pollution and Carbon Emissions in Wastewater Treatment" included sludge treatment in the construction of "Zero-wase cities". It called for the promotion of low - carbon technologies such as anaerobic digestion + biogas cogeneration and co - processing in cement kilns. It is estimated that each ton of sludge treatment can reduce carbon dioxide emissions by 1.2 tons.

3.2.6.4 Competitive landscape of sludge treatment in China

Sludge treatment industry players

At present, there are many market participants in China's sludge treatment industry, and the competitive landscape is relatively fragmented with low industry concentration. Most enterprises involved in sludge treatment mainly focus on wastewater treatment, with sludge treatment being a business expansion to complete the wastewater treatment industry chain. Only a few enterprises in the industry are specifically engaged in sludge treatment. The following lists some of the leading enterprises in China's sludge treatment industry.

Table 14 Major industry players in sludge treatment market

Company Name	Founded	Core Business	Technical/Model Advantages	Market Position & Regional Coverage	Revenue
Hangzhou Guotai Environmental Protection	2001	Municipal sludge treatment, energy-saving and environmental protection equipment, and ecological restoration, covering the full "pretreatment-drying-incineration" chain with an annual treatment capacity	Proprietary RRS® sludge treatment technology (energy consumption 30% lower than traditional processes), MDS multi-stage chemical-biological deodorization technology (odor removal rate >99%), applied in cities like Shanghai, Hangzhou, and Nanchang.	Leading enterprise in China's sludge treatment industry, with a top market share in East China; technology recognized by the Basel Convention as a "zero-waste city" model, replicated in 6 provinces including	2023 revenue: ~RMB 1.5 billion, CAGR over 15%.

		exceeding 4,000 tons/day.		Jiangsu and Anhui.	
Chongqing Water Group	1992	Harmless disposal of urban sludge, with a daily treatment capacity of 1,992 tons (2022), planned to increase to 4,680 tons/day by 2025, with supporting sludge drying and land application services.	Cement kiln co-processing technology (1.2 tons CO_2 reduction per ton of sludge), "plant-network integration" model reducing logistics costs by 25%, serving Chongqing and surrounding areas.	Leading sludge processor in Southwest China, with a market share of over 30% in Chongqing, undertaking sludge disposal for municipal wastewater plants, technology applied in Sichuan-Chongqing region.	2023 revenue: ~RMB 8 billion, sludge treatment revenue share >10%.
Beijing Enterprises Water Group	2000	Urban sludge treatment and disposal, focusing on the "sludge drying-incineration-building materialization" closed loop, with supporting smart water management systems, participating in PPP projects in Qinhuangdao, Mianyang, etc.	Aerobic granular sludge (AGS) technology (first commercial application in Asia), "seven-stage" biochemical process (effluent meets quasi-Class IV surface water standards), digital management platform improving operational efficiency by 15%.	Operates in 35 cities nationwide, with significant advantages in North and South China; ranked 6th in China's Top 10 Environmental Enterprises (2023), leading in national sludge treatment capacity.	2023 revenue: ~HKD 20 billion, sludge treatment business growth 20% annually.
Xingrong Environment	2002	Resource utilization of municipal sludge, with a current	Earthworm bio-composting technology (enhanced composting	Leading enterprise in Central and Western China,	2023 revenue: ~RMB 8.5 billion, sludge

		daily treatment capacity of 2,500 tons (planned for 2025), covering anaerobic digestion, aerobic fermentation, drying, and incineration technologies.	efficiency), "sludge-biogas-power generation" energy recycling model, with recycled products included in the *Green Product Government Procurement List*.	with a market share of over 25% in Sichuan, technology applied in Chengdu, Xi'an, etc., selected into the "Zero-Waste City" pilot technology database in 2023.	treatment profit margin 20% higher than traditional landfilling.
Shanghai Environment	2004	Integrated urban environmental services, integrating sludge treatment, municipal solid waste, and waste incineration, providing "collection-treatment-resource utilization" one-stop solutions.	Digital management system (full-life-cycle sludge traceability), "sludge-waste co-incineration" model (energy recovery efficiency >40%), with the Songjiang Sludge Drying and Incineration Plant as a regional benchmark in Shanghai.	Core service provider in the Yangtze River Delta, with a market share of over 30% in Shanghai, operating in 20 cities nationwide; ranked 8th in China's Top 10 Environmental Enterprises (2023).	2023 revenue: ~RMB 12 billion, sludge treatment revenue share >15%.

3.2.6.5 Market trends and opportunities

Firstly, in China, the complex and diverse composition of sludge is a major challenge. The characteristics of sludge from a sewage plant are determined by the upstream sewage. In the case of incomplete pipe networks and unclear sewage acceptance, domestic sludge has the characteristics of being mixed and having a low calorific value, which to a large extent restricts some processes and poses a significant challenge to sludge treatment and disposal.

Secondly, the high moisture content of sludge is a prominent problem. Usually, the moisture content of newly produced sludge is as high as 95% or more, which makes the sludge bulky and the transportation and treatment costs extremely high. To reduce the moisture content, effective dehydration technology is needed, but this often requires a lot of energy and resources.

Furthermore, the limited disposal methods for sludge are also one of the challenges. Common sludge disposal methods include landfill, incineration, composting, etc. Although landfills is relatively simple to

operate, they require a lot of land resources and may cause pollution to the soil and groundwater due to imperfect operation and management. Incineration can reduce the amount of sludge and make it harmless, but the construction and operation of incineration facilities are expensive, and secondary pollution may occur during the incineration process. If the incineration temperature is not high enough, harmful gases such as dioxins will be produced. Although composting can convert sludge into organic fertilizer, it has high requirements for the quality of sludge and requires strict control conditions, otherwise, it may cause excessive harmful substances in the fertilizer.

In terms of the economy, the high cost of sludge disposal is a challenge that cannot be ignored. From sludge collection, transportation, and treatment to final disposal, each link requires a large amount of investment. For example, the purchase of advanced dehydration equipment, the construction of incineration facilities, and environmental monitoring all require huge investments. However, for some small and medium-sized sewage treatment plants, due to limited funds, it is often difficult to bear these costs, resulting in the inability to effectively carry out sludge disposal.

China's "Implementation Plan for the Harmless Treatment and Resource Utilization of Sludge" clearly requires that by 2025, the harmless disposal rate of urban sludge should reach more than 90%, and cities at or above the prefecture level should reach 95%. It also widens financing channels through tools such as tax preferences (70% VAT refund on collection), special bonds, and REITs. Dutch companies can participate in PPP projects or government cooperation based on their technological advantages. For example, a Beijing - based company has cooperated with Royal HaskoningDHV from the Netherlands to introduce the Nereda aerobic granular sludge technology, and the demonstration project has been implemented.

China's sludge treatment faces issues such as low organic content, high sand content, and heavy metal pollution. Traditional processes (such as earthworm composting) have unstable efficiency. The Netherlands has mature technologies in anaerobic digestion, phosphorus recovery, and efficient dewatering. Dutch companies have advantages in treating difficult - to - handle sludge (such as heavy - metal - containing sludge) and can fill the technological gaps in China. China's "dual - carbon" goals are driving the transformation of sludge treatment towards energy recovery and low - carbon operation. Dutch technological pathways are highly compatible. Dutch UASB anaerobic process and sidestream anaerobic ammonium oxidation (DEMON) technologies have been applied in Wuxi, Jinan, and other places in China, significantly reducing energy consumption and increasing carbon emission reduction.

Dutch companies can enter the market through technology licensing, joint ventures, and joint research and development: cooperating with Chinese environmental protection companies to provide core equipment (such as dewatering machines, phosphorus recovery devices) or digital management systems, and integrating into the full - chain services of local companies.

3.3 Water Treatment Market Study

The water treatment industry is one of the most important urban basic service industries in various regions across the country. It is a fundamental industry that supports economic and social development and

ensures the daily production and living of residents, possessing the dual attributes of public utilities and environmental protection. Our country's daily production and living are inseparable from urban water supply and sewage treatment. From the perspective of the entire industry chain, the water treatment industry refers to the chain formed by raw water, water supply, water conservation, drainage, sewage treatment, and the recycling of water resources. In addition, it also includes derivative industries related to water treatment, such as the utilization of reclaimed water and sludge treatment. The water treatment industry chain is mainly composed of two parts: water supply and sewage treatment.

The work of sewage treatment mainly includes three aspects: First is sewage treatment, which includes the treatment of industrial wastewater and domestic sewage. Second is sludge treatment, which refers to the treatment of sludge generated after sewage treatment, such as landfilling. Third is the recycling of sewage, which means that after appropriate treatment, sewage reaches a certain water quality standard, meets specific usage requirements, and can be reused beneficially. This falls under the category of advanced treatment of sewage. Section 3.2.6 can be referred for sludge treatment segment analysis.

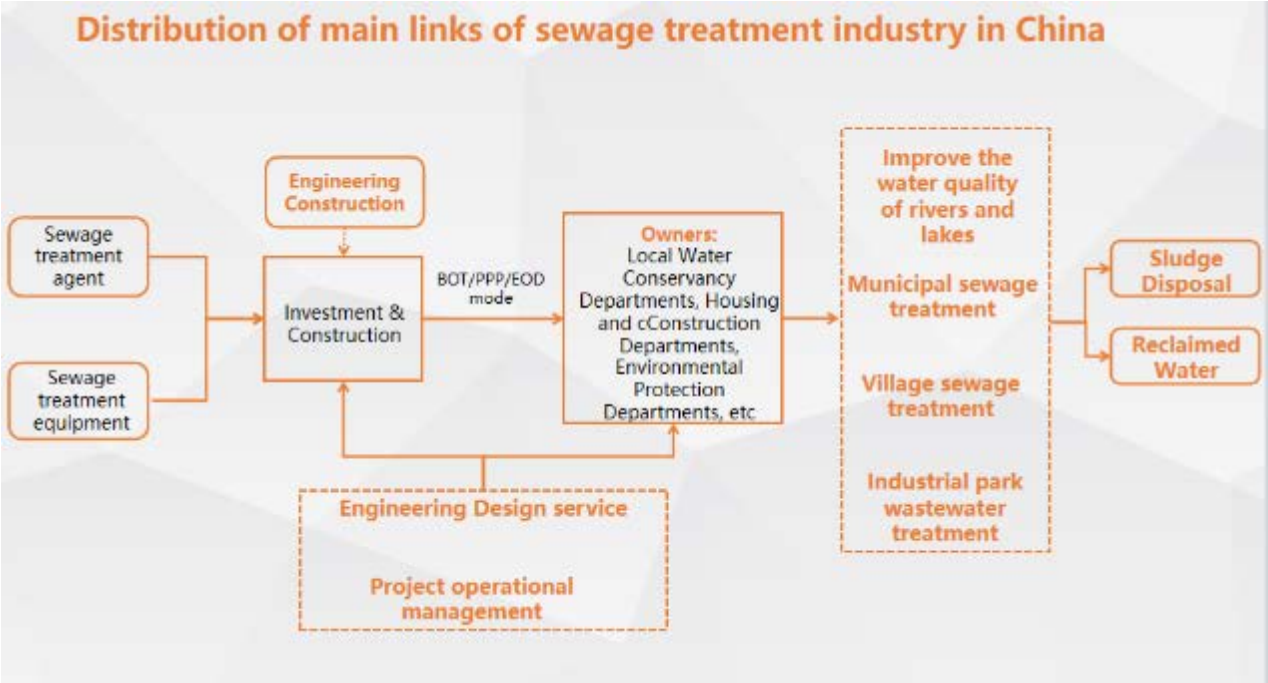


Figure 58 Distribution of main links of sewage treatment industry in China

Currently, water treatment technologies are primarily categorized into three major types: physical treatment, chemical treatment, and biological treatment. Among these, advanced technologies such as membrane separation, reverse osmosis, and ultraviolet disinfection are increasingly being applied in the field of water treatment. Additionally, the development of intelligent water treatment systems is an important trend in the industry, as these systems can achieve more efficient water resource management and more precise water quality control.

The separation accuracy of membranes mainly depends on the size of their filtration pores and can be divided into microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO)

membranes. Membrane technologies are widely used in various fields, including environmental protection, energy, electronics, and pharmaceuticals. Due to their ability to remove water pollutants that are difficult to eliminate through conventional treatment processes, membrane technologies are increasingly valued in the field of water treatment.

Different types of membrane technologies are applied in various sub-sectors, mainly including municipal sewage treatment and reclaimed water treatment, tap water treatment, industrial water reuse, seawater desalination, and household water purifiers.

3.3.1 China water treatment industry related policies

Between 1990 and 2000, with the rapid economic growth and accelerated urbanization, water environmental issues became increasingly severe. The Chinese government intensified its efforts in water environment management, implementing a series of laws, regulations, and policies that promoted the research and application of water environment management technologies.

After 2010, China established a more comprehensive policy system for water environment management, including the introduction and implementation of laws and regulations such as the Water Pollution Prevention and Control Law. The government further increased its investment in water environment management, driving the healthy development of the industry.

During the "13th Five-Year Plan" period, the rapid development of China's water treatment industry was mainly supported by government policies. Many sub-sectors and emerging fields (such as sponge cities, rural water environment management, urban black and malodorous water management, groundwater remediation, and zero discharge of industrial wastewater) saw vigorous market development. Meanwhile, with the increasing maturity of water treatment technologies, sectors such as reclaimed water treatment and smart water utilities have been more widely applied in the water treatment industry. As of now, more than 70% of established towns, over 90% of townships, and 80% of administrative villages in China have not yet treated domestic sewage, leaving significant room for improvement.

On January 4, 2021, the National Development and Reform Commission, the Ministry of Ecology and Environment, and nine other departments jointly issued the Guiding Opinions on Promoting the Resourceful Utilization of Wastewater. The opinions state that by 2025, the reuse rate of reclaimed water in water-scarce cities at or above the prefecture level nationwide will reach more than 25%, and the Beijing-Tianjin-Hebei region will reach more than 35%; by 2035, a systematic, safe, environmentally friendly, and economical pattern of wastewater resource utilization will be formed.

In terms of water environment quality, the proportion of good-quality surface water sections in China reached 90.4% in 2024, surpassing 90% for the first time, a year-on-year increase of 1 percentage point; the proportion of good-quality water in the nearshore marine areas was 83.7%, reaching the "14th Five-Year Plan" target ahead of schedule. The main streams of the Yangtze River have maintained stable water quality at Class II for five consecutive years, and the Yellow River for three consecutive years.

In recent years, the Chinese government has attached great importance to water environment management, introducing a series of policies and regulations to promote the development of the water treatment industry. For example, the implementation of policies such as the Three-Year Action Plan for Improving the Quality and Efficiency of Urban Water Pollution Management (2019–2021) and the 14th Five-Year Plan for Urban Water Pollution Management and Resource Utilization has provided strong policy support and guidance for the development of the water treatment industry. Fiscal subsidies and tax reduction policies from the government have also provided substantial support to enterprises, reducing their operating costs and further driving the development of the water treatment market.

The Key River Basins Water Ecological Environment Protection Plan proposes that by 2025, the total discharge of major water pollutants will continue to decrease, the water ecological environment will continue to improve, breakthroughs will be achieved in the prevention and control of non-point source pollution and the recovery of water ecology, and the water ecological environment protection system will be more complete. In terms of water environment, by 2025, the proportion of surface water reaching or better than Class III will reach 85%, a relatively complete urban water pollution prevention and control system will be basically formed, the centralized collection rate of urban domestic sewage will strive to reach more than 70%, and urban black and malodorous water bodies will be basically eliminated. The proportion of urban centralized drinking water sources reaching or better than Class III will not be lower than 93%.

According to the "14th Five-Year Plan for the Development of Urban Wastewater Treatment and Resource Utilization", by 2025, the blank areas of direct discharge outlets for domestic sewage and collection and treatment facilities in urban built-up areas will be basically eliminated, and the centralized collection rate of domestic sewage in Chinese cities will strive to reach more than 70%; the sewage treatment capacity of cities and county towns will basically meet the needs of economic and social development, and the sewage treatment rate of county towns will reach more than 95%; the sewage treatment requirements in water environment sensitive areas will basically meet the Class A emission standards, the utilization rate of reclaimed water in water-scarce cities at the prefecture level and above nationwide will reach more than 25%, and 35% in the Beijing-Tianjin area; the rate of water-scarce cities at the prefecture level and above in the middle and lower reaches of the Yellow River will strive to reach 30%, and the harmless disposal rate of urban sludge will reach more than 90%.

Table 15 Key policy requirements at the national level

Issuing Time	Policy name	Main content	Issuing Department
July 2024	Guiding Opinions on Accelerating the Development of the Seawater Fishery Industry	By 2027, the water conservation industry scale will reach one trillion yuan, and a number of specialized, precise, unique, and innovative "little giant" enterprises will be cultivated and formed. A preliminary development pattern of the water conservation industry, which is mainly based on enterprises, oriented by the market, driven by innovation, and combines industry, academia, research, and application, will be established. By 2035, a number of leading enterprises with a value	National Development and Reform Commission (NDRC), Ministry of Water Resources, Ministry of Industry and

		of 10 billion yuan will be cultivated, and the water conservation technology, process, product equipment manufacturing, and management services will reach the world - advanced level. A water conservation production and lifestyle will be fully formed.	Information Technology, Ministry of Housing and Urban-Rural Development, Ministry of Agriculture and Rural Affairs
July 2023	Action Plan for Improving the Level of Environmental Infrastructure Construction (2023 - 2025)	By 2025, the treatment and disposal capacity and level of environmental infrastructure will be significantly enhanced, with an additional sewage treatment capacity of 12 million cubic meters per day, the addition and renovation of 45,000 kilometers of sewage collection pipelines, and the construction, renovation, and expansion of reclaimed water production capacity of no less than 10 million cubic meters per day.	NDRC, Ministry of Ecology and Environment, Ministry of Housing and Urban-Rural Development
April 2022	Environmental Protection Action Plan for the Treatment and Rectification of Black and Smelly Water Bodies in Cities during the '14th Five-Year Plan' Period	By 2025, efforts will be made to ensure that black and odorous water bodies in the built-up areas of cities at or above the prefecture level are basically treated and remain clear in the long term; black and odorous water bodies in the built-up areas of county-level cities will be essentially eliminated. A work manual will be compiled, and a dedicated "APP" will be developed to standardize the investigation procedures and effectiveness assessment.	Ministry of Ecology and Environment, Ministry of Housing and Urban-Rural Development
February 2022	Guiding Opinions on Accelerating the Construction of Urban Environmental Infrastructure	By 2025, an additional sewage treatment capacity of 20 million cubic meters per day will be added, with the construction, renovation, and expansion of water production capacity of no less than 15 million cubic meters per day. The sewage treatment rate in county towns will reach over 95%, and the sewage resource utilization rate in water-scarce cities at or above the prefecture level will exceed 25%.	NDRC, Ministry of Housing and Urban-Rural Development, Ministry of Health
June 2021	Development Plan for Urban Sewage Treatment and Resource Utilization during the '14th Five-Year Plan' Period	Strengthen sewage treatment facilities. Cities and counties where the existing sewage treatment capacity is insufficient must accelerate the filling of the treatment capacity gap. New urban areas should synchronize the construction of sewage collection and treatment facilities with urban development. The scale of sewage treatment facility construction in large and medium-sized cities can be moderately advanced. Strengthen the construction of facilities for regeneration and utilization, and promote the resource utilization of sewage. Implement regional recycled water circulation and utilization projects in a location-specific manner downstream of key discharge outlets, at river mouths entering lakes, and at the confluences of tributaries with the main streams.	NDRC, Ministry of Housing and Urban-Rural Development
June 2021	Action Plan for the Development of Seawater Desalination and	By 2025, the total scale of national seawater desalination will exceed 290,000 tons per day, with an additional desalination capacity of over 125,000	NDRC, Ministry of Natural Resources

	Utilization (2021 - 2025) (2021-2025 年)	tons per day, of which coastal cities will add more than 105,000 tons per day.	
October 2020	Research on the Strategy for Becoming a Strong Country in New Materials by 2035	The development focus and direction in the field of key strategic materials mainly include high-performance fibers and their composite materials, new energy materials, and high-performance separation membrane materials.	State Council

3.3.2 China water treatment industry Market Analysis

The water industry mainly includes the municipal water supply and municipal wastewater industries. The water industry consists of a series of industrial nodes such as raw water, water transmission, water purification, water supply, water sales, wastewater treatment, reclaimed water recycling and related pipe network facility maintenance, and equipment production. From a business perspective, the water industry includes all aspects of manufacturing, transportation, distribution, and retail.

From 2018 to 2022, the market size of China's sewage treatment industry grew from 117.66 billion to 143.74 billion RMB. In 2023, the market size of sewage treatment is expected to reach 150.01 billion RMB, a year-on-year growth of 4.4%. In the future, with the steady acceleration of China's urbanization process and the continuous improvement of industrialization levels, the scale of China's wastewater treatment industry will continue to expand.

In recent years, China's environmental governance has gradually shifted to a comprehensive model of large regions and large projects, and the entire industry chain has also been continuously extended and improved. The upstream of the environmental protection industry chain is mainly composed of raw material and equipment suppliers, the midstream is pollution treatment suppliers and operation and maintenance service providers, which will involve a lot of resource inputs, and the downstream is mainly related to the environmental pollution emission industry, such as coal chemical industry, petrochemical industry, textile industry, metal industry and other polluting enterprises.

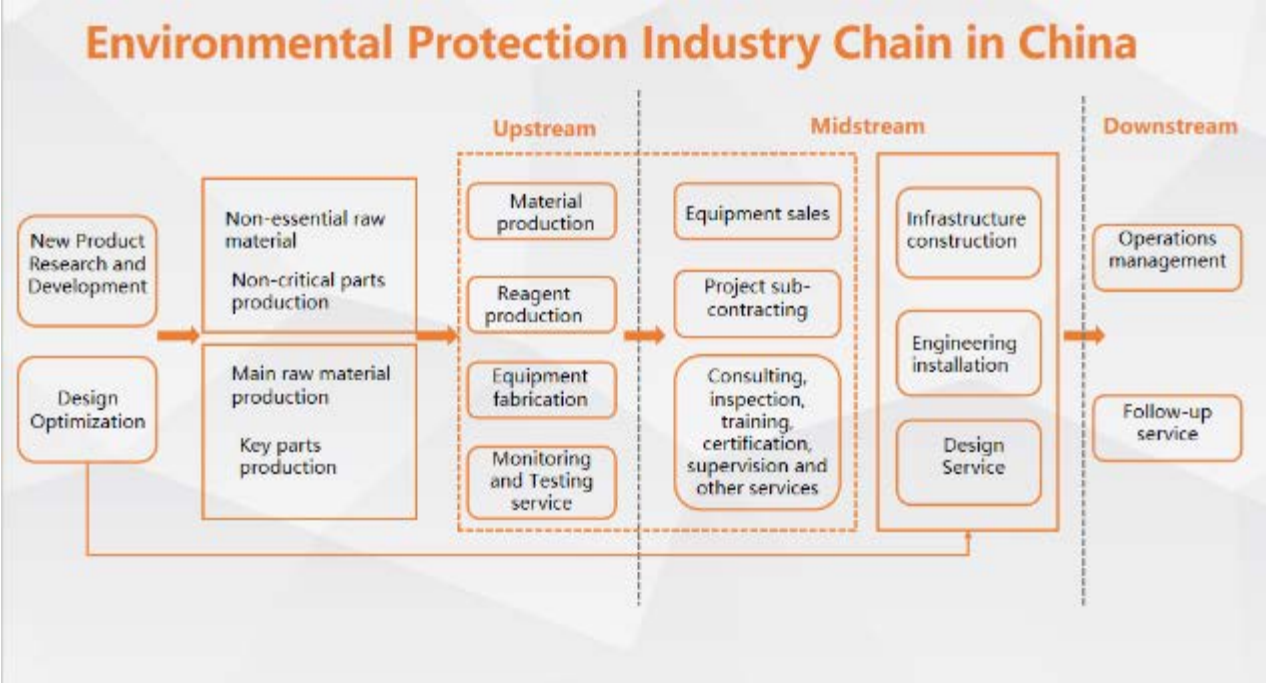


Figure 59 Environmental protection industry chain in China

3.3.2.1 The situation of municipal sewage in City

Current development status of China's urban sewage treatment market: With the continuous development of the economy and the continued advancement of urbanization, China's urban sewage discharge has shown a steady growth trend under the condition of a steady increase in water supply.

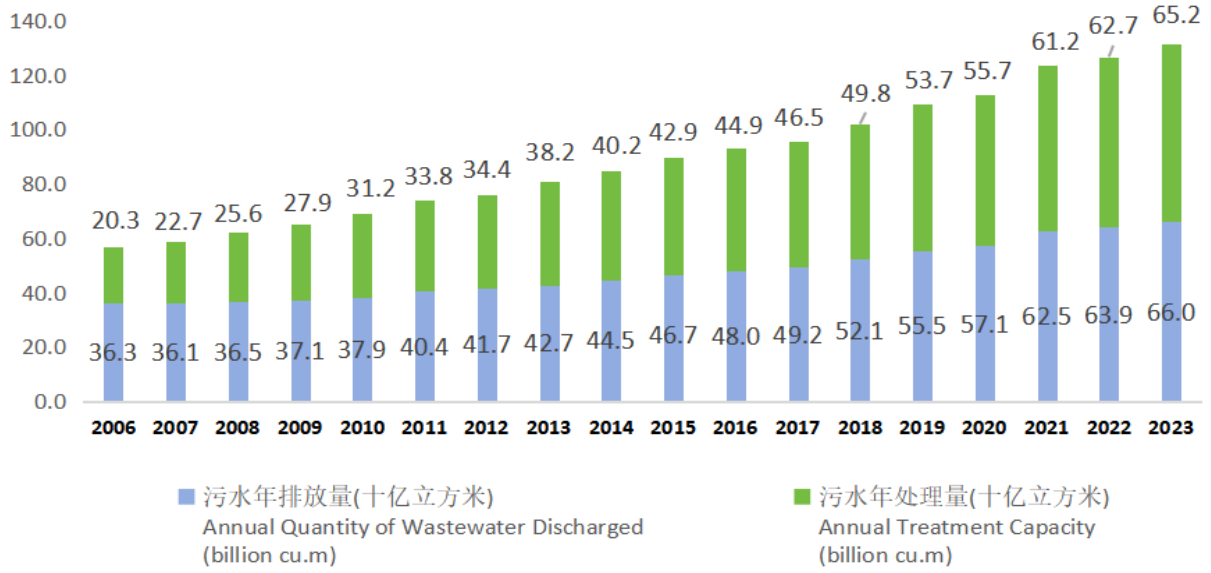


Figure 60 Annual Quantity of wastewater discharged

As of 2023, there are 2,967 sewage treatment plants in cities across the country, with a capacity of 64.27 billion cubic meters per day, an annual sewage discharge of 66.04 billion cubic meters, an annual sewage

treatment capacity of 65.2 billion cubic meters, and a daily sewage treatment capacity of 230 million cubic meters per day. The urban sewage treatment rate was 98.69 percent, the centralized treatment and disposal rate of urban sewage treatment plants was 95.78 percent.

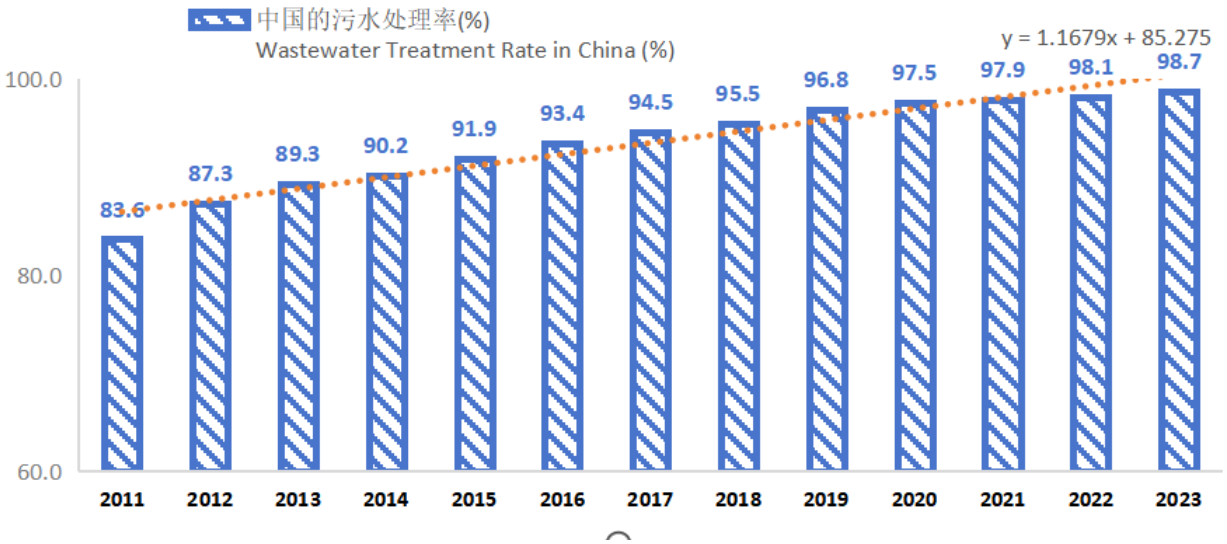


Figure 61 Wastewater treatment rate in China

At the national level in 2023, the difference between urban domestic sewage collection rate and sewage treatment rate will exceed 25%, and in some provinces and regions, the difference will exceed 68%. China's sewage collection system still needs to be improved.

According to the statistics, as of 2023, the three regions with the most urban sewage treatment plants in China are Guangdong (357), Shandong (236), and Jiangsu (217).

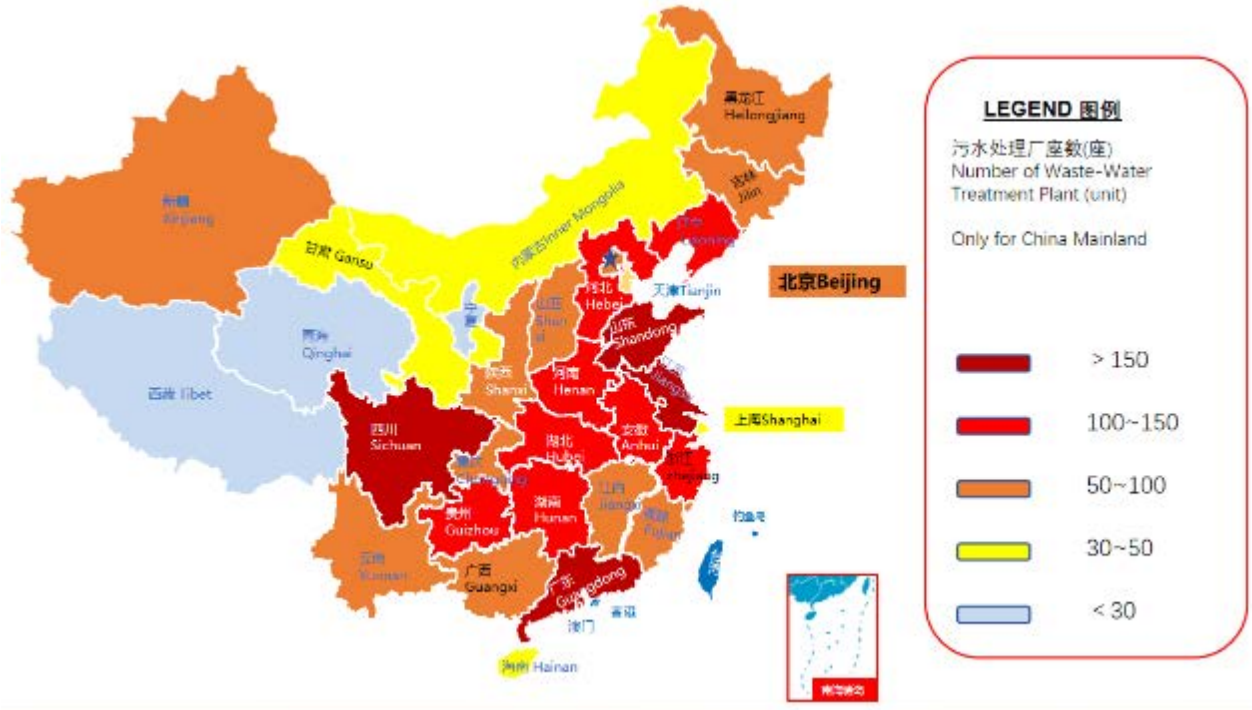


Figure 62 Number of waste water treatment plant

From the perspective of sewage plant treatment capacity statistics, the largest treatment capacity is Guangdong Province, with a capacity of 31.23 million cubic meters/day. Followed by Jiangsu Province (17.42 million m^3/day), Shandong Province (15.15 million m^3/day), Zhejiang (14.29 million m^3 /day).

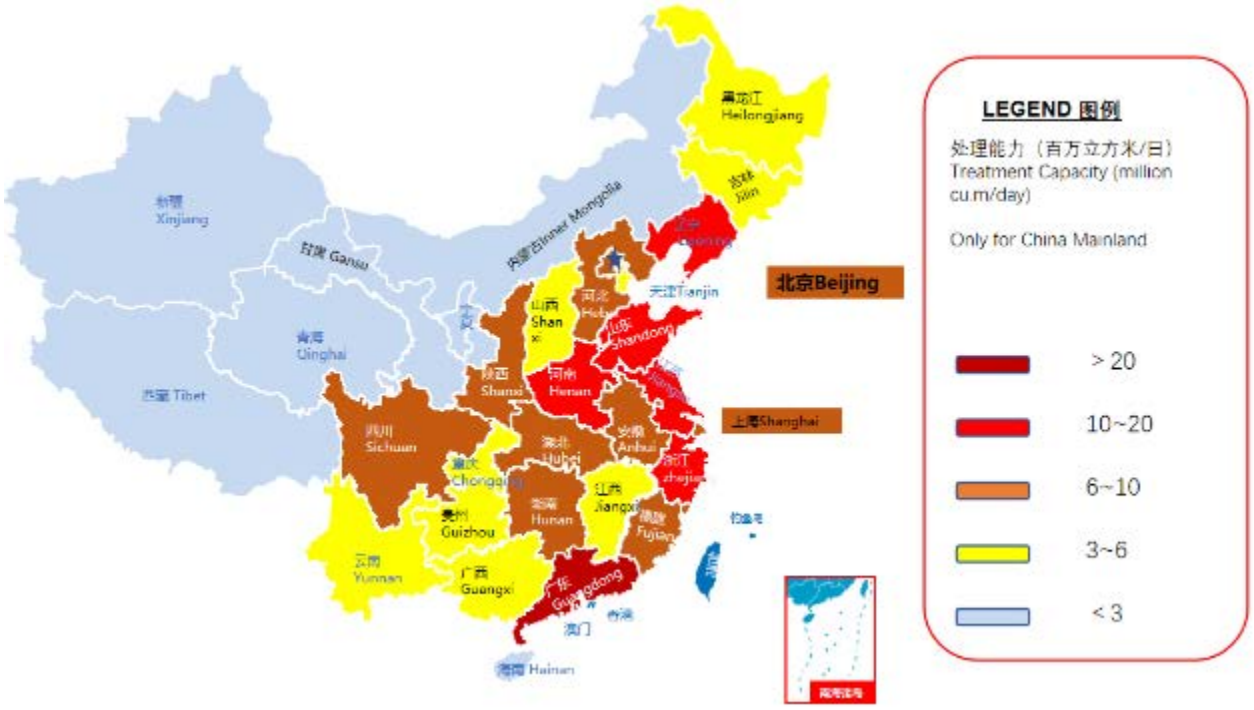


Figure 63 Treatment capacity of WWTP

The state encourages the sewage treatment industry to engage in technological innovation, promote advanced and applicable technologies and equipment, and improve the efficiency and quality of sewage treatment. Regulation of the industry will be stricter to promote standardized development. The state will increase its regulatory efforts in the sewage treatment industry, establish strict regulatory systems and standards, regulate the industry order, and promote healthy industry development. Meanwhile, the government will also strengthen the assessment and evaluation of sewage treatment enterprises, encourage enterprises to improve service quality and technological level, and enhance the overall image of the industry. In addition, the state will promote the green development of the sewage treatment industry. By promoting green technologies and reducing energy consumption and emissions, the environmental impact of the sewage treatment process will be reduced to achieve sustainable industry development.

3.3.2.2 Disposal of industrial wastewater

According to data released by the Ministry of Housing and Construction, from 2011 to 2022, China's total sewage discharge continued to improve, with sewage discharge from 48.322 to 75.390 billion cubic meters. Among them, the city sewage discharge is 63.897 billion cubic meters, and the county sewage discharge is 11.493 billion cubic meters. In 2023, the total amount of sewage discharge is about 78.429 billion cubic meters.

Taking 2022 data as an example, the total number of industrial wastewater treatment facilities in the country is 72,848 sets, the treatment capacity of industrial wastewater treatment facilities is 183.79 million tons per day, and the operating cost of industrial wastewater treatment facilities is 71.39 billion RMB. The paper making and paper products are the largest industry, followed by the textile industry and coal mining and washing industry.

In 2022, the total chemical oxygen demand of wastewater discharge in China was 25.958 million tons, including 368700 tons from industrial sources, 17.857 million tons from agricultural sources, 7.722 million tons from domestic sources, and 10800 tons from centralized pollution control facilities. The province with the highest emissions is Henan, with 18.48 million tons, followed by Hunan with 15.94 million tons and Guangdong with 15.45 million tons.

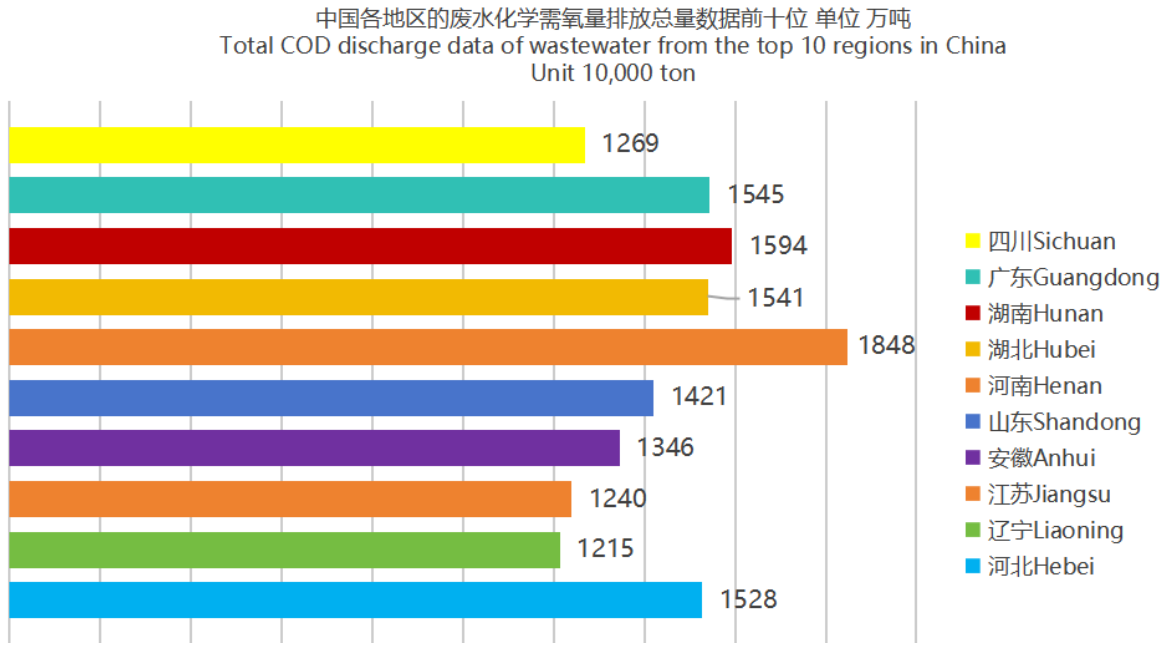


Figure 64 Total COD discharge data of wastewater from the top 10 regions in China

Divided by industry, the industries with the highest chemical oxygen demand emissions in industrial wastewater are the textile industry, paper making and paper products industry, Processing of food from agricultural product, food manufacturing industry, petroleum, coal and other fuel processing industry, wine, beverage and refined tea manufacturing industry, mining and washing of coal industry, and Nonferrous metal mining and beneficiation industry.

Figure 65 The industry with the highest discharge of chemical oxygen demand in industrial wastewater

In terms of the disposal capacity of industrial wastewater treatment facilities in various provinces, the highest are in Fujian, Hebei and Shandong. Fujian's treatment facilities have a treatment capacity of 16.61 million tons/day, Hebei's is 16.49 million tons/day, and Shandong's is 15.28 million tons/day.

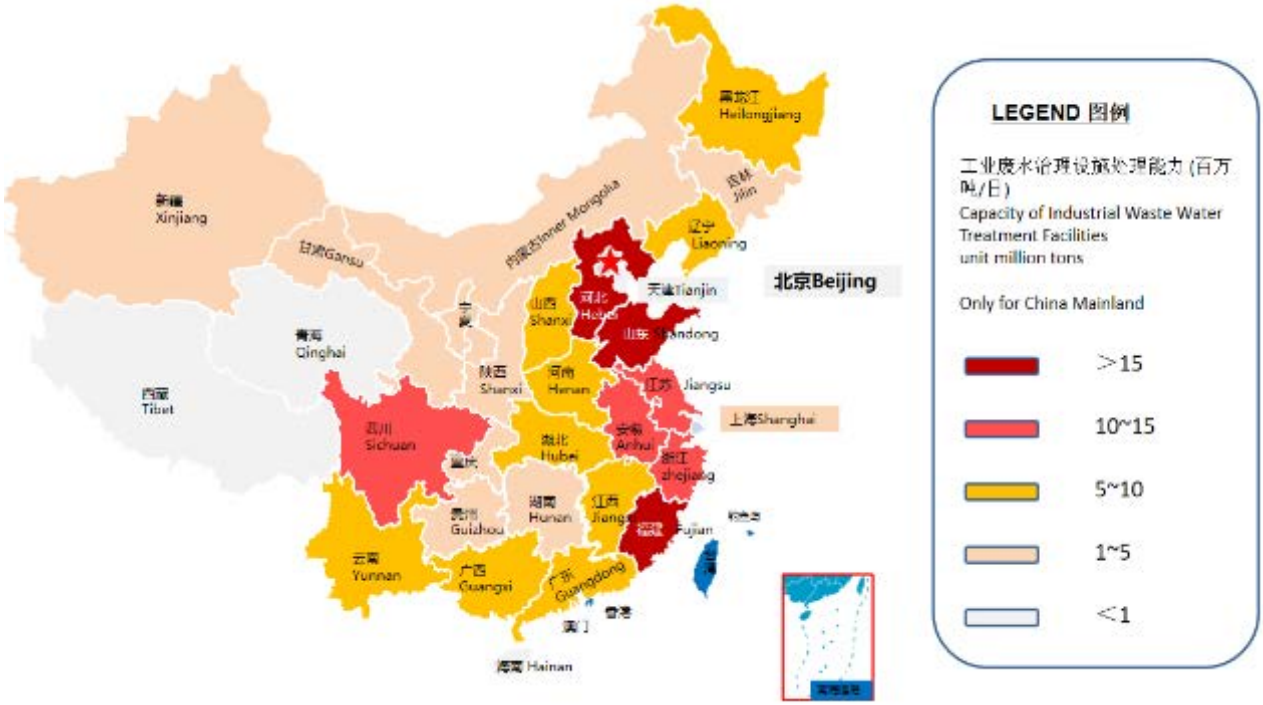


Figure 66 Capacity of industrial waste water treatment facilities

3.3.2.3 Membrane Industry

Membrane separation technology uses selectively permeable membranes as media and relies on driving forces such as pressure differences, concentration differences, and potential differences across the membrane to enable selective permeation of different components in the material to be separated through the membrane, thereby achieving separation or purification of substances. Compared with traditional separation technologies, membrane separation technology has the characteristics of no phase change during the process, low energy consumption in the separation process, material savings, convenient operation, operation at ambient temperature, and energy efficiency. It has been widely applied in the water treatment industry. In recent years, membrane separation technology has received increasing attention and has developed rapidly. More and more membrane technologies have been developed, such as pervaporation, supported liquid membranes, membrane bioreactors, controlled-release membranes, and biomimetic membranes. These membrane separation technologies are widely used in areas such as seawater purification, controlled release (e.g., artificial organs), reactors (immunological isolation for transplantation), and energy conversion (fuel cell membranes).

In the future, the main directions for technological innovation in the reverse osmosis membrane industry will be the development of new types of reverse osmosis membrane materials with strong anti-oxidation, acid and alkali resistance, and high water permeability, as well as reverse osmosis membrane modules with low energy consumption, anti-fouling, high-temperature resistance, high-pressure resistance, and special

separation capabilities. Additionally, with the continuous improvement of domestic reverse osmosis membrane material technology levels in China, the application level of reverse osmosis membrane technology will gradually increase, the application fields will expand further, and the market share of domestic reverse osmosis membrane manufacturers will also rise.

As the country places increasing emphasis on environmental protection, the future development trends for seawater desalination and zero liquid discharge of wastewater will be more refined technologies, larger-scale operations, and the gradual formation of complete industrial chains. In terms of technological direction, future efforts will focus on improving the efficiency of membrane systems and strengthening process integration. High efficiency, low energy consumption, and low investment will become the main development trends.

According to the data from the China Membrane Industry Association, in recent years, the total output value of China's membrane industry has been increasing year by year, with a total output value expected to reach 500 billion yuan by 2025 and 580 billion yuan by 2027, with a compound annual growth rate of around 8%.

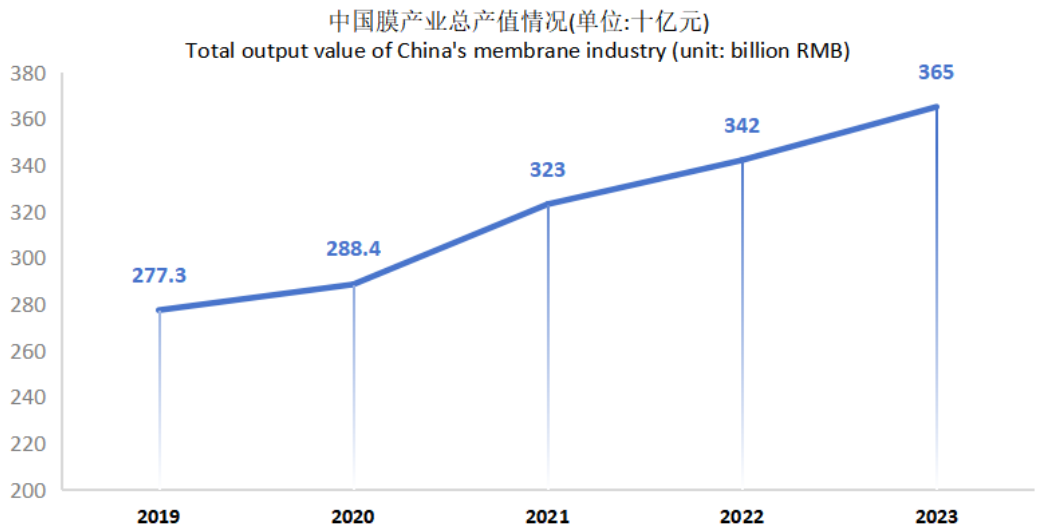


Figure 67 Total output value of China’s membrane industry

According to the report by the China Membrane Industry Association, in 2021, the application scenarios of membrane separation technology in China accounted for 35%, 20%, 8%, and 5% of industrial water treatment, industrial wastewater treatment, municipal sewage treatment, and urban drinking water treatment, respectively; Energy, medical, and seawater desalination account for 21%, 9%, and 1% respectively.

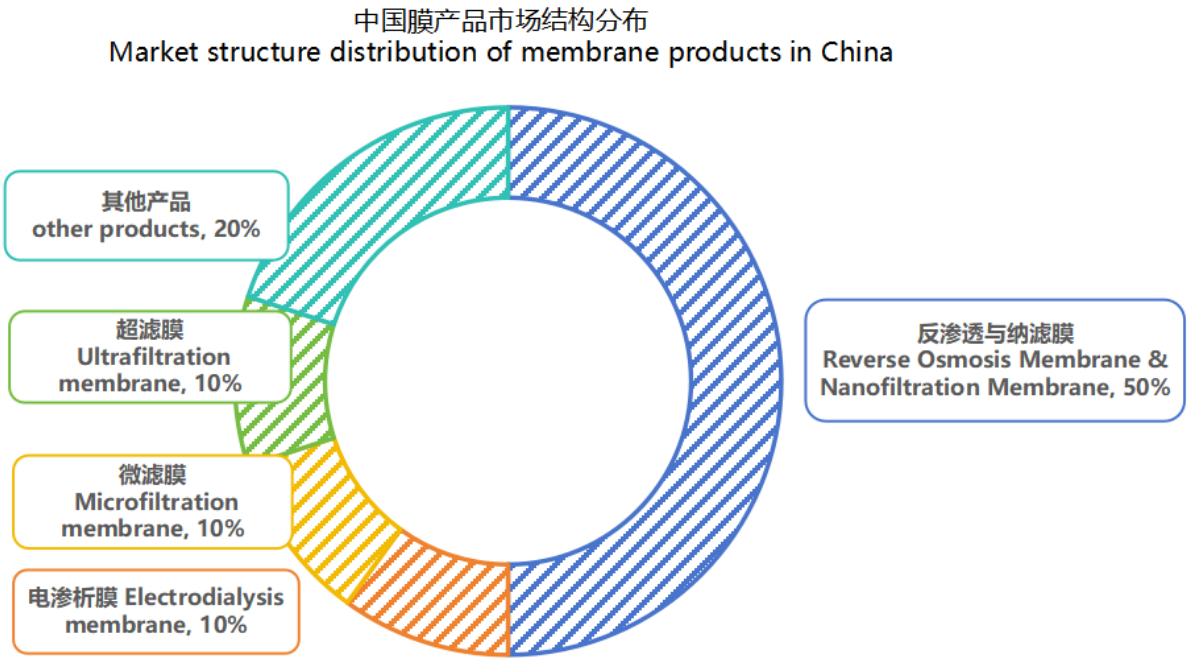


Figure 68 Market structure distribution of membrane products in China

According to a report by the China Membrane Industry Association, in 2021, the application scenarios of membrane separation technology in China accounted for 35%, 20%, 8%, and 5% of industrial water treatment, industrial wastewater treatment, municipal sewage treatment, and urban drinking water treatment, respectively; Energy, medical, and seawater desalination account for 21%, 9%, and 1% respectively. It can be seen that the current membrane separation technology in China focuses more on auxiliary water and sewage treatment, and also plays an important role in fields such as biomedicine and energy industry.

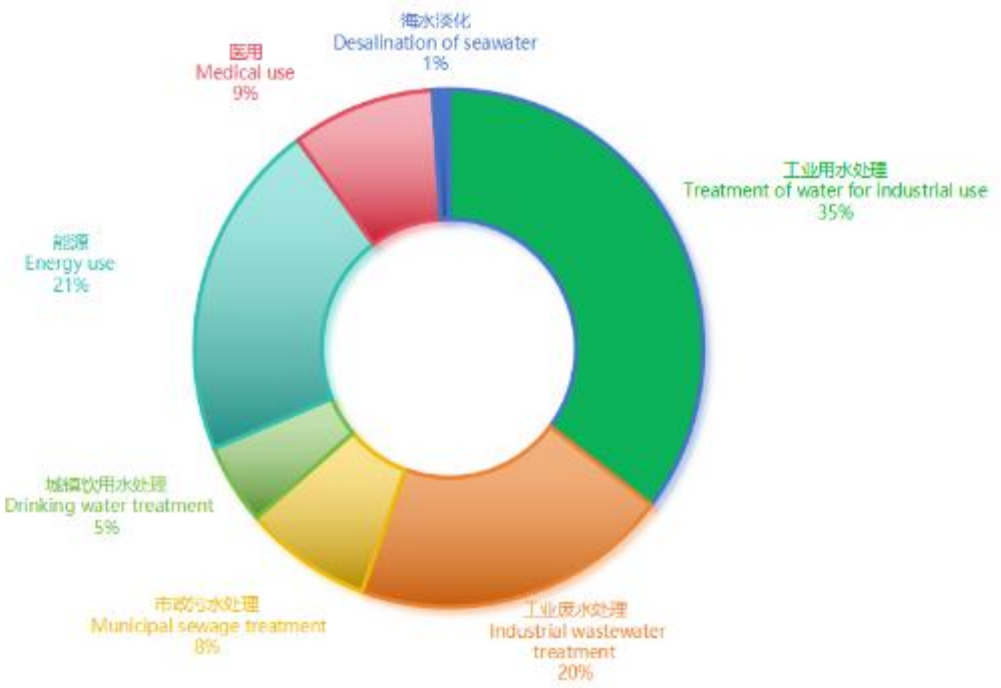


Figure 69 The application scenarios of membrane separation technology in China

3.3.3 China water reclamation market analysis

Reclaimed water refers to non-potable water that can be reused after wastewater and sewage have been treated to meet certain water quality standards. It can replace conventional water resources for agricultural irrigation, industrial utilization, landscape environment utilization, urban miscellaneous use, groundwater recharge, and other directions. Currently, China's water resources are relatively scarce, and unconventional water sources such as reclaimed water are important supplements to conventional water resources, playing a "second water source" role in some cities. The promotion and utilization of reclaimed water can not only alleviate the pressure of water scarcity, but also improve the ecological environment, with significant economic and ecological benefits.

Table 16 Objectives of water reclamation

Planning Name	Index	Target
Development Plan for Urban Sewage Treatment and Resource Utilization during the 14th Five Year Plan Period	Utilization rate of reclaimed water in prefecture level and above water scarce cities	More than 25%
	Utilization rate of reclaimed water in the Beijing Tianjin Hebei region	More than 35%
	Utilization rate of reclaimed water in prefecture level and above water scarce cities in the middle and lower reaches of the Yellow River Basin	More than 30%

Action Plan for Improving Industrial Water Efficiency	water reuse rate of in large-scale industrial enterprises nationwide.	around 94% 94%左右
Implementation Plan for Industrial Wastewater Recycling		Over 94% nationwide
	Reuse rate of industrial water above designated size	Steel:>97%; Petrochemical industry:>94%; Non-ferrous metal:>94%; Textile:>78%; Paper making:>87%; Food:>65%
	Municipal reclaimed water volume for industrial use	Significantly increase
	Water consumption per 10000 yuan of industrial added value	Decreased by 16% compared to 2020

Membrane treatment technology is a commonly used technique in water treatment and resource recovery, and it is widely applied in markets such as seawater desalination, wastewater treatment, drinking water regeneration, and the food and beverage industry. This technology plays a crucial role in water treatment and resource recovery, with the advantages of high efficiency, low energy consumption, and environmental friendliness. In the future development of membrane treatment technology, addressing membrane fouling, reducing costs, and integrating with renewable energy will be key focuses. Companies are currently conducting research and development to tackle challenges such as membrane fouling and cost reduction in order to further expand the application scope of this technology.

3.3.4 Competitive landscape of water treatment industry in China

3.3.4.1 The water treatment industry chain

The upstream of the industrial chain in the sewage treatment industry mainly consists of raw materials and equipment. Raw materials mainly include water treatment agents, while equipment mainly includes membrane components, water quality testing equipment, sewage treatment equipment, and sludge treatment equipment. The midstream of the industrial chain mainly involves the construction and operation of sewage treatment plants, including the operation and construction of sewage treatment facilities. Among them, the operation of sewage treatment facilities mainly includes equipment management, water quality management, equipment operation, and system management. The downstream of the industrial chain is the end market of sewage treatment, mainly including reclaimed water reuse, sludge disposal, sewage discharge, etc.

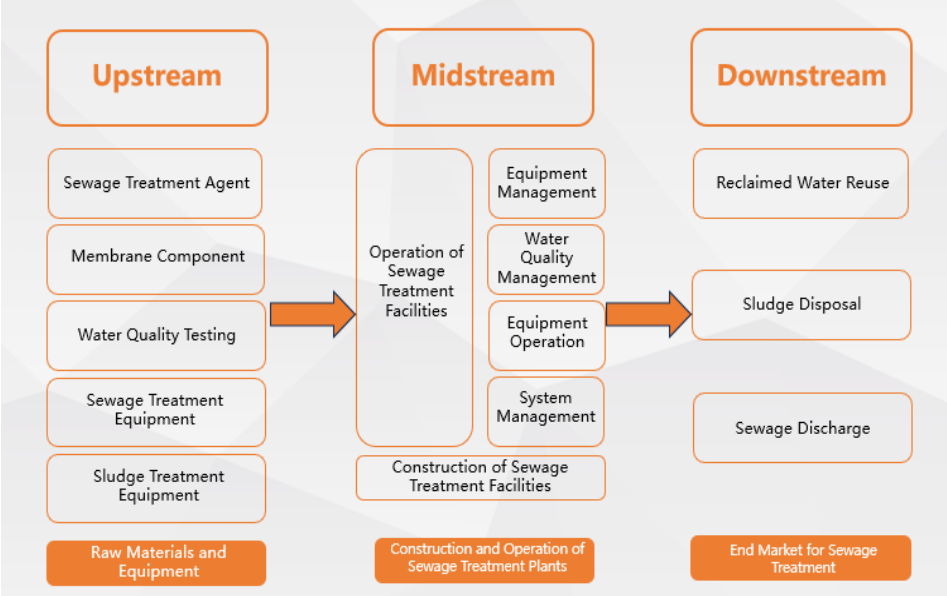


Figure 70 Industrial chain of sewage treatment industry

From the upstream and downstream perspectives of the water environment governance industry chain, the upstream mainly includes the manufacturing of various water environment governance equipment, chemicals and raw materials such as steel and cement, as well as facilities such as sewage discharge pipe networks; the midstream mainly includes the construction and operation management of water environment governance projects, mainly including the construction of main water environment governance projects and the construction of supporting water environment governance facilities; the downstream is mainly the end market for water environment governance, which mainly involves residents, governments, enterprises and institutions.

The downstream industries of water treatment services are generally large enterprises in the fields of steel metallurgy, petrochemicals, pulp and paper, and electricity. These enterprises often have a long settlement cycle and occupy a lot of funds. At the same time, as the business model of the environmental protection industry gradually shifts from a single equipment/product sales plus service business model to providing owners with engineering project general contracting, contract environment/energy management, etc., this model of operation puts higher requirements on the financial strength of environmental protection companies.

For example, in the process of general contracting of water treatment engineering construction, the general contractor often needs to occupy a large amount of operating funds because the settlement time and proportion between the general contractor and the purchaser and subcontractor are different from the settlement between the customer and the general contractor; when choosing a cooperative service provider, the customer will focus on the financial strength of the general contractor to avoid delays in the construction period. The investment amount of water treatment projects in industries such as coal chemical, petrochemical, and electricity is large, and the financial strength requirements for service providers will be relatively high.

3.3.4.2 The wastewater treatment industry and enterprises

At present, there are many market participants in China's wastewater treatment industry, with major players including multinational water groups, large state-owned enterprises, and private enterprises. In terms of enterprise scale, wastewater treatment enterprises are relatively large, with high registered capital. Among them, large enterprises with registered capital of more than 1 billion RMB include Beijing Enterprises Water Group, and Beijing Origin Water Technology Co., Ltd. From the perspective of corporate competitiveness, large state-owned listed companies, with their strong capital strength, abundant social resources, and other advantages, occupy a dominant position in the water treatment industry, actively explore and seize the market across the country, and are strong competitors of multinational water companies.

Currently, enterprises in China's sewage treatment industry are primarily dominated by state-owned enterprises, foreign and Hong Kong, Macao, and Taiwan investment enterprises, private enterprises, collective enterprises, and other types of enterprises. State-owned enterprises account for 45% of the market share in the sewage treatment industry. Foreign and Hong Kong, Macao, and Taiwan investment enterprises hold 16% of the market share. Private enterprises account for 7%, collective enterprises account for 3%, and other types of enterprises account for 29% of the market share.

From the perspective of corporate competitiveness, large state-owned listed companies, with their strong capital strength, abundant social resources, and other advantages, occupy a dominant position in the water treatment industry, actively explore and seize the market across the country, and are strong competitors of multinational water companies. Due to funding constraints, environmental protection companies mostly adopt the "investment, construction and operation integration" or PPP model, and the project payback period is usually long. In recent years, the problem of overdue payments by environmental protection companies has been more prominent, and the speed of capital return of companies has been extremely slow, which has aggravated the financial crisis and capital chain rupture risks of companies, and affected the healthy and orderly development of environmental protection companies. Recently, the Chinese government has introduced a package of debt reduction policies, which will help environmental protection companies reduce accounts receivable, optimize balance sheets, and have a positive impact on improving corporate cash flow.

It is anticipated that the water treatment industry in China will continue to exhibit a coexistence of regional monopolies and industry leaders in the future. In recent years, with the increased efforts in ecological governance and environmental protection in China, the water industry chain has seen the emergence of derivative sectors such as black and malodorous water treatment, integrated water environment management, and sludge disposal. These derivative sectors of the water industry require a high level of financial strength and technological capabilities, and it is expected that water-related derivative businesses will continue to be actively participated in by strong central state-owned enterprises (SOEs) or local SOEs in economically developed regions. Moreover, as the water industry in economically developed cities enters a mature stage with slowing demand growth, and given that the supporting facilities in counties and townships are still not fully developed, these areas are becoming opportunities for strong water enterprises to expand into new regions. However, considering that the water industry is vital to the national economy

and people's livelihoods, and that water industry operations are generally subject to long-term fixed contracts and geographical limitations, the number of water enterprises within the same region is limited, and the competitive landscape is essentially stable. Therefore, it is expected that the water industry as a whole will continue to display a coexistence of regional monopolies and cross-regional operating industry leaders.

The enterprises in China's sewage treatment industry can be divided into three competitive echelons based on their daily sewage treatment capacity. The first echelon consists of enterprises with a daily sewage treatment capacity exceeding 10 million tons, including Beijing Enterprises Water Group, Capital Environmental Group, and Origin Water. The second echelon includes enterprises with a daily sewage treatment capacity between 4 million and 10 million tons, such as Energy Conservation Guozhen, Chongqing Water, Chuangye Environmental Protection, and Xingrong Environment. The third echelon consists of enterprises with a daily sewage treatment capacity below 4 million tons, including Hongcheng Environment, Guozhong Water, Hanlan Environment, Zhongyuan Environmental Protection, Jinda Cai, and Yunnan Water, among others.

Table 17 Key players in China's sewage treatment industry

Company Abbreviation	Stock Code	Business Composition	Revenue: Billion Yuan	Gross Margin (%)
Beijing Enterprises Water Group Limited (BEWG) 北控水务	00371.HK	Municipal water, river basin water, industrial water, rural and township water, seawater and brackish water, sewage treatment, and reclaimed water services	113	38
CAPITAL ECO-PRO GROUP 首创环保	600008.SH	Urban sewage, rural and township sewage, and sludge disposal	138.66	35.4
Chongqing Water Group Co.,Ltd. 重庆水务	601158.SH	In the fields of urban water supply, sewage, reclaimed water, sludge, integrated water environment management, technology services, and environmental protection equipment.	32.83	28.82

3.3.4.1 The water treatment chemicals industry and enterprises

Water treatment agents refer to chemicals added during the water treatment process to remove most harmful substances (such as corrosives, metal ions, dirt, and microorganisms) from water and obtain satisfactory domestic or industrial water. The application of water treatment agents in sewage treatment mainly involves the use of coagulants, corrosion inhibitors, fungicides, pH regulators, scale inhibitors, sludge dewatering agents, defoamers, chelating agents, decolorizers and other agents. In recent years, the market size of China's water treatment agent industry has gradually increased, and predicted data shows that the market size of the water treatment agent industry will be about 51.02 billion yuan by 2025.

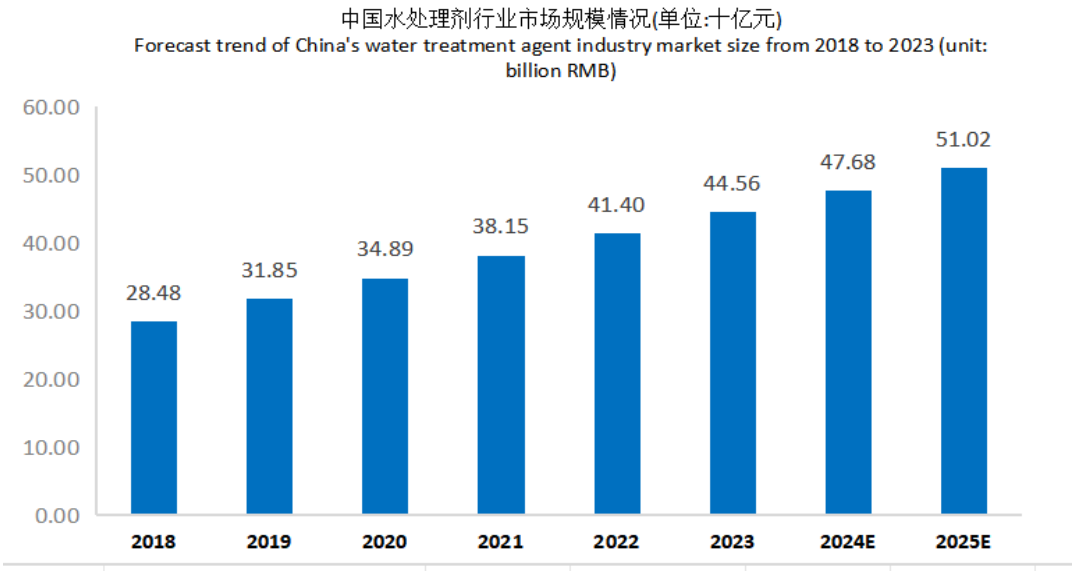


Figure 71 Forecast trend of China’s water treatment agent industry market size from 2018 to 2023

In recent years, the demand for water treatment agents in China has been strong, and the industry has developed rapidly, with over 100 types of products. In 2023, the market share of flocculants in the segmented market of China's water treatment agent industry will be 23.4%; The market share of corrosion inhibitors is 19.1%; The market share of fungicides is 17.6%; The market share of pH regulators is 14.2%; The market share of scale inhibitors is 6.9%; The total market share of other water treatment agents is 18.8%. Among them, corrosion inhibitors and scale inhibitors are mainly used to prevent corrosion and scaling of water pipelines and equipment, while coagulants help to coagulate and settle suspended solids in water.

Ecolab, Kemira, Kurita Water Industries Ltd., Suez and Solenis are the main operating companies of foreign-funded enterprises in the Chinese water treatment chemical market.

3.3.4.1 The membrane treatment industry and enterprises

In the upstream of China's sewage treatment industry chain, membrane modules play an extremely important role and are the core part of modern sewage treatment technology. Membrane modules are the key to achieving efficient solid-liquid separation. In the process of sewage treatment, membrane modules achieve thorough separation of sludge and water through membrane filtration. Compared to traditional activated sludge processes that mainly rely on gravity settling for separation, the filtration method of membrane modules significantly improves the effluent quality while significantly increasing the solid content of sludge, reducing the difficulty of sludge treatment and disposal.

Due to the later development of China's membrane industry compared to foreign countries, its market share in some high-end membrane products is still inferior to well-known foreign brands such as 3M, LG Chem, Siemens, Dow Chemical, etc. Among them, Dow Chemical and Japan's Toray occupy more than half of the global market share, making them undisputed giants in the industry and leading enterprises in China.

However, in some segmented fields, domestic membrane products have gradually gained more favor in the market due to their lower costs and better compatibility with application scenarios. The proportion of domestic substitution continues to rise. For example, in the field of small aperture ceramic membranes, Jiuwu High tech has successfully ranked first in China and top three globally with a market share of over 45% based on years of research and development experience. In the Chinese reverse osmosis membrane industry market in 2020, the market concentration was relatively low, with CR3 accounting for only 14.01%, of which Walton Technology accounted for 7.77%, Sanda Membrane accounted for 4.19%, and Jin Membrane Technology accounted for 2.05%. In addition, the Bishuiyuan MBR membrane accounts for over 70% of the newly added membrane based water treatment market share in China in recent years.

In commercial applications, high-end foreign brands are still the preferred choice for industrial seawater desalination and brackish water desalination projects, and there are even cases where the engineering party designates reverse osmosis membrane brands. International brands have an unshakable position, and Chinese domestic reverse osmosis membranes are temporarily unable to enter the market competition with foreign brands. However, in small-scale industrial water treatment projects, domestic brands still have certain applications relying on price advantages, such as reverse osmosis membranes produced by Walton and Qinsen High tech.

Membrane treatment industry players

The publicly listed companies related to the field of membrane separation technology are mainly divided into two categories. One category consists of equipment suppliers that only provide membrane products and supporting equipment. The other category includes companies that utilize membrane separation technology and related equipment to participate in the construction and operation of water projects such as sewage treatment and seawater desalination. Eight representative publicly listed companies have been selected from this group, including: Beijing OriginWater Technology Co., Ltd. (300070), Jiangsu Jiuwu Hi-Tech Co., Ltd (300631), Suntar Environmental Technology Pte Ltd. (688101), MOTECH (300334), VONTRON Technology Co., Ltd. (000920), Jiarong Technology (301148), Wave Cyber (688718) etc.

As of June 2024, in terms of the market value of publicly listed companies related to membrane products and services, Beijing OriginWater Technology Co., Ltd. (碧水源) has a market value of 17.722 billion yuan, significantly surpassing the other six publicly listed companies. The market values of the remaining six companies are mostly within the range of 2 to 4.5 billion yuan. In terms of operating revenue, the total operating revenue of the other seven publicly listed companies, excluding Beijing OriginWater Technology Co., Ltd., remains relatively low.

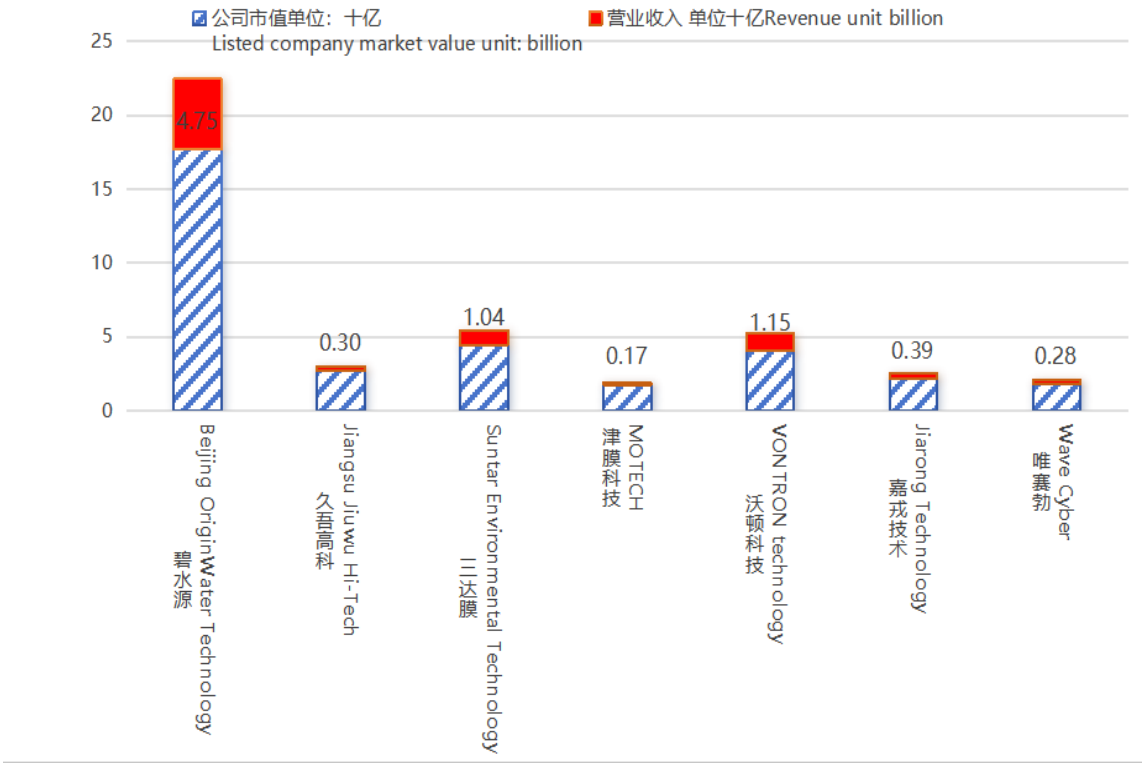


Figure 72 Listed membrane company market value

As of the publicly available data up to June 2024, the highest gross margin is that of VONTRON Technology Co., Ltd. (沃顿科技) at 38%, while the lowest is that of Jiarong Technology (嘉戎技术) with a gross margin of 22%.

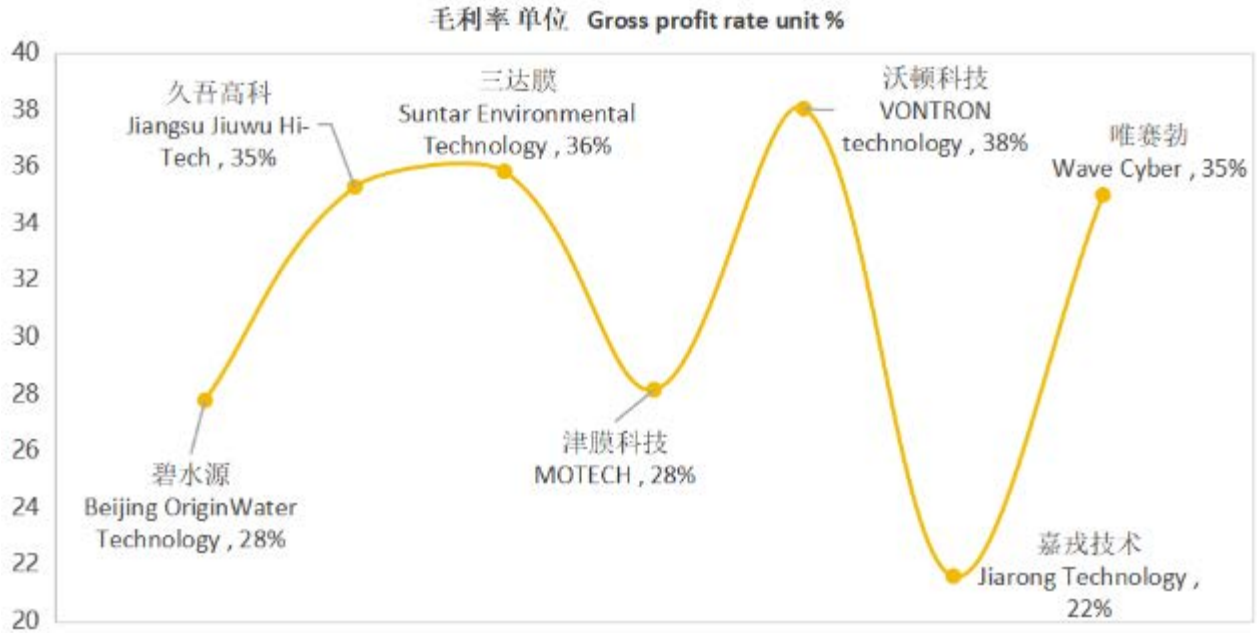


Figure 73 Gross profit rate

According to the publicly available data as of March 2024, the main business revenue and gross margin of the related companies' membrane business are shown in the table below.

Table 18 Business revenue and gross margin of the related companies' membrane business

Company Abbreviation	Establishment Date	Stock Code	Business Composition	Revenue: Billion Yuan	Gross Margin (%)	Business Type
碧水源 Beijing OriginWater Technology	2001	300070	Environmental Comprehensive Solutions	15.42	27.35%	Municipal and Water Supply and Drainage, Environmental Protection, Water Purification, Seawater Desalination, Membrane Module Products, Comprehensive Solutions and Complete Equipment for Membrane Integration Technology
			Operation and Maintenance Services	13.76	30.69%	
			Photonic Technology Comprehensive Solutions	3.057	23.56%	
			Municipal and Water Supply and Drainage	2.238	19.09%	
久吾高科 Jiangsu Jiuwu Hi-Tech Co., Ltd	1997	300631	Membrane Integration Technology Comprehensive Solutions and Complete Equipment	1.433	26.66%	Membrane Materials, Comprehensive Solutions for Membrane Integration Technology, and Complete Equipment
			Materials and Accessories	0.5695	53.25%	
三达膜 Suntar Environmental Technology Pte Ltd.	2005	688101	Application of Membrane Technology	3.373	36.87%	Reverse Osmosis and Nanofiltration Membrane Product Series, Membrane Element Pressure Vessels, Composite Pressure Tanks, and other applications of membrane technology, as well as water utility investment and operation
			Water Utility Investment and Operation	2.830	45.80%	
沃顿科技 VONTRON technology Co., Ltd.	1999	000920	Membrane Products	0.491	40.05%	Reverse Osmosis Membranes, Plant Fiber Products, Reclaimed Water Reuse Business
			Plant Fiber Products	0.198	34.09%	
			Reclaimed Water Reuse	0.029	/	
			Membrane Separation	0.034	/	

津膜科技 MOTECH (300334)	2003	300334	Separation Membranes and Water Treatment Equipment	0.088	36.35%	Membrane Engineering, Membrane Products, Wastewater Treatment
			Water Treatment Project	0.030	11.09%	
			Wastewater Treatment	0.012	25.06%	
			Design Services	1.38 million	6.44%	
嘉戎技术 Jiarong Technology	2009	301148	High-Concentration Wastewater Treatment Services	0.148	40.88%	The R&D, production, and sales of membrane separation equipment and high-performance membrane modules, as well as the provision of high-concentration wastewater treatment services
			Membrane Separation Equipment	0.058	27.89%	
			Membrane Modules and Consumables	0.038	46.45%	
唯赛勃 Wave Cyber	2001	688718	Composite Material Pressure Vessels	0.064	32.66%	The R&D, production, and sales of product series of reverse osmosis and nanofiltration membranes, membrane element pressure vessels, composite pressure tanks, and other applications of membrane technology, as well as water utility investment and operation
			Reverse Osmosis and Nanofiltration Membrane Sheets	0.055	34.60%	
			Reverse Osmosis and Nanofiltration Membrane Elements	0.037	46.72%	
			Membrane Element Pressure Vessels	0.017	25.60%	
			Accessories and Others	0.008	47.42%	

3.3.4.3 Profiles of Typical Water Treatment Companies

Beijing Enterprises Water Group (HK: 00371): A Flagship Enterprise in China's Water Industry 北控水务（HK: 00371）

Beijing Enterprises Water Group is a flagship enterprise under the Beijing Enterprises Group, focusing on the business of water resource recycling and water ecological environment protection. It is listed on the Hong Kong Main Board. Integrating industry investment, design, construction, operation, technical services, and capital operation, Beijing Enterprises Water ranks among the top in China in terms of water treatment scale. The company's business scope covers a wide range of areas, including raw water supply, water supply, sewage treatment, reclaimed water utilization, river basin comprehensive management, environmental remediation, and solid waste treatment.

According to the performance report published by Beijing Enterprises Water, the company's operating revenue in 2023 was 24.519 billion RMB. As of June 2024, sewage and reclaimed water services accounted for 67% of its operating revenue, water governance construction services accounted for 13%, technical services and equipment sales accounted for 3%, urban resource services accounted for 2%, and water supply services accounted for 15%.

Beijing Enterprises Water not only has a large number of water projects and investments in China but also actively expands into international markets, with investments and operations in Asia, Europe, Africa, and other regions. As of June 30, 2024, the company's service areas cover 31 provinces, municipalities, and autonomous regions in China (including Hong Kong and Taiwan), more than 100 prefecture-level cities, and eight countries, namely Malaysia, Singapore, Australia, New Zealand, Portugal, Angola, and Botswana. It has over 20,000 employees worldwide. The company owns a total of 1,457 water plants and rural sewage treatment facilities, including 1,217 sewage treatment plants and rural sewage treatment facilities, 167 water supply plants, 72 reclaimed water treatment plants, and 1 seawater desalination plant, with a total design capacity of 44 million tons per day.

Beijing OriginWater Technology Co., Ltd. (300070.SZ): A Benchmark in China's Water Industry and a Leading Enterprise in Membrane Technology 碧水源（300070.SZ）

Founded in 2001, the company is a high-tech enterprise in the Zhongguancun National Independent Innovation Demonstration Zone. It was listed on the ChiNext Board of the Shenzhen Stock Exchange in 2010 as a well-known brand of independent innovation in Zhongguancun, becoming one of the leading stocks on the ChiNext Board. In September 2020, China Communications Construction Company's wholly-owned subsidiary, China Urban Construction Holdings, acquired a controlling stake in Beijing OriginWater, making the State-owned Assets Supervision and Administration Commission of the State Council (SASAC) the actual controller of the company. Specializing in environmental protection and water treatment, the company has a full industry chain in the water treatment field and is committed to solving China's water environment problems with its independently developed membrane technology, continuously providing comprehensive solutions for the ecological environment construction of urban and rural areas.

The company has established membrane R&D and manufacturing bases in Beijing, Tianjin, Nanjing, Kunming, Wuxi, and other places. Its core technologies include microfiltration (MF), ultrafiltration (UF), super-low-pressure selective nanofiltration (DF), and reverse osmosis (RO) membranes, with an annual production capacity of 18 million square meters of MF and UF membranes and 12 million square meters of

NF and RO membranes. Relying on its independently developed core membrane technology, the company has developed a series of ultrafiltration and microfiltration membrane products, industrial nanofiltration membrane products, industrial reverse osmosis membrane products, industrial zero-discharge membrane products, and integrated products. Among them, high-performance and low-energy membrane bioreactors (MBR), dual-membrane new water source process (MBR-DF), and intelligent integrated wastewater purification systems (ICWT) have gained widespread recognition and application. The company has formed five major business segments: wastewater reclamation, high-quality drinking water, seawater desalination, industrial zero discharge, and lithium extraction from salt lakes.

The company has participated in the governance of several water environment-sensitive areas, including the Yangtze River Basin, the Yellow River Basin, and the water system of the capital, as well as the Danjiangkou Reservoir, the water source for the South-to-North Water Transfer Project. It has built thousands of membrane-based water treatment projects, hundreds of key national water environment treatment projects, dozens of underground reclaimed water plants, several high-quality drinking water projects, and seawater desalination projects. Beijing Origin Water's MBR membranes account for over 70% of the market share of membrane-based water treatment in China, with a total daily water treatment capacity of over 20 million tons and the ability to add more than 7 billion tons of high-quality reclaimed water annually. In recent years, the company has actively expanded into the new energy sector of lithium extraction from salt lakes and has become an active participant in the Belt and Road Initiative, focusing on international market layout. In line with its business strategy transformation in recent years, the company has gradually shifted from an engineering-oriented enterprise to a "equipment + operation" enterprise.

Jiangsu Jiuwu Hi-Tech Co., Ltd. (300631.SZ): A Leading Enterprise in Membrane Separation Technology 久吾高科（300631.SZ）

Jiangsu Jiuwu Hi-Tech Co., Ltd. is dedicated to the research and development as well as the application of membrane materials such as ceramic membranes and membrane separation technologies. It is currently a well-known domestic enterprise in the field of separation membranes with independent intellectual property rights. The company has a complete business system, ranging from the production of membrane materials, the manufacturing of membrane modules and complete equipment, to providing comprehensive solutions for membrane integration technology. It has accumulated extensive application experience and customer resources in membrane separation technology in various fields, including industrial process separation in pharmaceuticals, chemicals, food, and new energy, as well as in industrial wastewater treatment and municipal water treatment.

The company has also innovatively applied membrane separation technology in the regeneration and utilization of waste acids, alkalis, and salts. Currently, the company's products are sold to more than 40 countries and regions worldwide and have received widespread recognition from domestic and international customers. Relying on years of research and development experience in separation materials, the company has successfully independently developed the preparation technology for titanium and aluminum series lithium adsorbent materials after several years of R&D investment and experiments. With

its sound R&D system, the company continues to optimize and enhance key performance indicators of lithium adsorbents, such as dissolution rate and adsorption efficiency. Coupled with the company's membrane integration technology, it has developed a "adsorption + membrane method" for lithium extraction from salt lakes, which can be applied to the development and utilization of lithium resources in different types of brines in domestic and international salt lakes. The company has become one of the few domestic enterprises that simultaneously master the key materials and processes for lithium extraction from salt lakes and have the ability for continuous R&D and innovation.

In recent years, the company has continued to deepen and implement its new energy development strategy and has achieved certain results in the market promotion of salt lake lithium extraction solutions, as well as in the R&D and industrialization of core materials for salt lake lithium extraction. In 2023, the company successively signed contracts for the 2500t/a lithium chloride membrane purification project of SDLA salt lake in Argentina by Shengxin Lithium, the 5000t/a lithium extraction membrane treatment system project from old brine of Lop Nur salt lake by Xinjiang Guotou Luoke, and the 2000t/a lithium chloride pilot production line BOT project of Bangor salt lake in Tibet, with a total contract value exceeding 700 million yuan. The company is expected to gain more market opportunities with the continuous development of the salt lake lithium extraction market.

Suntar Environmental Technology Pte Ltd. (688101.SH): A Specialist Enterprise in Industrial Membrane Separation 三达膜（688101.SH）

Suntar Environmental Technology Pte Ltd. focuses on membrane material research and development (R&D), membrane module production, membrane software development, membrane equipment manufacturing, membrane system integration, and membrane technology application. The company has mastered the development methods of advanced inorganic non-metallic membrane materials and high-performance composite membrane materials. It has established a membrane industry chain covering “membrane materials - membrane modules - membrane equipment - membrane software - membrane applications.”

The company's services span two major application areas: special separation and water treatment. It provides means and methods for clean production and green manufacturing to upgrade traditional industrial production processes and offers innovative membrane technology-based solutions for separation and purification in process industries as well as for wastewater resource utilization. Committed to addressing the four major demands of customers in various process industries - “improving product quality, increasing product yield, reducing production costs, and minimizing waste emissions” - Suntar is a well-known domestic science and technology innovation enterprise integrating advanced membrane material R&D, special separation membrane technology application, membrane-based water treatment, and water utility investment and operation. The company's main business involves industrial feed liquid separation, product separation and purification, wastewater resource utilization, and drinking water safety assurance. Its applications cover multiple industries, including food and beverage, pharmaceutical and chemical, biofermentation, metallurgy and petrochemicals, water quality purification, and environmental protection. It

serves a wide range of customers, including manufacturing enterprises, municipal management departments, and end-user families for purified water, and is a well-known domestic science and technology innovation enterprise integrating advanced membrane material R&D, special separation membrane technology application, membrane-based water treatment, and water utility investment and operation.

The company's R&D in water utility investment and operation is based on the R&D of membrane technology application, mainly focusing on the application of membrane technology in the field of wastewater treatment. The R&D directions include the development and improvement of membrane materials, the upgrading of wastewater treatment processes, and the reduction of membrane application costs.

3.3.5 Market trends and opportunities

China's water industry exhibits a competitive landscape characterized by the coexistence of regional monopolies and industry leaders. There remains an imbalance in the development between urban and rural areas within China's water sector. In terms of water supply, cities and counties have entered a stable development phase, while rural water supply still has sapce for further development.

Regarding sewage treatment, sewage treatment in prefecture-level cities and counties is generally in a mature stage. However, with the advancement of urbanization, there is still potential for further growth in sewage treatment in these areas. In terms of profitability, water price reforms may lead to an overall improvement in the profit expectations of the water industry. However, given the industry's strong public welfare nature and its close connection to people's livelihoods, the profit increase in the short term is still limited, and the industry remains highly dependent on government subsidies.

The development of government special bonds and the EOD (Ecology-Oriented Development) model is expected to drive continuous investment growth in the water sector. In terms of cyclical and competitive risks, the water industry has weak cyclical characteristics, high entry barriers, and very low substitutability. It is an environmentally friendly industry encouraged by the government. The current competitive landscape is characterized by the coexistence of regional monopolies and industry leaders, with a limited number of water enterprises within the same region. In terms of industry growth and risk performance, the growth of the water industry is becoming more stable, with relatively timely overall fund recovery. However, the efficiency of fund recovery has declined in recent years. The overall debt burden is controllable, and the debt repayment capacity indicators are still acceptable.

From the current stage, China has a high water supply penetration rate, and the overall water supply industry is in a mature stage; The sewage treatment industry is developing rapidly, and sewage treatment in prefecture level cities and county towns is basically in a mature stage, but there is a large gap in sewage treatment in towns and villages; The scale of reclaimed water is relatively small and still in the early stage of development.

The membrane industry is a high-tech strategic industry in China. During the "12th Five-Year Plan" period, the membrane industry was listed as a key direction for national industrial development and received

focused cultivation because it covered both energy conservation and environmental protection and new materials, two strategic emerging industries. During the "13th Five-Year Plan" period, the policy direction clearly identified high-performance separation membrane materials as a key strategic material for development, and the membrane industry experienced rapid growth. Looking forward to the "14th Five-Year Plan," since the membrane industry currently has relatively mature technology and China's wastewater resource utilization is still in its infancy, the plan proposes specific requirements for wastewater resource utilization, such as urban sewage treatment capacity, reclaimed industrial water utilization rate, and water reuse, which will greatly promote the development of the membrane industry.

With the rapid development of Internet technology, the use of advanced digital technologies such as big data, artificial intelligence, cloud computing and the Internet of Things to intelligently control pollution and protect the environment has become an important direction for the development of the environmental protection industry. Data shows that the scale of China's smart environmental protection market has grown rapidly from 48.9 billion RMB in 2017 to 80.5 billion RMB in 2023, with an average annual compound growth rate of 8.66%.

The market size of China's industrial wastewater treatment is expected to exceed 150 billion yuan by 2025. Industries such as chemical, metallurgy, and power have an urgent demand for efficient and low - energy - consumption technologies. The Netherlands' accumulation in technologies such as anaerobic ammonium oxidation and advanced oxidation can effectively solve the problem of treating high - concentration organic wastewater in China.

China's membrane industry market size has grown rapidly, increasing from 2.8 billion yuan in 1999 to 430 billion yuan in 2023, with an annual compound growth rate of as high as 23.33%. The growth trend is expected to continue, with the market size projected to exceed 500 billion yuan by 2026. The water treatment membrane market accounts for a large proportion, offering Dutch companies a vast potential market.

China's urban sewage treatment rate has reached 98%, but the increasingly strict discharge standards (such as Class IV surface water) are driving the upgrading of existing facilities. The Netherlands' MBR (membrane bioreactor) technology and intelligent monitoring systems (such as real - time water quality sensors) can meet the needs for higher - standard treatment. Although China has achieved domestic production in the MBR membrane field, it still relies on imports for high - end reverse osmosis membranes (such as those used in seawater desalination). The Netherlands has advantages in membrane material research and development (such as anti - fouling composite membranes) and energy recovery technologies (such as pressure exchangers).

China and the Netherlands have a cooperation history of more than 30 years in the water sector. Chinese companies and research institutions have shown great interest in conducting membrane treatment technology cooperation with Dutch companies. They hope to introduce Dutch technologies to enhance their own technological levels and market competitiveness. This provides a favorable cooperative environment for Dutch companies to enter the Chinese market. More than 30% of China's environmental protection

projects are PPP projects, and Dutch companies can join local engineering companies to participate in large - scale projects.

Dutch companies can benefit from trade fairs. The 2025 Amsterdam Water Show, organized by the Netherlands, will be held in Shanghai. It is expected to attract 600 exhibitors and 20,000 professional visitors, covering various fields such as water treatment equipment manufacturers and technology research institutions. Dutch water treatment companies can showcase their membrane treatment technologies and products at the fair, and have face - to - face exchanges and cooperation with Chinese companies, research institutions, government departments, and others to expand market channels and enhance brand awareness.

4. COMPETITIVE LANDSCAPE ANALYSIS AND OPPORTUNITIES

4.1 Competitors

The main market participants in China's environmental governance industry include large central and state-owned enterprises, private enterprises, as well as foreign-funded enterprises and multinational companies.

Large central and state-owned enterprises occupy an important position in the environmental governance industry. With their strong financial strength, technological reserves and market influence, they actively participate in the construction and operation of various environmental governance projects.

With the continuous promotion of environmental protection policies and the growth of market demand, more and more private enterprises are entering the environmental governance industry. These enterprises usually have flexible operating mechanisms and keen market insight and can find development opportunities in specific fields or market segments.

Some foreign-funded enterprises and multinational companies have also entered China's environmental governance market through joint ventures and cooperation, bringing advanced technology and management experience, and injecting new vitality into the development of China's environmental governance industry.

4.2 Industry Opportunities

Policies such as carbon peaking and carbon neutrality provide strong support for the environmental protection and energy conservation industries, and the development of the environmental protection industry is full of opportunities.

The "dual carbon" work has been incorporated into the overall layout of ecological civilization construction and the overall economic and social development. Adhering to the coordinated promotion of carbon reduction, pollution reduction, green expansion and growth has become the main path. Against the background of achieving the goals of carbon peak and carbon neutrality, China's economic transformation has accelerated, and the various new business forms and new technologies spawned by this will usher in huge development opportunities. As an important foundation for improving the quality of the ecological environment and strengthening the construction of ecological civilization, and as an important support for achieving the goals of "carbon peak and carbon neutrality", the environmental protection industry will also have important development opportunities.

The focus of environmental industry development has shifted from end-of-pipe governance to a comprehensive governance model that is cross-domain, multi-factor, and systematically coordinated.

At present, China's environmental protection industry has entered a systematic governance stage. Ecological environmental governance has shifted from a single-segmented governance field to a systematic and complex governance model, and from a single pollution source governance to a multi-

sector comprehensive governance direction, ultimately achieving comprehensive governance of the overall environment. The environmental protection industry has developed from a business model based on environmental protection engineering and equipment to a business model where environmental protection engineering, equipment, and environmental services coexist. In this context, companies in the industry not only need to have the ability to accurately identify pollution problems and solve single pollution sources, but also be able to provide customers with system solutions through integrated design, modular construction, and integrated operations.

Environmental protection business transformation - the smart environmental protection market is gradually increasing in size

In recent years, with the rapid development of Internet technology, the use of advanced digital technologies such as big data, artificial intelligence, cloud computing and the Internet of Things to intelligently control pollution and protect the environment has become an important direction for the development of the environmental protection industry. Data shows that the scale of China's smart environmental protection market has grown rapidly from 48.9 billion RMB in 2017 to 80.5 billion RMB in 2023, with an average annual compound growth rate of 8.66%.

Table 19 Policy drivers during the 14th Five-Year Plan period

Issuing Time	Policy name	Main content	Benefited industry
December 2021	“14th Five-Year Plan” Ecological and Environmental Monitoring Plan”	By 2025, the "big monitoring" pattern of government-led, departmental coordination, corporate responsibility, social participation, and public supervision will be more mature and finalized, the high-quality monitoring network will be more complete, and a fixed pollution source monitoring and supervision system with the pollutant discharge permit system as the core will be formed. The monitoring and evaluation system that is compatible with ecological and environmental protection has been continuously improved, the authenticity, accuracy and comprehensiveness of monitoring data have been effectively guaranteed, the ability to integrate and apply new technologies has been significantly enhanced, and new results have been achieved in the modernization of ecological and environmental monitoring.	Sewage, solid waste, air, monitoring and testing, and Internet data integration services
December 2021	“Fourteenth Five-Year” Work Plan for Building Waste-Free Cities	Promote the construction of “zero-waste cities” in about 100 prefecture-level cities and above. By 2025, the intensity of solid waste generation in “zero-waste cities” will decrease rapidly, the level of comprehensive utilization will be significantly improved, the capacity for harmless disposal will be effectively guaranteed, the synergistic effect of pollution and carbon reduction will be fully utilized, the concept of “one network” for solid waste management information will basically be realized, and the solid waste governance system and governance capabilities will be significantly improved.	Industries related to the treatment of solid waste and sewage sludge
December 2021	“14th Five-Year Plan”	It is mentioned that by 2025, the treatment rate of rural domestic sewage will reach 40%, the overall water	Energy conservation

2021 年 12 月	Comprehensive Work Plan for Energy Conservation and Emission Reduction	quality of the Yangtze River Basin will remain excellent, and the water quality of the main river will stably reach the Class II standard for surface water.	assessment, energy audits, new rural energy sources, sewage and solid waste treatment industries
February 2022	“Guiding Opinions on Accelerating the Construction of Urban Environmental Infrastructure”	By 2025, the new sewage treatment capacity will be 20 million cubic meters per day, the new and renovated collection pipe network will be 80,000 kilometers, the new, renovated and expanded reclaimed water capacity will be greater than or equal to 15 million cubic meters per day, the sewage treatment rate in county towns will be greater than or equal to 25%, and the utilization rate of sewage resources in water-short cities at the prefecture level and above will be greater than or equal to 90%.	Sewage treatment and membrane treatment technology
May 2022	Notice on Issuing the Action Plan for the Treatment of New Pollutants	Improve laws and regulations, and establish a sound new pollutant control system. Encourage social capital to enter the field of new pollutant control, and guide financial institutions to increase credit support for new pollutant control. New pollutant control enjoys tax incentives according to regulations.	New pollutant governance, water supply and sewage treatment
March 2024	Implementation Opinions on Accelerating the Establishment of a Modern Ecological and Environmental Monitoring System	In the next five years, the intelligent transformation of ecological and environmental monitoring data will accelerate, the quality of monitoring data will continue to improve, application support will be more efficient, pilot demonstrations will be effective, monitoring management systems and mechanisms will be more streamlined, basic monitoring capabilities will be comprehensively strengthened, and important progress will be made in the construction of a modern monitoring system.	Ecological and environmental monitoring and Internet data integration business

4.3 Industry analysis

There are obvious differences in the performance of various sub-sectors within the environmental protection industry. The solid waste management and water operations sectors performed steadily, while the energy conservation and water treatment sectors faced greater challenges. Benefiting from the stable operation of waste incineration power generation projects and the cost reduction, efficiency improvement and capacity expansion of the resource recycling sector, the corporate revenue and net profit attributable to shareholders of the solid waste management industry have achieved positive growth. In the first three quarters of 2024, the revenue of the solid waste management sector reached 119.53 billion RMB, a year-on-year increase of 10.7%, and the net profit attributable to shareholders reached 8.82 billion RMB, a year-on-year increase of 1.7%.

In recent years, China's environmental governance has gradually shifted to a comprehensive model of large regions and large projects, and the entire industry chain has also been continuously extended and improved. The upstream of the environmental protection industry chain is mainly composed of raw material and equipment suppliers, the midstream is pollution treatment suppliers and operation and maintenance

service providers, which will involve a lot of resource inputs, and the downstream is mainly related to the environmental pollution emission industry, such as coal chemical industry, petrochemical industry, textile industry, metal industry and other polluting enterprises.

Solid waste industry chain analysis

The solid waste treatment industry chain covers all aspects from the generation, collection, transportation, and treatment to the final disposal of solid waste. The upstream of the solid waste treatment industry chain mainly involves the manufacturing and supply of solid waste treatment equipment, the midstream is the e construction and operation management of solid waste treatment, and the downstream is the reuse of resources after solid waste treatment.

Water environment governance industry chain

From the upstream and downstream perspectives of the water environment governance industry chain, the upstream mainly includes the manufacturing of various water environment governance equipment, chemicals and raw materials such as steel and cement, as well as facilities such as sewage discharge pipe networks; the midstream mainly includes the construction and operation management of water environment governance projects, mainly including the construction of main water environment governance projects and the construction of supporting water environment governance facilities; the downstream is mainly the end market for water environment governance, which mainly involves residents, governments, enterprises and institutions.

The downstream industries of water treatment services are generally large enterprises in the fields of steel metallurgy, petrochemicals, pulp and paper, and electricity. These enterprises often have a long settlement cycle and occupy a lot of funds. At the same time, as the business model of the environmental protection industry gradually shifts from a single equipment/product sales plus service business model to providing owners with engineering project general contracting, contract environment/energy management, etc., this model of operation puts higher requirements on the financial strength of environmental protection companies.

For example, in the process of general contracting of water treatment engineering construction, the general contractor often needs to occupy a large amount of operating funds because the settlement time and proportion between the general contractor and the purchaser and subcontractor are different from the settlement between the customer and the general contractor; when choosing a cooperative service provider, the customer will focus on the financial strength of the general contractor to avoid delays in the construction period. The investment amount of water treatment projects in industries such as coal chemical, petrochemical, and electricity is large, and the financial strength requirements for service providers will be relatively high.

4.4 Competitive analysis

The Porter Five Forces analysis framework is a tool for analyzing the competitive structure of an industry and corporate strategy. It reveals the competitive environment of an industry and the competitive position of

a company by analyzing five basic competitive forces in the industry: the bargaining power of suppliers, the bargaining power of buyers, the threat of new entrants, the threat of substitutes, and the competition among existing competitors in the industry. Below, we will use the Porter Five Forces analysis framework to analyze the competitive structure of the solid waste treatment industry.

Bargaining power of suppliers

In the solid waste treatment industry, the main suppliers include solid waste treatment equipment providers, technical service providers, and other raw materials and service suppliers. Due to the particularity of solid waste treatment equipment and technology, the bargaining power of suppliers is relatively strong, especially those with core technology and patents.

At the same time, national environmental protection policies and environmental standards continue to raise the requirements for solid waste treatment equipment and technology, which strengthens the bargaining power of high-quality suppliers.

Buyer's bargaining power

The main buyers in the solid waste treatment industry include governments, enterprises and communities. Due to the mandatory nature of environmental protection policies, buyers' demand for solid waste treatment services is relatively stable. However, in government bidding and project cooperation, buyers have relatively strong bargaining power and have certain requirements for price and service quality.

The threat of new entrants

The barriers to entry in the solid waste treatment industry are relatively high, requiring significant capital investment, technological accumulation and government approval. At the same time, changes in environmental protection policies laws and regulations may increase the uncertainty and risks for new entrants.

However, with the increasing awareness of environmental protection and the continuous expansion of the environmental protection market, new investors and enterprises may enter the solid waste treatment industry, increasing the competitive pressure in the industry.

Threat of substitutes

The substitutes in the solid waste treatment industry mainly include different solid waste treatment technologies and methods, such as recycling, incineration, landfill, etc. With the advancement of technology and the improvement of environmental protection requirements, some new solid waste treatment technologies and methods may pose a threat to traditional solid waste treatment methods.

Competition from existing competitors in the industry

There are many large solid waste treatment enterprises and some small and medium-sized solid waste treatment service providers in the solid waste treatment industry, and the industry is relatively competitive. Enterprises compete fiercely in terms of price, service quality, technological innovation and market expansion. At the same time, the entry of international solid waste treatment enterprises may also increase

the competitive pressure in the industry and encourage the industry to develop towards higher levels of technology and service.

Foreign Companies Entering the Chinese Market

Foreign companies possess advanced treatment technologies, strong R&D capabilities, and rich management and market experience. However, they also face several challenges. Their financing capabilities are relatively weak, and they experience significant financial pressure. The promotion of new technologies is hindered by the lack of social and networking resources, and their products, due to the absence of market-oriented sales, fail to achieve large-scale production, resulting in high costs.

From an external environmental perspective, the Chinese government has provided comprehensive policy support for the environmental treatment industry in recent years. To strengthen environmental protection, relevant laws and regulations have been introduced or revised in a timely manner. Although China's GDP growth rate is slowing down, the overall economic size means that government spending on environmental protection and investment in the environmental protection sector are increasing year by year. With the growing environmental awareness of the public and economic development, the demand for water/waste treatment is expected to rise. These factors present opportunities for the rapid development of foreign companies.

However, foreign companies also face various threats in the Chinese market, such as disorderly competition, slower development of target customer enterprises, continuous entry of new players, the emergence of new substitute technologies, and the rising costs of domestic raw materials and labor. These factors, when combined in different ways, lead to different strategic approaches. Utilizing the SWOT matrix to analyze and select strategies can help companies formulate future action plans.

Success experience of Dow entering Chinese Market

Dow Chemical entered the Chinese market in 1979, seizing the opportunity of China's reform and opening up. It has since expanded its business by establishing production and R & D bases in places like Shanghai and Zhangjiagang, forming a full - scale business system that covers purchasing, R & D, production, and services.

Technical innovation and product adaptation are key to Dow's success in China. It continuously launches cutting - edge material science solutions to meet the demands of China's fast - growing fields like new energy vehicles and renewable energy. Leveraging its localized R & D advantage, Dow adjusts its product development cycle as per market needs and accelerates product verification with its local R & D team to keep up with the rapid changes in the Chinese market.

In terms of localization strategies, Dow places great emphasis on local talent and R & D. It has built a mainly local R & D team. In production and the supply chain, Dow establishes local production bases to lower costs and speed up market response. It also customizes products and services based on local

customer needs. For instance, it has launched innovative products like fully traceable post - consumer recycled resins and high - performance membrane - dedicated recycled resins.

Regarding partnerships, Dow collaborates closely with Chinese governments and research institutions to boost industrial development and innovation. It also partners with leading enterprises in various industries to co - develop new products and solutions. Examples include showcasing innovative thermal interface materials with Carbice in China, signing a memorandum of understanding with Shanghai Zhankun Industrial Supermarket Co., Ltd., and working with Liby and Procter & Gamble to enhance laundry detergent bottle recycling.

4.5 Recommended market strategies

China's industrial manufacturing industry ranks first in the world. At the same time, China's environmental conditions are generally complex and changeable, involving many different types of pollutants in the environment. These problems have led to a relatively large demand for environmental technology equipment in China. China's 1.4 billion population, rapid urbanization and people's pursuit of high standards for the environment are all important market demands for China's green development of environmental governance. Therefore, in the future development path, China's solid waste treatment and wastewater disposal industries will show a dual trend of intelligence, automation, greening and recycling. This is not only an inevitable product of technological innovation, but also a clear reflection of the national environmental protection policy orientation.

Intelligence and automation will become the main driving force for technological upgrading in China's solid waste and wastewater treatment industries. With the continuous maturity of advanced technologies such as artificial intelligence, big data, the Internet of Things and machine vision, the solid waste and wastewater disposal industry will gradually break away from the traditional, labor-intensive operation model and shift to an intelligent and automated operation model. For example, programmable controllers can achieve precise control of waste/wastewater treatment equipment and improve operational efficiency; the Internet of Things and machine vision technologies can automate and accurately sort waste, reduce sorting costs, and increase recycling rates. The application of these technologies can not only significantly improve equipment processing efficiency and reduce enterprise operating costs, but also provide strong support for the healthy and sustainable development of the industry.

Greening and recycling will become an important direction for the future development of the solid waste/wastewater treatment industry. Driven by national environmental protection policies, solid waste/wastewater treatment companies will pay more and more attention to waste recycling, and realize waste resource utilization and reduce waste/wastewater pollution to the environment by introducing advanced domestic and foreign technological innovations. For example, through advanced physical or chemical technologies, waste can be converted into renewable resources to achieve waste recycling and reduce environmental pollution during waste treatment.

Strengthen cooperation with local governments in China to promote the construction of an EOD model for solid waste/wastewater projects.

Environmental protection projects are characterized by non-profit and socially beneficial projects. The investment in such projects mainly comes from government financial funds. The project characteristics have the pain points of large investment scale, low profitability, and excessive dependence on subsidies. At the same time, there is a natural shortcoming that environmental governance benefits are difficult to convert into governance investment returns. To solve such problems, the Chinese government promotes the pilot of EOD model projects, to promote the construction and implementation of ecological protection and environmental governance projects through market-oriented and diversified methods. Local governments use different policies such as prices, finance, and finance to encourage and guide various entities to build and implement ecological and environmental protection projects. For example, Anhui, Fujian, Jiangsu, Shandong, Zhejiang, Hubei, Guangxi, and other provinces have successively carried out provincial EOD pilots and issued local innovative policies. For example, Jiangsu Province gives priority to providing "environmental protection loans" and "environmental protection guarantees" for EOD model projects, and the provincial finance gives financial rewards. Guangxi has developed a "Guihui Loan-Ecological Loan", with a subsidy ratio of 3%, a subsidy period of one year, and a maximum subsidy of 5 million RMB. Therefore, cooperating with local governments to create an EOD model for solid waste/wastewater is an important means for foreign-funded enterprises to promote the implementation of ecological and environmental protection projects.

Taking advantage of the opportunity of the construction of zero-waste cities, we will work with different stakeholders to vigorously promote the demonstration of advanced foreign technologies for solid waste/wastewater.

The "Opinions of the CPC Central Committee and the State Council on Comprehensively Promoting the Construction of a Beautiful China" proposed to strengthen the management of solid waste and new pollutants, and achieve full coverage of the construction of "zero-waste cities" by 2035. At present, various parts of the Chinese government have taken this as a starting point to promote the green, low-carbon and high-quality development of cities. Therefore, strengthening the construction of a system for local government agencies, universities, etc. to provide solid waste/wastewater disposal technology to support zero-waste cities, and creating foreign disposal technology demonstration cases with the help of local governments' "zero-waste city" green finance implementation plans, can effectively obtain various policy, financial and tax support under the zero-waste city implementation framework.

For example, Guangzhou provides green loans green bonds and other financial products for the construction of a waste-free city. As of the end of September 2024, the balance of green loans in Guangzhou was 1.28 trillion RMB, a year-on-year increase of 26.3%, ranking first among all cities in the province. The cumulative issuance of various types of domestic and foreign green bonds exceeded 200 billion RMB. At the same time, financial institutions in Guangzhou promote products such as pledge loans for ecological public welfare compensation income rights, mortgage loans for carbon emission rights, loans

for renewable energy subsidy confirmation, and "green bonds + climate bonds" double-standard green bonds.

Therefore, foreign-funded environmental protection companies entering the Chinese market can make use of such green financial service solutions, combined with advanced technological advantages in the harmless disposal of solid waste/wastewater, and focus on the disposal and utilization of solid waste such as industrial solid waste, construction waste, and municipal sludge. They can establish demonstrations, standards, specifications, and typical cases of foreign green manufacturing technologies in the Chinese region, and provide technical support for the construction of "zero-waste cities" in various regions.

Improve the localization capabilities of solid waste/wastewater treatment technology and services. Nowadays, China's environmental protection management service market is showing a trend of comprehensive, regional, and large projects, and foreign-funded enterprises have unparalleled advantages over domestic enterprises in management systems, product research and development, industrial control, etc. Based on such advantages, it is more accurate to identify the subsequent construction needs of the Chinese market, which requires foreign companies to have more localized decision-making capabilities and services. It is also recommended that the company's R&D center be located in China, to provide timely and effective feedback on the needs of the Chinese market and truly and effectively develop new products and technologies suitable for the Chinese market based on the needs of the Chinese water and solid waste disposal markets.

In terms of business development, it is necessary to strengthen the joint operation and management of Chinese local enterprises and use the local channels of Chinese central enterprises and state-owned enterprises to serve the diversified needs of domestic customers together with domestic business enterprises, especially to use the advantages of solid waste/wastewater technology to carry out technical cooperation with China's central enterprises and state-owned enterprises and other leading enterprises, such as Beijing Enterprises Water Group in urban sewage treatment, China Everbright Group Co., Ltd. in solid waste disposal, and Chongqing Sanfeng Environmental Group Co., Ltd.

Increase digital marketing channels. Foreign-funded solid waste/wastewater and other environmental protection companies have become important participants in the Chinese economy. However, in China, the rapid development of the digital economy is a very important field. Therefore, foreign-funded enterprises entering China also face new challenges: multinational companies must ensure that their business is quickly implemented and grows, while also paying close attention to changes in China's marketing environment. This not only requires Foreign-funded to be close to Chinese customers in the selection of marketing channels but also requires them to formulate and implement marketing digital transformation strategies that are adapted to the local market characteristics.

Transform from a supplier of equipment and solutions to a supplier of smart integrated water/solid waste/monitoring management systems. It is recommended to directly cooperate with local central state-owned enterprises and professional universities in the construction of Smart Digital systems. By developing integrated smart solid waste/wastewater solutions, the main focus is on green buildings, industrial parks,

industrial zero emissions, water resource utilization, comprehensive water environment management, stormwater management, water conservancy, rural water supply and drainage, and solid waste markets. Under the wave of digitalization, foreign-funded enterprises can only better adapt to the needs of the local Chinese market and develop high-quality development by combining their technological advantages with the characteristics of the Chinese market.

4.6 Recommended Action Plan

For foreign water companies entering the Chinese market, the following action plans are recommended:

4.6.1 Enhancing Corporate Financing Capabilities

Financing channels can be categorized into two main types based on the source of funds: internal financing and external financing. Internal financing primarily comes from the funds accumulated through the company's production and business activities, as well as the company's working capital, representing the flow of funds within the company. External financing refers to the circulation of funds between different fund holders, i.e., funds sourced from outside the company. External financing can be further divided into direct financing and indirect financing based on whether financial intermediaries are involved in the fund-raising process. Direct financing involves obtaining funds directly from the market or investors, such as equity financing and bond financing. Indirect financing, also known as debt financing, refers to the lending and borrowing activities between companies and banks or other financial institutions.

Given the favorable development opportunities in China's water treatment market, capital has become the main bottleneck constraining the development of companies in the ecological and environmental sector. Especially at this stage, when companies intend to undertake large-scale demonstration projects, a significant amount of capital is required at the initial stage of the project. Relying solely on internal financing is no longer sufficient to meet the project's funding needs, and it is necessary to consider leveraging external funds to alleviate financial pressure. Based on the current situation, the characteristics of the water treatment industry, and the company's development strategy, the following external financing methods can be adopted:

1．Policy-based Financing from the Government. In recent years, both the national and local governments have introduced financing policies targeting science and technology small and medium-sized enterprises (SMEs) as well as the environmental protection industry. These policies can be fully utilized to obtain special financing funds.

In China, the management of government funds and resources for solid waste and wastewater pollution control is overseen by key ministries: the National Development and Reform Commission (NDRC), the Ministry of Ecology and Environment (MEE), and the Ministry of Agriculture and Rural Affairs (MARA).

National Development and Reform Commission (NDRC)

Central Budget Investment: Focuses on resource conservation and environmental protection initiatives such as bulk solid waste utilization, circular economy parks, and renewable resource recovery systems. For wastewater, it includes near-zero discharge projects and upgrades to centralized sewage treatment

facilities. Pollution Control Projects: Involves advanced wastewater treatment and hazardous waste disposal in key industries like chemicals and steel.

Ministry of Ecology and Environment (MEE)

Central Ecological Environment Fund: Supports wastewater treatment projects including black and malodorous water remediation, industrial park sewage treatment, and rural domestic sewage treatment. Soil Pollution Prevention Fund: Aids in restoring contaminated sites and supports solid waste resource technology and medical waste disposal under the "waste-free city" program.

Ministry of Agriculture and Rural Affairs (MARA)

Initiatives to control agricultural non-point source pollution include recycling livestock and poultry waste via biogas engineering and organic fertilizer production project, as well as utilizing straw for fuel and feed. The county-wide rural living environment improvement project focuses on constructing facilities for domestic waste and sewage treatment. Funding scale: The central government will allocate 4.8 billion RMB in 2023.

Application conditions: large-scale farms (pig annual output ≥5000), straw utilization ≥10,000 tons/year of enterprises.

Ministry of Industry and Information Technology (MIIT)

Providers of green manufacturing system solutions funding are supported with technologies such as near-zero discharge of industrial wastewater and high-value utilization of industrial solid waste, exemplified by converting steel slag into building materials. Key projects for industrial energy conservation and green development offer green credit at interest rates 10%-20% below the benchmark, along with discounted loans.

Ministry of Finance (MoF)

In collaboration with 11 provinces and cities in the Yangtze River Economic Belt, the National Green Development Fund has been established. It targets investments in areas like solid waste recovery, hazardous waste disposal, and smart water management. Under the Public-Private Partnership (PPP) model, subsidies are provided during the operational period for eligible PPP projects.

2．Project Financing. Project financing refers to loans granted for a specific engineering project, using the project's assets, expected revenues, or rights as the primary collateral. This type of financing or loan activity is non-recourse or limited recourse. The Dutch companies can select projects with reliable expected returns to attract project investors for joint investment, sharing project costs and risks, and jointly obtaining project profits.

3．Equity Financing. The company's top priority at present is to promote membrane treatment technology and capture market share. By introducing strategic investors with similar philosophies, the Dutch companies can not only obtain sufficient funds but also enhance its core competitiveness by leveraging the strategic investors' strengths in management, market, and talent. Currently, most leading water treatment companies in China develop regionally by cooperating with local governments or their affiliated national or

local water companies, or by being controlled by local governments to gain government-led advantages in local production and operations.

4.6.2 Enhancing R&D Efforts in the Chinese Market

The development of the water treatment industry is inextricably linked to the competitive advantage of core technologies. To maintain a technological edge, companies must continuously engage in research and development (R&D) and innovation. With the transformation and upgrading of the industrial structure, increased regulatory requirements from the government, and improved treatment standards, the Chinese sewage treatment market will inevitably face challenges and demands for the use of new materials, processes, and equipment. The development of China's strategic emerging industries has brought new growth opportunities for the membrane industry. For example, energy conservation and environmental protection, high-end equipment manufacturing, and new energy and new materials are all areas of potential growth. As a technology-oriented company that places great emphasis on R&D, to maintain a leading technological advantage and ultimately convert it into the company's core competitive strength, the company must continuously enhance its scientific research and development capabilities. Core competitiveness can help companies maintain a sustained competitive edge and should be a key focus of the company's development strategy. Therefore, only by continuously conducting R&D and technological innovation in the Chinese market can the company keep pace with the market and maintain a leading technological position. The R&D goal is to improve water treatment efficiency and reduce water treatment costs through technological innovation, ultimately saving investment funds for customers, which is also a key factor in whether the company can gain a competitive advantage in the market.

Secondly, it is essential to strengthen the research and development of common technologies such as modularization, intelligence, mechatronics of membrane equipment, and the generalization, standardization, and integration of components. With the continuous advancement of Industry 4.0, information technologies such as artificial intelligence, big data, and the Internet of Things are gradually being integrated into traditional manufacturing industries. By establishing a cloud service platform and leveraging digital information technology, the company can achieve intelligent management of membrane products and their application processes, providing customers with high-quality products and efficient services. In completed engineering projects, data transmission technology can be used to upload various parameters collected by the underlying instruments to the cloud server. After data analysis by the cloud support system, real-time operation and maintenance support can be provided to users. High-quality products combined with intelligent cloud platforms can offer users precise data analysis, simulation of operating conditions, and prediction, obtaining the optimal solution for products in the system operation process. This can achieve efficient recycling and utilization of high-salinity wastewater resources and energy conservation and emission reduction.

Finally, actively engage in cooperation and exchanges with research institutes and universities to support continuous funding in the collaborative network of innovation chains, industry-university-research cooperation, and technological innovation. The company can leverage the industry-university-research

transformation platforms of relevant domestic universities to jointly carry out demonstration projects and research in the Chinese region.

4.6.3 Expanding Marketing Strategies

The current policy orientation of the Chinese government will lead to a large influx of new entrants into the water/waste treatment industry. Faced with the increasingly fierce competition in the environmental protection market, foreign companies can only stand out and secure a foothold in the market by intensifying market development efforts and promptly adjusting their current marketing strategies. The specific measures are as follows:

1．Recruit Experienced Sales Talents and Build a Professional Marketing Team. Hire sales professionals with rich market experience to join the company and form a specialized marketing team to enhance market development capabilities. In newly entered markets, experienced marketing personnel should be recruited to develop potential markets and expand market share through a professional marketing team. At the same time, establish a major customer marketing system. Given the broad market prospects in the environmental protection industry, where state-owned enterprises (SOEs) and local SOEs account for a large proportion of major customers, it is necessary to develop standard processes for market insights. By organizing marketing activities within specific market segments, more market demand information can be obtained, and precise marketing can be conducted for target markets to provide more sales leads. While maintaining existing customers to ensure continuous output, gradually expand into more business areas to increase long-term stable revenue. Segment customers to achieve precise targeting of customer needs.

2．Leverage Advertising Effects to Promote Company Technologies. Utilize various promotional channels such as industry magazines, professional newspapers, websites, and specialized exhibitions to attract the attention of target customers and expand product influence.

3．Focus on industries in China that have future development prospects and can apply Dutch solid waste and wastewater treatment technologies.Taking solid waste treatment and membrane water treatment as examples, promising market segments include resource recycling in the new energy industry and industrial solid waste treatment. Focusing on three key areas: power battery recycling and utilization, high-value utilization of recycled plastics, and extraction of rare and precious metals from electronic waste. Power battery recycling is critical due to China's new energy vehicle penetration rate surpassing 35% in 2023, with retired batteries projected to reach 780,000 tons by 2025 (annual growth rate exceeding 50%). This process involves recovering nickel, cobalt, and lithium. High-value utilization of recycled plastics and extraction of rare and precious metals from electronic waste are also significant. Key regional markets are the Yangtze River Delta (battery recycling cluster), Pearl River Delta (electronic waste distribution center), and Chengdu-Chongqing (Western solid waste treatment hub). In addition, some Chinese companies are also conducting research and application on extracting lithium from salt lakes using membrane technology in Qinghai Province.

4．Dutch SMEs can enter the Chinese market by focusing on "technology precision matching + localization cooperation." First, they should conduct a comprehensive survey of the current situation, needs,

competitive landscape, and relevant policies and regulations of solid waste management in various regions of China. Based on their own technological strengths, size, and resource conditions, they can determine their product or service positioning in the Chinese market. They can leverage policy benefits to enter high - growth areas, reduce risks through industry - university - research cooperation, and strengthen intellectual property protection and digital marketing. They can participate in the China International Environmental Protection Exhibition, Solid Waste Management Conference, and other events to showcase their technological cases and promote their market presence and brand building. They can also establish production bases in China or collaborate with local suppliers to achieve localized production and procurement, reducing production and transportation costs. Meanwhile, they can take advantage of China's strengths in raw materials and component supply, optimize procurement channels, improve production efficiency, reduce product costs, and enhance market competitiveness. In the future, focus can be placed on the markets for industrial hazardous waste and construction waste recycling in regions such as the Yangtze River Delta and the Pearl River Delta, as well as international cooperation opportunities in provinces along the "Belt and Road."

5. OVERALL CONCLUSION

After market analysis, it is found that the Chinese market is highly competitive and changes rapidly due to policies. The rapid development of technology and the financial situation of local governments are also decisive factors. Although some markets have gradually increased, but mostly due to the rapid response and layout of local manufacturers. After conducting market research, Arcadis made the following suggestions to Dutch companies:

Highlight Advantages

It is recommended for the Dutch companies to determine their main technological advantages, application scenarios, and whether their technologies offer unique advantages in the Chinese market. For example, in the membrane industry, the treatment efficiency of membrane companies in China is rapidly improving. Leading companies in the industry, aiming to maintain their dominant position in the long-term development of technology, are willing to collaborate with Dutch companies that have advanced foreign technologies to reduce operating costs and improve economic benefits.

Establish Demonstration Projects

For most Dutch companies, they lack certain brand awareness and influence in the Chinese market, so it is very important to establish demonstration projects. According to the bidding requirements of the Chinese government, many projects require companies to submit demonstration project cases.

Innovate the Business Model

After gaining experience in demonstration projects, members can innovate the Business Model and expand the market. For example, we can participate in the implementation of China's waste-free city planning projects, participate in the industrial upgrading opportunities of chemical parks in the central and western regions, provide subsidies for technology transfer of new pollution control demonstration projects.

Recruit Capable Marketing Personnel

It is recommended to recruit marketing personnel who are familiar with the project operation models of local governments. Through these marketing personnel, collaborations can be established with industrial park management committees, local governments, and enterprises within the parks. By integrating membrane/solid waste products through design institutes, a demonstration park model for projects can be created, which can then be promoted nationwide.

In conclusion, the Chinese market provides these foreign companies with significant opportunities, but also unique challenges. By leveraging their own strengths, addressing weaknesses, seizing opportunities and reducing threats, these companies can successfully enter the Chinese market and thrive.

Although there may be various competitions and obstacles for foreign technologies to enter China, the characteristics of China's environmental governance market are that technology research and development is relatively difficult, but after the technology is applied, it will show a rapid growth trend. Dutch environmental companies have the first-mover advantage in technology. What they need to do to enter the

Chinese market is to make sure that their solid waste/hazardous waste technology can solve specific environmental pollution problems in China. Secondly, they need to adopt various innovative business models to cooperate with different stakeholders, gain the trust of owners and customers, and jointly build regional demonstration projects in China to reduce unfavorable factors such as high prices, long supply chains and maintenance time, so as to flourish in the Chinese market.

6. REPORT LIMITATIONS

Data Usability and Knowledge Gaps

Arcadis can guarantee that the technical work and professional judgment are based on the regulations and standards under the environment and Waste/Water domains in China. With professional attitudes, Arcadis always provides appropriate technical consultancy and assessment to our clients.

Although much data has been retrieved, due to limited data published by the Chinese Government, some of the information, such as the latest statistics data, was not found or was unavailable.As well as the limited research ability of the author himself, the report analysis may be incomplete.

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7. APPENDIX

Appendix 1 List of Laws and regulations

Table 1 The statistics of the relevant sectors involved in solid waste management

Governing Body	Responsibilities	Points related to solid waste management
Local People's Governments	Local people's governments at all levels are responsible for the prevention and control of solid waste pollution of the environment in their administrative regions, have the responsibility for the supervision and management of the prevention and control of solid waste pollution of the environment, subject to the supervision and management of higher levels of government, and have the responsibility for the prevention and control of waste pollution of the environment under their jurisdictions, the target responsibility system and the appraisal and evaluation system.	Responsible for the overall management of solid waste in the jurisdiction
The customs department	Control of imported and exported wastes, based on the Announcement on Matters Relating to the Comprehensive Ban on the Import of Solid Wastes, which specifies that the import of solid wastes by any means will be prohibited from January 1, 2021, onwards.	Responsible for the management of imported and exported wastes
Development Reform Commission Sector	The National Development and Reform Commission (NDRC) is the government department responsible for researching, formulating and organizing the implementation of the city's national economic and social development strategies, medium- and long-term development plans and annual development plans.	Responsible for the development strategy and planning of the solid waste industry in the jurisdiction
Industry and Information Technology Department	To formulate and implement industrial planning, industrial policies and standards; to monitor the daily operation of the industrial sector; to promote the development of major technology and equipment and independent innovation; to formulate and implement policies on industry and informatization; and to formulate industrial and informatization development plans, policies and measures, and organize and implement the guiding and promotion of industrial investment by national and local development strategies:	Responsible for solid waste industry disposal technical standards, policy support
Natural resources Department	Its job responsibilities are: 1. Fulfill the responsibilities of owners of natural resource assets such as land, minerals, forests, wetlands and water owned by the whole nation and the responsibilities of land use control of space; 2. Responsible for natural resources survey, monitoring and evaluation, to carry out the implementation of the indicator system and statistical standards for natural resources survey, monitoring and evaluation, and to implement the natural resources survey, monitoring and evaluation system; 3. Responsible for the unified confirmation of the rights and registration of natural resources; 4. Responsible for the Compensable use of natural resources assets; 5. Responsible for the rational development and utilization of natural resources; 6. Responsible for establishing a spatial planning system and supervising its implementation; 7. Responsible for coordinating the ecological restoration of national land space; 8. Responsible for organizing the implementation of the strictest system of arable land protection; 9. Responsible for the management of the geological survey industry and geological work; 10. Responsible for the implementation of the guidelines and policies on natural resources and territorial spatial planning, the decision-making deployment and the supervision and inspection of the implementation of laws and regulations.	Responsible for corporate territorial spatial planning and management of natural resources in solid waste disposal facilities

Governing Body	Responsibilities	Points related to solid waste management
Ministry of Housing and Urban-Rural Development Department	1. Formulate policies related to housing security and guide their implementation; 2. Guide housing construction and reform of the housing system, and formulate national housing construction plans and guide their implementation; 3. Draft laws and regulations on housing and urban and rural construction, and formulate departmental regulations; 4. Organize the formulation of national standards for the implementation stage of construction; 5. Organize and formulate real estate market regulation policies in conjunction or cooperation with relevant departments and supervise their implementation; 6. Implementation of supervision and enforcement of bidding activities for housing and municipal engineering projects; 7. Study and formulate policies and plans for urban construction and direct their implementation; 8. Formulate policies, rules and regulations on the quality of construction works, building safety production and the filing of completion inspection and acceptance and supervise their implementation.	Construction, operation and management of solid waste disposal facilities
Transportation Department	1. Responsible for formulating development plans and policies for the transportation industry in the administrative region and organizing their implementation; 2. Responsible for the safety supervision of the transportation industry, formulating and implementing traffic safety regulations and standards 3. Responsible for the construction and management of infrastructure in the transportation industry, including roads, bridges, tunnels ports, etc.; 4. Responsible for the market supervision of the transportation industry and maintaining a fair and competitive market environment; 5. Responsible for environmental protection energy conservation and emission reduction in the transportation industry, and promoting the development of green transportation; 6. Responsible for emergency management in the transportation industry, and organizing response to emergencies in the field of transportation; 7. Responsible for scientific and technological innovation and informatization in the transportation industry, and enhancing the overall technological level of the industry; 8. Responsible for the cultivation of talents education and training in the transportation industry, and enhancing the professional skills of the practitioners. 9. Responsible for international cooperation and exchanges in the transportation industry, and promoting the internationalization of the industry; 10、Responsible for handling complaints and disputes in the transportation industry, and protecting the legitimate rights and interests of consumers and enterprises.	Traffic management during solid waste transportation
Agricultural and Rural Department	Scientific and technological innovation and agricultural modernization; Rural revitalization strategy; Food security; Eco-environmental protection.	Rural solid waste and environmental management
Business Department	The Announcement on Matters Relating to the Comprehensive Ban on the Importation of Solid Wastes specifies that from January 1, 2021, the importation of solid wastes by any means is prohibited.	Solid waste management for commercial activities
Health Department	1. Develop and organize the implementation of disease prevention and control plans, along with immunization strategies and intervention measures for serious public health issues that threaten people's health. 2. Oversee and manage public health within the designated area, enhancing the comprehensive supervision system for health and wellness. 3. Guide the establishment of primary healthcare, maternal and child health service systems, and the development of general practitioner teams. 4. Identify and determine the health objectives for	Disease prevention, public health management of solid waste

Governing Body	Responsibilities	Points related to solid waste management
	care management within the district. 5. Supervise and guide safety production efforts within the health industry. 6. Complete any additional tasks assigned by the district party committee and the district government.	

Table 2 List of solid waste management laws

Laws and regulations	Date of enactment	Latest revised implementation schedule	Involving solid waste management
The Constitution of the People's Republic of China	1982	March 11, 2018	Article 26 of the Constitution of the People's Republic of China provides that the State protects and improves the living environment and the ecological environment by preventing and controlling pollution and other public hazards.
Criminal Law of the People's Republic of China	1997	March 1, 2024	Article 338 of the Criminal Law of the People's Republic of China stipulates that anyone who, in violation of State regulations, discharges, dumps or disposes of radioactive wastes, wastes containing pathogens of infectious diseases, toxic substances or other hazardous wastes into land, water or the atmosphere, thereby causing a major pollution accident that results in major losses of public or private property or serious consequences of injury or death of any person shall be sentenced to not more than three years' fixed-term imprisonment or detention, and shall be fined concurrently or singly. A single fine; where the consequences are particularly serious, the penalty shall be fixed-term imprisonment of not less than three years and not more than seven years, and a fine. Article 339 provides that anyone who violates State regulations by dumping, stockpiling or disposing of solid wastes outside the country within the country shall be sentenced to fixed-term imprisonment of not more than five years or criminal detention, and shall be fined; anyone who causes a major pollution accident that results in public or private property suffering major losses or seriously jeopardizes human health shall be sentenced to fixed-term imprisonment of not less than five years and not more than one year and shall be fined; anyone whose consequences are particularly serious shall be sentenced to fixed-term imprisonment of not less than 10 years and shall be fined. Without the permission of the relevant departments of the State Council, the unauthorized import of solid wastes for use as raw materials causes major environmental pollution accidents, resulting in major losses to public or private property or seriously endangering human health, shall be sentenced to not more than five years fixed-term imprisonment or criminal detention, and shall be fined; if the consequences are particularly serious, he shall be sentenced to not less than five years and not more than ten years fixed-term imprisonment and shall be fined. Anyone who imports solid wastes that cannot be used as raw materials in the name of raw material utilization shall be convicted in accordance with the provisions of article 155 of the Criminal Law (i.e., shall be punished as a smuggling offense).
General Principles of Civil Law of the People's Republic of China	1986	October 1, 2017	Article 124 of the General Principles of Civil Law of the People's Republic of China stipulates that any person who violates the provisions of the State on the protection of the environment and the prevention of pollution and causes damage to others by polluting the environment shall bear civil liability in accordance with the law.
Environmental Protection Law of the People's Republic of China	1989	January 1, 2015	The Environmental Protection Law of the People's Republic of China comprehensively regulates the system and institution of environmental protection. It is divided into several parts, such as general provisions, supervision and management of the environment, protection and improvement of the environment, prevention and control of environmental pollution and other public hazards, legal responsibility, and by-laws.

Laws and regulations	Date of enactment	Latest revised implementation schedule	Involving solid waste management
			The State promotes cleaner production and resource recycling. It is prohibited to apply solid wastes and wastewater that do not meet agricultural and environmental protection standards to agricultural land.
Law of the People's Republic of China on Prevention and Control of Environmental Pollution by Solid Wastes	1995	September 1, 2020	The Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution comprehensively stipulates the system and regime for the environmental protection of solid waste pollution. It is divided into general provisions, supervision and management of the prevention and control of solid waste pollution of the environment, prevention and control of solid waste pollution of the environment, special provisions on the prevention and control of hazardous waste pollution of the environment, legal liability and by-laws.
Marine Environmental Protection Law of the People's Republic of China	1982	January 1, 2024	Article 24 stipulates: "No unit may dispose of or deposit tailings, slag, ash, garbage or other wastes on the shoreline without the approval of the environmental protection department of the coastal province, autonomous region or municipality directly under the Central Government. Where approval has been granted in accordance with the law for the establishment of waste dumps and disposal sites on the shoreline, protective dykes shall be constructed to prevent the loss of waste to the sea". Article 38 also stipulates: "No unit may dump any waste into the maritime areas under the jurisdiction of the People's Republic of China without the approval of the State Administration of Ocean Affairs. Units that need to dump waste must submit an application to the State Administration of the Oceans and Seas, and may do so only after approval by the State Administration of the Oceans and Seas and the issuance of a permit".
Circular Economy Promotion Law of the People's Republic of China	2008	October 26, 2018	Management of solid wastes requiring reduction, reuse and resourcing activities in the production, distribution and consumption processes.
Cleaner Production Promotion Law of the People's Republic of China	2012	February 29, 2012	Within the territory of the People's Republic of China, units engaged in production and service activities and departments engaged in related management activities continuously take measures such as improving design, using clean energy and raw materials, adopting advanced process technology and equipment, improving management, and comprehensively utilizing them, to cut down on pollution at the source, to improve the efficiency of resource utilization, and to reduce or avoid the generation and discharge of pollutants during the process of production, service and product use, in order to Reduce or eliminate hazards to human health and the environment.

Table 3 Important administrative regulations on solid waste management

Name of the legislation	Acting Year	Main Content
Regulation on the Protection of Aquatic Resources Breeding	1979	It is prohibited to discharge into fishery waters sewage, oil, oily mixtures and other polluting substances and waste that are harmful to aquatic resources.
Rules for the Administration of Ships of Foreign Nationality	1979	If a ship needs to dump garbage and other wastes in the harbor, it should show the signal specified by the harbor to invite the garbage ship (car).
Decision on Strengthening Environmental Protection during the Period of National Economic Adjustment	1981	Strict implementation of the "three simultaneous" requirement for new, altered and expanded capital projects
Notification of the request for a report on issues related to the activities of the International Drinking Water Supply and Sanitation Decade	1981	Rural areas should vigorously develop various forms of harmless treatment and comprehensive utilization of garbage, manure and sewage, and improve rural sanitation and environmental hygiene.
Decision on focused and systematic technological transformation of existing enterprises	1982	On the development of a disposal scheme for used and end-of-life equipment.
Interim measures for the collection of sewage charges	1982	All enterprises and institutions should implement the "Trial Standards for Industrial "Three Wastes" Emission" and other relevant standards issued by the State.
Several provisions on combating industrial pollution in the context of technological transformation	1983	Each industrial enterprise should closely combine with the technological transformation, to carry out the comprehensive utilization of industrial wastes.
Regulations on the Prevention of Marine Pollution from Ships	1983	No ship shall discharge oil, oily mixtures, waste and other toxic substances into the fresh waters of harbors near estuaries, specially protected marine areas and marine nature reserves.
Regulations on the Management of Environmental Protection in Marine Petroleum Exploration and Exploitation	1983	Disposal of large quantities of industrial waste is regulated in accordance with the provisions on marine dumping: sporadic industrial waste may not be dumped in fishery waters and waterways.
Notification of provisional regulations on certain issues related to the development of integrated resource utilization	1985	The State encourages enterprises to actively engage in the comprehensive utilization of resources and implements preferential policies for the production and construction of the comprehensive utilization of resources.
Marine Dumping Regulations	1985	Waste from foreign countries shall not be transported to waters under the jurisdiction of the People's Republic of China for dumping, including the disposal of ships, aircraft, platforms and other man-made structures at sea.
Regulations on the Safe Management of Chemical Dangerous Goods	1987	Enterprises that produce or use chemically hazardous substances must properly dispose of wastewater, waste gas and waste residue following the provisions of the Environmental Protection Act.

Name of the legislation	Acting Year	Main Content
Regulations on the Prevention of Environmental Pollution from Ship breaking	1988	Wastes such as garbage, residual oil, waste oil, oil sludge, oily sewage and flammable and explosive substances must be sent to the shore for centralized treatment and must not be disposed of using seepage pits or seepage wells.
Interim Measures for the Reimbursable Use of the Special Fund for the Control of Pollution Sources	1988	The "three wastes" comprehensive utilization project is one of the scopes of use of the fund.
Highway Regulations	1988	It is not allowed to quarry sand and gravel, build dykes, dump garbage, compress or widen the riverbed, or carry out blasting operations within 200 meters upstream and downstream of large-scale diversion bridges and public and private ferry crossings.
River Management Ordinance	1988	Disposal of slag, rock slag, coal ash, soil, garbage, etc. is prohibited within the river management area.
Decision on strengthening the management of non-ferrous metals	1989	Strengthening the recovery and recycling of scrap non-ferrous metals
Enforcement Rules of the Water Pollution Control Law	1989	Units that build, repair, dismantle or salvage ships shall take precautions to prevent the pollution of water bodies by oily mixtures of oils and other wastes when carrying out their operations.
Regulations on the Management of Pollution Damage to the Marine Environment by Land-based Pollutants	1990	Unauthorized stockpiling, disposal, and handling of solid waste on shorelands is prohibited.
Regulations on the Prevention and Control of Pollution and Damage to the Marine Environment by Coastal Engineering Construction Projects	1990	Construction of shore-based shipyards, and ship repair yards, should be set up with the nature and scale of residual oil, waste oil receiving and treatment facilities, industrial and ship garbage receiving and treatment facilities, etc.
Decision on further strengthening environmental protection	1990	It is prohibited to transfer toxic and hazardous wastes and garbage from abroad, which are included in the list of hazardous characteristics, to the country for disposal, and pollution by transfer is strictly prevented.
Regulations for the Implementation of the Standardization Law	1990	Provides that national standards for environmental protection shall be drafted and approved by the competent department for environmental protection under the State Council and that the numbering and publication methods shall be formulated in conjunction with the administrative department for standardization under the State Council.
Opinions on the Active Development of the Environmental Protection Industry	1990	It specifies the current environmental protection industries and products that need to be developed urgently, including solid waste treatment and disposal equipment and waste resources comprehensive utilization equipment.

Name of the legislation	Acting Year	Main Content
Enforcement Rules of the Air Pollution Prevention and Control Law	1991	Transportation, loading and unloading, and storage of substances that can emit toxic and harmful gases or dust, must follow the relevant provisions of the closed or covered, spraying and other protective measures.
Notice on Strengthening the Management of Recycling and Utilization of Renewable Resources	1991	The domestic shortage of scrap metal, to strictly implement the relevant departments of the State Council on the export of scrap iron and steel and scrap non-ferrous metals, without approval, is strictly prohibited to export.
Implementation of the Infectious Disease Control Act	1991	Cities should build public toilets, harmless disposal sites for garbage and feces, and public sanitation facilities such as sewage and rainwater drainage treatment systems in accordance with urban sanitation standards.
Regulations on the Management of Urban Amenities and Environmental Hygiene	1992	All units and individuals shall dump garbage and feces in accordance with the time, place and manner prescribed by the administrative department of urban environmental sanitation of the urban people's government.
Circular on a few observations on solving the problem of urban household waste in China	1992	Vigorously carry out the recycling and comprehensive utilization of municipal waste and improve the recycling rate.
Circular on Several Opinions on Further Strengthening the Comprehensive Improvement of the Urban Environment	1992	Large and medium-sized cities should gradually implement the containerization of garbage collection and closed transport.
Regulations on Planning and Construction Management of Villages and Market Towns	1993	Any unit or individual should maintain the appearance of the village and town and environmental sanitation, properly dispose of piles of manure, garbage, firewood and grass, maintain trees and plants, and beautify the environment.
Regulations on the Protection of Basic Farmland	1994	Fertilizers and municipal waste and sludge used as fertilizers provided to basic farmland protection zones must comply with the relevant national standards.
Urgent notice on resolutely controlling the transfer of waste from abroad to China	1995	Effectively strengthen the management of waste imports. Waste imports are managed in two categories: those that are prohibited from being imported and those that can be used as raw materials but whose import must be strictly limited.
Views on the further development of integrated resource utilization	1996	Strict management to improve the recovery and recycling of waste materials
Decisions on a number of issues related to environmental protection	1996	Effective measures to prohibit the transfer of waste pollution
Medical Waste Management Ordinance	2003	In order to strengthen the safe management of medical waste, prevent the spread of disease, protect the environment and safeguard human health, these regulations are formulated in accordance with the Law of the People's Republic of China on Prevention and Control of Infectious Diseases and the Law of the People's Republic of China on Prevention and Control of Environmental Pollution by Solid Wastes. The medical waste referred to in these regulations refers to

Name of the legislation	Acting Year	Main Content
		the direct or indirect infectious, toxic and other hazardous wastes generated by medical and health institutions in the course of medical treatment, prevention, health care and other related activities.
Imported solid wastes as raw materials inspection Quarantine supervision and management measures	2009	These measures apply to the import of solid wastes as raw materials (hereinafter referred to as waste materials) inspection and quarantine and supervision and management.
Measures for the Management of Solid Waste Imports	2011	The import of solid wastes referred to in these Measures refers to the activities of bringing solid wastes from outside the People's Republic of China into the territory of the People's Republic of China.
Extended Producer Responsibility (EPR) Program	2016	By 2020, the policy system related to the extended producer responsibility system will have taken initial shape, significant progress will have been made in product eco-design, and the standardized recovery and recycling rate of discarded products of key varieties will have reached an average of 40 percent. By 2025, laws and regulations related to the extended producer responsibility system will be perfected, the extended producer responsibility system in key areas will be operating in an orderly manner, product Eco-design will be generally implemented, the proportion of recycled raw materials used in key products will reach 20%, and the rate of standardized recovery and recycling of discarded products will reach 50% on average.
Guidance on the comprehensive utilization of bulk solid waste in the Fourteenth Five-Year Plan	2021	At present, the accumulated stockpile of bulk solid waste is about 60 billion tons, and the annual new stockpile is nearly 3 billion tons, among which, the utilization rate of red mud, phosphogypsum, steel slag and other solid wastes is still relatively low, occupying a large amount of land resources, and there exists a large ecological and environmental safety hidden danger. It is necessary to thoroughly implement the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes and other laws and regulations, vigorously promote the reduction of bulk solid wastes at source, the utilization of resources and harmless disposal, strengthen the whole chain of governance, and make efforts to solve the outstanding contradictions and problems, and to promote the comprehensive utilization of resources to achieve new development of the industry.
Implementation of the Reform Program for Strengthening Hazardous Waste Regulation and Utilization and Disposal Capacity	2021	Enhancement of hazardous waste regulation and utilization and disposal capacity, and effective prevention and control of environmental and safety risks of hazardous waste
Opinions of the General Office of the State Council on Accelerating the Construction of a Waste Recycling System	2024	To accelerate the construction of a waste recycling system, by 2025, a waste recycling system covering all fields and segments will have been initially built, and positive progress will have been made in the recycling of major wastes. The annual utilization of tailings, fly ash, coal gangue, smelting slag, industrial by-product gypsum, construction waste, straw and other bulk solid waste has reached 4 billion tons, and the comprehensive utilization rate of new bulk solid waste has reached 60%. The annual utilization of major renewable resources such as scrap iron and steel, scrap copper, scrap aluminum, scrap lead, scrap zinc, scrap paper, scrap plastic, scrap rubber and scrap glass has reached 450 million tons. The annual

Name of the legislation	Acting Year	Main Content
		output value of the resource recycling industry has reached 5 trillion RMB. By 2030, a comprehensive, efficient, standardized and orderly waste recycling system will be built, the resource value of various types of waste will be fully tapped, the proportion of recycled materials in the supply of raw materials will be further increased, the scale and quality of the resource recycling industry will be significantly improved, and the level of waste recycling will be among the world's foremost in general.
Sewage permit management	2024	The competent ecological and environmental authorities have implemented comprehensive permit management for the discharge of air pollutants, water pollutants, industrial solid waste, industrial noise and other pollutants from sewage disposal units.

Table 4 Key sectoral regulations on solid waste management

Name of the regulation	Acting year	Issuing unit	Main Content
On industrial and mining enterprises to control the "three wastes" pollution to carry out comprehensive utilization of product profit retention methods notice	1979	Ministry of Finance, State Council Leading Group for Environmental Protection	Definition of products subject to comprehensive utilization by industrial and mining enterprises
Pilot scheme on living hygiene at railroad works sites	1980	Ministry of Railways	Selection of appropriate locations for the installation of garbage pits (bins) and their regular management
Measures for Sanitary Supervision at State Border Crossings	1982	Ministry of Health, Ministry of Transportation, Civil Aviation Administration of China and Ministry of Railways	Domestic waste at border crossings should be removed daily, and weekly dumpsites should be set up for regular removal.
Code of Good Manufacturing Practice	1984	State Administration of Medicine (SAOM)	Waste materials. Production, living garbage should be separately concentrated, fixed point fixed ware, covered piles, special person in charge, regular clean-up.
Decision on the Promulgation of the Coal Mine Safety Regulations	1986	Ministry of Coal Industry	Gangue, furnace ash, garbage and other debris, shall not be piled up in the place where flash floods and rivers wash away.
Working System of Chinese Medicine Hospital (Trial)	1986	Health department	Disposal of dirt and garbage should be done carefully to prevent cross-contamination
Interim Measures for Reporting Incidents of Environmental Pollution and Damage	1987	PRC Environmental Protection Agency	Solid waste pollution accidents are listed as one of the types of environmental pollution and damage accidents.
Quantitative Assessment Implementation Measures for Comprehensive Improvement of Urban Environment	1988	State Council Environmental Protection Committee	Comprehensive industrial solid waste utilization rate, industrial solid waste treatment and disposal are two of the indicators.
Measures for the management of environmental impact assessment certificates for construction projects	1989	PRC Environmental Protection Agency	Relevant provisions on evaluation certificates that include solid waste

Name of the regulation	Acting year	Issuing unit	Main Content
Enforcement Rules of the State Border Sanitary and Quarantine Law	1989	Health department	Inbound and outbound scrap and other goods the arrive at the port of entry, the carrier's agent or the owner of the goods, must be declared to the health and quarantine authorities and subject to health and quarantine.
Circular on the issuance of the National Outline for the Development of Comprehensive Utilization of Resources 1989-2000	1989	State Planning Commission (SPC)	Resources such as industrial wastes discharged in the current year are to be utilized and rationally disposed of in the current year.
Drinking Water Source Protection Zone Pollution Prevention and Control Regulations	1989	State Environmental Protection Agency, Ministry of Health, Ministry of Construction, Ministry of Water Resources, Ministry of Mines and Geology	Prohibition of the dumping of industrial wastes, municipal garbage, feces and other wastes into water bodies
Notice on the campaign to create a national health city	1989	National Sanitation Council	Responsibility for cleaning and cleaning is implemented, and garbage is removed daily.
Regulations on Work Safety and Environmental Protection in Shipbreaking	1990	Ministry of Materials	Shipbreaking yards must have anti-pollution facilities and equipment such as calcium carbide slag and its wastewater treatment facilities, garbage dumps, etc.
Notice on strict control of imports of donated used tires	1990	Ministry of Materials, Ministry of Economy and Trade, General Administration of Customs, Overseas Chinese Affairs Office of the State Council	Local governments at all levels and relevant authorities should strictly control the import of waste tires donated from abroad.
Circular on Strict Control of the Transfer of Hazardous Wastes from Overseas to China	1991	State Environmental Protection Agency, General Administration of Customs	Strictly control the transfer of hazardous waste and garbage from abroad to the country
Ten-Year Plan and Outline of the Eighth Five-Year Plan for PHCCO, Patriotic Health Campaign Committee Office	1991	PHCCO, Patriotic Health Campaign Committee Office I	Research, promotion, application and technical services on applied technologies and standards for the treatment and utilization of garbage and sewage, the conversion of latrines into water, and the elimination of the four pests and other sanitation problems.

Name of the regulation	Acting year	Issuing unit	Main Content
Trial Specification on On-site Management of Foreign Economic and Trade Import and Export Enterprises	1991	Ministry of Foreign Trade and Economic Cooperation (MOFTEC)	Fixed point piles of wastepaper, waste, garbage, etc. should be segregated from the surrounding area and cleaned up daily.
Regulations for the prevention of environmental pollution from PCB-containing electrical installations and their wastes	1991	National Environmental Protection Agency and Ministry of Energy	It is strictly prohibited for any organization or individual to sell, acquire, or dismantle PCB-containing electrical installations.
Regulations on the Prevention and Control of Environmental Pollution in the Production and Construction of Chromium Compounds	1992	Ministry of Chemical Industry and State Environmental Protection Agency	Implementation of a production license system and a pollutant discharge declaration and registration system for enterprises producing chromium compounds
Pollutant Discharge Declaration and Registration Regulations	1992	PRC environmental protection agency	Solid waste storage and disposal sites of sewage disposal units should be suitable for sampling, monitoring, measurement and other working conditions.
Railroad station, passenger train health supervision and management measures	1992	Ministry of Railways	Station garbage should be cleaned daily and is strictly prohibited to be piled up randomly.
Rules for the Implementation of the Law of the People's Republic of China on Prevention and Control of Infectious Diseases by Railroads	1992	Ministry of Railways	Railroad passenger transport units must take measures to make waiting rooms and means of transportation meet hygienic standards. Dispose of garbage and feces according to regulations.
Regulations for the Prevention and Control of Environmental Pollution from Tailings	1992	PRC environmental protection agency	Enterprises generating tailings must formulate tailings pollution prevention plans and take effective measures to prevent and control environmental pollution and hazards caused by tailings.
Circular on the Issuance of Notes on Three Tax Items of Fixed Assets Investment Direction Adjustment Tax on Pollution Control, Environment Protection and Energy Conservation Projects	1993	State Administration of Taxation, State Planning Commission	The scope of application of the zero-rating of this tariff line includes the treatment of industrial and domestic waste.
Municipal household waste management measures	1993	Ministry of Construction	All units and individuals engaged in municipal household garbage business collection and transportation services must transport household garbage to designated household garbage transfer

Name of the regulation	Acting year	Issuing unit	Main Content
			stations and disposal sites and must not dump it arbitrarily.
Circular on Strict Control of Imports of Wastes from EC Countries	1994	PRC Environmental Protection Agency	Provides a list of waste categories that can be imported under normal commercial trade, subject to authorization, and are prohibited from import.
Environmental engineering design certificate management method	1995	PRC Environmental Protection Agency	Environmental engineering design includes process design of environmental pollution prevention and control projects for wastewater, waste gas, solid waste, etc.: waste resourceization engineering design, etc.
Circular on the issuance of the Outline for the Development of New and Renewable Sources of Energy	1995	General Office of the State Planning Commission, General Office of the State Science and Technology Commission, General Office of the State Economic and Trade Commission	Strengthening research on and application of technologies for the recycling of organic waste from urban and rural people's lives and industry and agriculture.
Measures for the Management of Environmental Protection in the Electric Power Industry	1996	Ministry of Power Industry	Enterprises must arrange for pollution prevention and control funds, and after-tax proceeds from comprehensive utilization continue to be used for comprehensive utilization.
Interim Provisions on Environmental Protection Management of Waste Imports, Supplementary Provisions	1996	State Environmental Protection Administration, Ministry of Foreign Trade and Economic Cooperation, General Administration of Customs, State Administration of Industry and Commerce and State Administration of Commodity Inspection	Application and approval procedures for imported wastes, and the national catalog of wastes used as raw materials whose importation is restricted.
Provisions on strengthening the management of imported waste shipments	1996	Ministry of Transport	Carriers shall not carry wastes the import of which is prohibited in China.

Name of the regulation	Acting year	Issuing unit	Main Content
Management of Pre-shipment Inspection of Imported Wastes (Trial)	1996	PRC State Administration of Import and Export Commodity Inspection (SACI)	The country allows the import of wastes as raw materials, pre-shipment inspection must be implemented.
Circular on the updating of the national catalog of wastes as raw materials subject to import restrictions	1996	PRC Environmental Protection Agency	Additions to the list of wastes as raw materials whose import is restricted by the State
Regulations on the Maintenance of Environmental Hygiene on Passenger Trains, at Stations and Along Railroad Lines	1997	NAC, Ministry of Health, Ministry of Railways and SEPA	The garbage of passenger trains should be encapsulated in garbage bags and put at the specified stations along the line for unified treatment, and it is strictly prohibited to throw them outside the train.
Provisions on Strengthening Environmental Protection in Township Enterprises	1997	PRC Environmental Protection Agency	Strictly prohibit the illegal import, processing and utilization of solid wastes from abroad
National List of Hazardous Wastes	1998	State Environmental Protection Administration, State Economic and Trade Commission, Ministry of Foreign Trade and Economic Cooperation, Ministry of Public Security	Hazardous wastes are categorized into 47 categories, and the most recent National Hazardous Waste Inventory (2021 Edition) is now available.
Measures for the Management of Medical Waste in Healthcare Institutions	2003	Health department	Collection management related to medical waste
Guidelines for the Review and Licensing of Hazardous Waste Operators	2009	Ministry of Environmental Protection	Units engaged in the collection, storage, utilization and disposal of hazardous wastes must apply to the competent administrative department for environmental protection (hereinafter referred to as the "environmental protection department") at or above the county level for a hazardous waste business license. To guide and standardize the review and licensing work of environmental protection departments for units applying for hazardous waste operating licenses, the Guidelines for Review and Licensing of Hazardous Waste Operating Units (hereinafter referred to as "the Guidelines") are developed.

Name of the regulation	Acting year	Issuing unit	Main Content
Measures for the Management of Radioactive Solid Waste Storage and Disposal Licenses	2013	Ministry of Environmental Protection	Applicable to the management of applications for and approval of licenses to store and dispose of radioactive solid wastes
Circular on the issuance of the Program on Promoting the Pilot Resource Utilization of Agricultural Waste	2016	Ministry of Agriculture, National Development and Reform Commission, Ministry of Finance, Ministry of Housing and Urban-Rural Development, Ministry of Environmental Protection, Ministry of Science and Technology	Efforts are being made to explore the construction of an effective governance model for the resource utilization of agricultural waste.
Measures for Soil Environment Management on Agricultural Land (Trial)	2017	Ministry of Environmental Protection, Ministry of Agriculture	Protecting the soil environment on agricultural land. Units and individuals engaged in large-scale livestock and poultry farming and agricultural product processing should, in accordance with the requirements of the relevant norms, determine the way of harmless treatment of wastes and the site for their elimination.
Action Program on Resource Utilization of Livestock and Poultry Manure (2017-2020)	2017	Ministry of Agriculture	By 2020, the establishment of scientific norms, clear rights and responsibilities, constraints strong livestock and poultry waste resource utilization system, building breeding cycle development mechanism, livestock and poultry manure resource utilization capacity significantly improved, the national comprehensive utilization rate of livestock and poultry manure reached 75% or more, large-scale farms manure treatment facilities equipment supporting rate reached 95% or more, large-scale farms manure treatment facilities equipment supporting rate one year ahead of time Reach 100%. Large livestock counties, national modern agricultural demonstration zones, experimental demonstration zones for sustainable agricultural development and modern agricultural industrial parks have taken the lead in realizing the above goals.
Assessment Measures for the Resource Utilization of Livestock and Poultry Breeding Waste (for Trial Implementation)	2018	Ministry of Agriculture, Ministry of Ecology and Environment	Local people's governments at all levels are generally responsible for the work of resource utilization of livestock and poultry breeding waste in their administrative areas. The people's governments of all provinces (autonomous regions and municipalities) shall formulate work programs for their regions based on the overall objectives set by the State.
Measures for the Management of	2021	Ministry of Ecology and Environment,	These Measures shall apply to the transfer of hazardous wastes within the territory of the People's

Name of the regulation	Acting year	Issuing unit	Main Content
Hazardous Waste Movements		Ministry of Public Security, Ministry of Transportation	Republic of China and the supervision and management thereof.
Publication of the Hazardous Waste Exclusion Management List (2021 Edition)	2021	Ministry of Ecology and the Environment (MEP)	Solid wastes that meet the requirements of this list are not hazardous. This list is dynamically adjusted according to the actual situation.
Circular on the issuance of a categorized catalog of medical waste (2021 edition)	2021	National Health Commission, Ministry of Ecology and Environment	Categorization requirements for medical waste management
Circular on the issuance of the Work Program for the Construction of Zero-Waste Cities in the 14th Five-Year Plan period	2021	Ministry of Ecology and Environment, Development and Reform Commission, Ministry of Industry and Information Technology, Ministry of Finance, Ministry of Natural Resources, Ministry of Housing and Urban-Rural Development, Ministry of Agriculture and Rural Development, Ministry of Agriculture and Rural Development, Ministry of Commerce, Ministry of Culture and Tourism, Ministry of Health, People's Bank of China, General Administration of Taxation, General Administration of Market Supervision, Bureau of Statistics, State Administration of Bankruptcy, China Banking and Insurance Regulatory	In November 2021, the Opinions of the State Council of the Central Committee of the Communist Party of China on Fighting the Battle of Pollution Prevention and Control explicitly proposed to steadily promote the construction of "Zero-Waste Cities". In order to implement the decision-making and deployment of the CPC Central Committee and the State Council, and to guide localities to do a good job in the construction of "Zero-Waste Cities", the Ministry of Ecology and Environment, together with the Development and Reform Commission and other 17 departments and units, formulated the "Work Program".

Name of the regulation	Acting year	Issuing unit	Main Content
		Commission, Postal Service, China National Supply and Marketing Corporation.	
Circular on Pilot Hazardous Waste Collection for Micro and Small Enterprises	2022	Ministry of Ecology and the Environment (MEP)	Actively promote the establishment of a standardized and orderly hazardous waste collection system for small and micro-enterprises, improve and perfect the management system of hazardous waste collection units, and effectively solve the urgent, difficult, worrying and long-awaited hazardous waste collection and treatment problems of small and micro-enterprises. Small and microenterprises are mainly enterprises that generate relatively small quantities of hazardous waste but also include social sources such as motor vehicle repair points, scientific research institutions and school laboratories. The amount of hazardous waste generated by small and micro-enterprises is small, but the types of hazardous waste are varied and extensive, and if not collected and treated promptly, there will be greater environmental risks. Small and micro enterprises have long been plagued by difficulties in the collection and treatment of hazardous waste, and there is an urgent need to open up the "last kilometer" of hazardous waste collection.
Typical Technical Models and Cases of Resource Utilization of Rural Organic Wastes	2022	General Office of the Ministry of Agriculture and Rural Development, National Rural Revitalization Bureau, General Division	In order to improve the level of harmless treatment and resource utilization of organic waste such as perishable garbage and toilet waste in rural areas, the Ministry of Agriculture and Rural Development and the National Rural Revitalization Bureau have selected four typical technical models and seven typical cases of resource utilization of organic waste in rural areas, which are hereby issued.
Circular on the issuance of the Overall Implementation Plan for the Construction of Major Hazardous Waste Projects (2023-2025)	2023	Ministry of Ecology and Environment, Development and Reform Commission	By 2025, through the construction of the national technology center, six regional technology centers and 20 regional disposal centers, the capacity to apply basic research on the prevention and control of ecological and environmental risks of hazardous wastes, the capacity to research and development of utilization and disposal technologies, and the capacity of technological support for management decisions will be improved, to provide a backing guarantee and a leading demonstration for the utilization and disposal of hazardous wastes in the country, especially for the special categories of hazardous wastes.
Announcement on the publication of the Catalog of Solid Waste Classification and Codes	2024	Ministry of Ecology and the Environment (MEP)	Define types of solid waste

Name of the regulation	Acting year	Issuing unit	Main Content
Implementation plan for the full implementation of the sewage licensing system	2024	Ministry of Ecology and the Environment (MEP)	By 2025, the management of industrial noise and industrial solid waste discharge permits will be fully completed.

Table 5 Shanghai's Solid Waste Regulations

Acting year	Name of local legislation	Examples of key elements
1984	Shanghai Municipal Environmental Sanitation Management Regulations (Trial)	Domestic garbage and feces from units and residents are managed and removed by the sanitation department. The sanitation department should make sure that domestic garbage is cleared daily and that septic tanks are regularly emptied of fecal matter.
1987	Regulations on the Setting of Environmental Sanitation Facilities in Shanghai Cities and Towns	Garbage containers shall not be set up on major traffic roads and their sidewalks; when other roads need to be set up, they shall be agreed upon by the public security traffic management department.
1989	Enforcement Rules of Shanghai Environmental Hygiene Management Regulations	The management unit of the landfill, disposal point and landfill site of construction waste and engineering residue should have a person in charge of the environmental cleaning work.
1989	Shanghai Environmental Hygiene Management Regulations	When loading, unloading and transporting goods and garbage and manure, the site should be neat and clean, and should not be leaked or scattered on the way.
1990	Regulations on the Management of Environmental Sanitation in Shanghai Waters	Measures shall be taken to prevent the scattering, spilling and floating of garbage, feces and powdery and light goods when they are transported, loaded, or unloaded.
1992	Shanghai Construction Waste and Engineering Sludge Disposal Management Regulations	Establishes the responsibilities of the Shanghai Municipal Dirt Management Office.
1995	Shanghai Environmental Protection Regulations	Strictly control solid waste pollution, and prohibit the mixing of hazardous wastes into domestic garbage or other wastes: arbitrary dumping of domestic garbage, feces, industrial wastes or other solid wastes.
1995	Measures for the Prevention and Control of Pollution from Hazardous Wastes in Shanghai	Enterprises, institutions and individuals that generate hazardous wastes in their production and operation activities have the responsibility to prevent and control pollution by hazardous wastes and other responsibilities stipulated by laws and regulations.
1995	Notice on Strengthening the Management of Disposal of Construction Waste and Engineering Dirt in the City	Generate slag waste units, which should be to the slag management department for slag waste emission disposal plan declaration procedures.
1995	Interim Provisions on the Management of Environmental Sanitation in Shanghai's Market Towns and Villages	Domestic waste disposal site should be set up in accordance with the unified requirements of the municipal environmental health management department, and the provisions of the health protection zone and the implementation of anti-pollution measures.
2004	Shanghai Livestock and Poultry Breeding Management Measures	The discharge of pollutants from livestock and poultry farms shall comply with the emission standards set by the State and the City. The city encourages livestock and poultry farms to return livestock and poultry manure to the land ecologically or to produce biogas, organic fertilizer and other substances. Livestock and poultry farms that return livestock and poultry manure to the land in accordance with the specifications will be deemed to have met the discharge standards. Specific specifications for the ecological return of livestock and poultry manure to the land shall be formulated and

Acting year	Name of local legislation	Examples of key elements
		published by the Municipal Environmental Protection Bureau in conjunction with the Municipal Agriculture Commission. Livestock and poultry farms should be set up to meet the environmental requirements of livestock and poultry manure storage places, the implementation of harmless treatment, and take effective measures to prevent the scattering of livestock and poultry manure, overflow. Livestock and poultry farms shall not arbitrarily discharge livestock and poultry manure, methane, marsh residue or sewage directly into water bodies or other environments.
2006	Regulations on Prevention and Control of Environmental Pollution from Medical Waste Disposal in Shanghai	The provisions of this regulation apply to the scope of the city's administrative area of medical waste collection, transportation, storage, disposal and related environmental pollution prevention and management activities.
2019	Shanghai Municipal Domestic Waste Management Regulations	The Ordinance is a local law enacted by the city of Shanghai to strengthen the management of domestic waste, improve the urban and rural environment and promote the construction of an ecological civilization. The regulations comprehensively stipulate the management requirements for all aspects of the classification, collection, transportation, treatment and resource utilization of household garbage, and clarify the responsibilities and obligations of the government, enterprises, social organizations and individuals in the management of household garbage, and promote the reduction, resource utilization and harmless treatment of household garbage. The regulations also emphasize publicity and education on the classification of domestic waste, encourage and guide citizens to actively participate in waste classification, and set corresponding legal liabilities for violations of waste classification regulations to ensure the effective implementation of the regulations. Through these measures, Shanghai aims to improve the efficiency of domestic waste disposal, reduce environmental pollution and enhance the city's ability for sustainable development.
2021	Notice on Strengthening the Environmental Management of General Industrial Solid Waste Generating Units in the City	Waste-producing units shall effectively assume the main responsibility for the management of general industrial solid waste, in strict accordance with the "Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes" and the relevant requirements specified in this Circular, to implement the job responsibilities, to form an organization and leadership system with a clear definition of the responsible person, clear powers and responsibilities, and to establish and improve the responsibility for the prevention and control of environmental pollution throughout the entire process of the generation, collection, storage, transportation, utilization and disposal of general industrial solid wastes. Establish and improve the responsibility of pollution prevention and environmental control in the whole process of generation, collection, storage, transportation, utilization and disposal of general industrial solid wastes, to achieve strict internal management, standardized transfer and disposal and clear management accounts.
2023	Shanghai Pudong New Area Solid Waste Resourceful Reuse Several Provisions	The provisions of this regulation apply to the Pudong New Area administrative area of solid waste recycling activities related to resource utilization.
2023	On the issuance of the Shanghai "no waste cell" construction assessment management procedures (Trial Implementation)" and	The regulations apply to the construction and assessment management of "Zero-Waste cells". "Zero-Waste cells" refer to all types of social production and living units, including but not limited to institutions, factories, industrial parks, enterprise groups, communities, campuses, shopping malls, restaurants, hotels,

Acting year	Name of local legislation	Examples of key elements
	"Assessment Rules for the Construction of "Zero-Waste Cells" in Shanghai (2023 Edition)".	scenic spots, hospitals and so on, that have outstanding performance in the reduction of solid waste at source, the utilization of resources and the environmentally sound disposal of solid waste.
2024	Regulations on the Construction of Zero-Waste Cities in Shanghai	The Ordinance is a local regulation enacted in Shanghai to promote the construction of Zero-Waste Cities and the minimization, resourcefulness and harmless disposal of solid waste. The regulations cover solid waste management in various fields, including industry, agriculture and construction, emphasize the principles of reduction at source, separate collection, resource utilization and safe disposal, and clarify the responsibilities and obligations of the Government, enterprises and the public in solid waste management. The regulations also propose a series of incentives, such as financial subsidies and tax incentives, to encourage enterprises and individuals to participate in the resourceful utilization of solid waste, while setting strict legal responsibilities for violations, in order to ensure that solid waste is effectively managed and utilized and to promote sustainable urban development.
2024	Implementation Plan for the Classification of Domestic Waste in Shanghai 2024	1. List of tasks for promoting the classification and reduction of domestic waste in 2024; 2. List of key task indicators for the classification of domestic waste in each district in 2024
2024	Shanghai's 14th Five-Year Plan for Hazardous Waste Supervision and Capacity Building for Utilization and Disposal	In order to implement the requirements for the construction of Shanghai Eco-city, accelerate the short board of medical waste and hazardous waste collection, treatment and disposal, continuously improve and perfect the city's medical waste and hazardous waste environmental supervision and collection, transportation and disposal capacity, and strengthen and upgrade the city's ability to prevent environmental risks and ensure safety, this plan is formulated.
2014	Emission Standards for Air Pollutants from Domestic Waste Incineration (DB31/768-2013)	Establishes air pollutant emission standards for domestic waste in Shanghai

Table 6 Table Selected regulations on solid waste in the Beijing-Tianjin-Hebei region

Acting year	Name of local legislation	Examples of key elements
2010	Beijing Municipal Water Pollution Prevention and Control Regulations	It applies to the pollution prevention and control of surface water bodies and underground water bodies within the administrative area of Beijing, as well as water resource management recycled water utilization and other related activities associated with water pollution prevention and control.
2011	Beijing Municipal Domestic Waste Management Regulations	These regulations apply to the management activities of domestic waste in the administrative area of Beijing, including solid waste generated by units and individuals in their daily lives or in activities providing services for daily life.
2018	Beijing Municipal Work Program for Promoting Resource Utilization of Livestock and Poultry Breeding Waste	Establishing a system for the resource utilization of livestock and poultry breeding waste, building a mechanism for the development of breeding cycles, and improving the comprehensive utilization rate of livestock and poultry manure within the administrative area of Beijing.
2020	Pilot Implementation Program for the Construction of Zero-Waste Cities in Beijing Economic-Technological Development Area (BDA)	Integrate the construction of "Zero-Waste Cities" with urban development and ecological environment management, deepen the reform of comprehensive solid waste management from the overall level of the city, comprehensively improve the level of solid waste management, enhance the comprehensive competitiveness, provide a solid foundation for the green development of the economy and society, enhance the people's sense of access to the improvement of ecological environment quality, and create an international first-class "Yizhuang New City". It will also make every effort to build an international first-class "Yizhuang New City", which is suitable for living and working; explore and summarize feasible paths and specific models for the development zone to realize the construction of a "Zero-Waste Cities", and form a batch of vivid experiences in the process of building an upgraded version of the development zone and constructing a new high ground for reform and opening up; and provide a solid foundation for the 219 national-level economic and development zones in China to develop their development zones. It will also provide a new development model for the 219 national-level development zones in China to explore solid waste management and cultivate green industrial chains, and form a sustainable development model that takes into account both economic development and environmental benefits.
2020	Regulations on Prevention and Control of Environmental Pollution by Hazardous Wastes in Beijing	These Regulations shall apply to the prevention and control of environmental pollution by hazardous wastes within the administrative area of Beijing. It strengthens the management of hazardous waste and prevents hazardous waste from polluting the environment.
2020	Beijing Construction Waste Disposal Management Regulations	The provisions of this regulation apply to the city's administrative area of construction waste dumping, piling, storage, transportation, abatement, utilization and other disposal activities and their supervision and management.
1999	Tianjin Measures for Prevention and Control of Environmental Pollution by Hazardous Wastes	Those engaged in hazardous waste generation, collection, transportation, storage, utilization and disposal activities within the administrative area of Tianjin must comply with these Measures.

Acting year	Name of local legislation	Examples of key elements
2008	Tianjin Construction Waste Management Measures	These Measures shall apply to the dumping, transportation, disposal, resource utilization and management-related activities of construction waste in the administrative area of Tianjin.
2016	Tianjin Water Pollution Prevention and Control Regulations	These regulations shall apply to the pollution prevention and control of surface water bodies such as rivers, lakes, canals, reservoirs and other underground water bodies within the administrative area of Tianjin.
2017	Tianjin livestock and poultry waste resource utilization work program	Integrate the carrying capacity of resources and environment, the ability to guarantee the supply of livestock products and the ability to utilize the resources of breeding waste, synergistically promote the development of production and environmental protection, rewards and penalties, combining blocking and plugging, accelerating the transformation and upgrading of animal husbandry and green development, and guaranteeing the stability of livestock product supply.
2020	Tianjin Domestic Waste Management Regulations	These regulations shall apply to the source reduction, placement, collection, transportation, treatment, resource utilization and supervision and management activities of domestic garbage within the administrative area of Tianjin.
2022	Tianjin's "14th Five-Year Plan" Work Program for the Construction of "Zero-Waste Cities"	With the main line of promoting the reduction, resourcefulness and harmlessness of solid waste, focusing on hazardous waste, industrial solid waste, agricultural waste, domestic garbage and construction waste, integrating urban development and solid waste management, strengthening the construction of the system, technology, market, supervision and other safeguard systems, giving full play to the synergistic effect of pollution reduction and carbon reduction, and perfecting the governance system of a modernized metropolis.
2013	Measures for the Management of Kitchen Waste in Hebei Province	These measures shall apply to the generation, collection, transportation, and disposal of food waste and its related management activities within the administrative area of Hebei Province.
2018	Regulations on Prevention and Control of Water Pollution in Hebei Province	These regulations shall apply to the pollution prevention and control of surface water bodies such as rivers, lakes, canals, channels, wetlands, depressions, pits and ponds, precipitation reservoirs, flood storage areas, and groundwater bodies within the administrative area of Hebei Province.
2022	Regulations on Prevention and Control of Solid Waste Pollution in Hebei Province	These Regulations shall apply to the prevention and control of environmental pollution by solid wastes and the supervision and management within the administrative area of Hebei Province. These regulations shall not apply to the prevention and control of pollution of the marine environment by solid wastes and the prevention and control of pollution of the environment by radioactive solid wastes.
2022	Regulations on the Management of Classification of Urban and Rural Domestic Waste in Hebei Province (amended in 2021)	These Regulations shall apply to the reduction of domestic waste at source, placement, collection, transportation, treatment, resource utilization and their management, service and supervision in the administrative area of Hebei Province. Domestic garbage as referred to in these Regulations refers to solid wastes generated in daily life or activities providing services for daily life, as well as solid wastes regarded as

Acting year	Name of local legislation	Examples of key elements
		domestic garbage under the provisions of laws and administrative regulations.
2022	Notice of the General Office of the People's Government of Hebei Province on the Issuance of the Work Program for the Construction of Zero-Waste Cities in Hebei Province during the "14th Five-Year Plan" Period	To promote solid waste reduction, resource utilization and harmlessness as the main line, coordinate the integration of the system, technology, market, supervision and other elements, build "no waste" new energy, new industry, new tourism and new factories, form a new development pattern of prevention and control of solid waste pollution and environment, give play to the synergistic effect of pollution reduction and carbon reduction, promote the city's green and low-carbon transformation, and serve the high-quality development of economy and society. High-quality economic and social development, to accelerate the construction of a modernized economic powerhouse province, beautiful Hebei to add green heritage.
2024	Hebei Province 2024 Work Program on Resource Utilization of Livestock and Poultry Manure	In order to further promote the use of livestock and poultry manure resources, and continue to strengthen the prevention and control of livestock and poultry waste pollution, boosting the high-quality development of animal husbandry, the development of this program.

Table 7 Selected Regulations on Solid Waste in Jiangsu Province

Acting year	Name of local legislation	Examples of key elements
2009	Regulations on Prevention and Control of Solid Waste Pollution in Jiangsu Province	The Ordinance is a local law enacted in Jiangsu Province to prevent solid waste from polluting the environment, protect public health and promote sustainable economic development. The regulations set out in detail the management requirements for the entire process of solid waste generation, collection, storage, transportation, utilization and disposal, clarifying the generator's responsibility system, reinforcing the special management of hazardous wastes, and promoting the minimization, resourcing and environmentally sound treatment of solid wastes. The regulations also cover penalties for violations to ensure that solid wastes are effectively managed and safely disposed of to reduce their impact on the environment while encouraging the public to participate in and supervise the prevention and control of solid waste pollution, in order to realize the coordinated development of the environment and the economy. Through the implementation of these provisions, Jiangsu Province aims to enhance solid waste management and protect and improve the ecological environment.
2011	Measures for the Management of Kitchen Waste in Jiangsu Province	In order to strengthen the management of kitchen waste, ensure food safety, promote resource recycling, maintenance of urban and rural landscapes and environmental health, according to the relevant laws and regulations, combined with the actual situation in this province, the formulation of these measures.
2017	Jiangsu Province livestock and poultry waste resource utilization work program	Based on local resource endowment, combined with the actual breeding, develop a new type of breeding mode as the focus, to the local close to the fertilizer utilization as the basis, according to local conditions to take different treatment mode, suitable for fertilizer, suitable for gas, suitable for electricity, electricity, comprehensively promote the resource utilization of livestock and poultry breeding waste.
2018	Implementation Program for Urban and Rural Living Waste Management in Jiangsu Province	Accelerate the construction of urban and rural living garbage treatment facilities, strengthen the systematic management of the whole process of urban and rural living garbage, comprehensively enhance the level of harmless treatment and resource utilization of urban and rural living garbage, further improve the quality of the urban and rural living environment and promote the high-quality development of urban and rural construction.
2020	Regulations on Prevention and Control of Water Pollution in Jiangsu Province	The Regulation is a local law enacted in Jiangsu Province to protect and improve the quality of the water environment, prevent and control water pollution, protect public health and promote sustainable economic and social development. The regulation specifies in detail the basic principles of water pollution prevention and control, the responsibilities of the government and relevant departments, water pollutant discharge standards, water environment monitoring and assessment, protection of drinking water sources, control of the total amount of key water pollutant discharges, management of sewage discharge permits, environmental risk prevention and emergency response. It emphasizes the importance of controlling water pollution at the source, specifies specific requirements for water pollution prevention and control in different fields, such as industry, agriculture, and living, and sets strict legal responsibilities for illegal discharges, in order to ensure the safety of the water environment and the sustainable use of water resources in Jiangsu Province. Through the implementation of these regulations, Jiangsu Province aims to strengthen the protection of the water environment, improve the quality of the water environment and maintain the ecological balance.
2022	Work Program for the Construction of	Efforts have been made to solve the current outstanding and difficult problems, such as the large amount of solid waste generated, the inadequate collection and transportation system, the low level of resource utilization, the uneven disposal capacity and the insufficient information-based management tools,

Acting year	Name of local legislation	Examples of key elements
	Zero-Waste Cities in Jiangsu Province	and to implement targeted measures one by one to achieve a breakthrough in key issues and effectively resolve environmental risks.

Table 8 Selected solid waste-related regulations in Zhejiang Province

Acting year	Name of local legislation	Examples of key elements
2009	Regulations on Prevention and Control of Water Pollution in Zhejiang Province	These Regulations shall apply to the prevention and control of pollution of surface water bodies and underground water bodies within the administrative area of the province. The prevention and control of environmental pollution in the sea areas under the jurisdiction of the province shall be governed by the Marine Environmental Protection Law of the People's Republic of China and the Marine Environmental Protection Regulations of Zhejiang Province.
2017	Regulations on Prevention and Control of Solid Waste Pollution in Zhejiang Province	These Regulations shall apply to the prevention and control of environmental pollution by solid wastes and their supervision and management within the administrative area of the province. The prevention and control of pollution of the marine environment by solid wastes and the prevention and control of pollution of the environment by radioactive solid wastes shall not be subject to these Regulations.
2017	Zhejiang Province livestock and poultry breeding waste high-level resource utilization work program	Taking efficient ecological agriculture as the direction of development, insisting on the equal importance of preserving supply and ecology, insisting on government support, enterprise main body, market-oriented operation, in accordance with the idea of source reduction, process control and end utilization, taking biogas, bio-gas, agricultural organic fertilizer and rural energy as the main direction of utilization, further perfecting the system, reinforcing the implementation of the responsibility, perfecting the supporting policies, strictly enforcing the law and supervision and strengthening the scientific and technological support. Continuously deepen the livestock and poultry waste treatment and resource utilization, and further promote the transformation and upgrading of animal husbandry and agricultural green development.
2018	Zhejiang Province rural living garbage management special planning (2024-2027)	This plan is to effectively improve the classification and treatment of rural household waste, the precise classification of the source, the standardization of placement and transportation, the recycling of resources, the standardization of the operation and maintenance of stations, the refinement of sanitation and cleaning, and the reduction, resourcefulness and harmless utilization of rural household waste.
2020	Work Program for the Construction of Zero-Waste Cities in Zhejiang Province	The program promotes the formation of a green development mode and lifestyle and continuously promotes the reduction of waste at source and the utilization of resources, minimizing the amount of landfill, and minimizing the environmental impact of the development model.
2022	Zhejiang Province kitchen waste management measures	In order to strengthen the management of kitchen waste, maintain environmental health, food safety and public health, and promote the recycling of resources, according to the "People's Republic of China Solid Waste Pollution Prevention and Control Law" and "Zhejiang Province, urban amenities and environmental sanitation regulations" and other laws and regulations, combined with the actual situation in this province, the development of this approach.

Table 9 Selected solid waste-related regulations in Anhui Province

Acting year	Name of local legislation	Examples of key elements
2008	Regulations on Prevention and Control of Water Pollution in Huaihe River Basin of Anhui Province	The Regulation is a local regulation of Anhui Province on the water environment problems unique to the Huaihe River Basin, aiming to strengthen the prevention and control of water pollution in the Huaihe River Basin, to protect and improve water quality, to guarantee the safety of the people's drinking water as well as to promote the sustainable development of the economy and society. The regulations set out in detail the management measures for the control of wastewater discharges, water resource protection, ecological restoration, environmental monitoring, and emergency response to pollution accidents in the Huaihe River Basin, clarifying the responsibilities and obligations of the government, enterprises, and the public in the prevention and control of water pollution, and reinforcing the supervision of and penalties for unlawful discharges, in order to ensure the sustainable use of water resources in the Huaihe River Basin and the benign cycle of the aquatic ecosystem. Through the implementation of these regulations, Anhui Province seeks to achieve a sustained improvement in the quality of the water environment in the Huaihe River Basin and to provide a safer and healthier water environment for residents and ecosystems in the basin.
2018	Anhui Province solid waste source control implementation measures	This law and regulation is a local regulation formulated in Anhui Province to strengthen the environmental management of solid wastes, prevent solid wastes from polluting the environment and promote resource conservation and recycling. It clarifies the principles and requirements for the control of solid waste at source, stipulates the measures of reduction, harmlessness and resourcefulness that should be taken by units and individuals generating solid waste, strengthens the special management of hazardous waste, requires the establishment of solid waste management accounts, and regulates the collection, storage, transportation and disposal activities of solid waste. In addition, the measures also emphasize the government's regulatory responsibilities and public participation in supervision and set corresponding legal responsibilities for violations, to reduce the generation of solid wastes and environmental risks through source control and promote the standardization and scientization of solid waste management in Anhui Province.
2018	Anhui Province livestock and poultry waste resource utilization three-year action plan (2018-2020)	Coordinate the promotion of livestock and poultry waste resource utilization work, to market, industrialization as the main line, to the source reduction, process control, end-use as the governance path, efforts to build livestock and poultry waste resource utilization circular economy development new system, the formation of a reasonable layout, planting and raising, agriculture and animal husbandry cycle, the industrial chain of the comprehensive utilization of livestock and poultry manure industrialization of the new pattern, to realize the environment to improve the farmers to increase their income, The win-win goal of industry cultivation.
2022	Regulations on the Management of Classification of Household Garbage in Anhui Province	These regulations shall apply to the classification, placement, collection, transportation, and disposal of household garbage and its supervision and management activities in the administrative area of Anhui Province. The domestic garbage referred to in these regulations refers to solid waste generated in daily life or activities providing services for daily life, as well as wastes that are regarded as domestic garbage as stipulated by laws and administrative regulations.
2024	Action Program for the Construction of "Zero-Waste Cities" in Anhui Province	This program is to accelerate the level of solid waste reduction, resource utilization and harmless disposal, coordinate the construction of the system, technology, market, supervision and other safeguard systems, promote the construction of "no-waste cells", cultivate the "no-waste concept", and help fight the battle of pollution prevention and control. The Government will also promote

Acting year	Name of local legislation	Examples of key elements
		the construction of "Zero-Waste cells" and cultivate the concept of "Zero-Waste" to help fight the battle against pollution.

Table 10 Selected solid waste-related regulations in Guangdong Province

Acting year	Name of local legislation	Examples of key elements
2020	Regulations on Prevention and Control of Water Pollution in Guangdong Province	These Regulations shall apply to the prevention and control of pollution of surface water bodies and underground water bodies such as rivers, lakes, canals, channels and reservoirs within the administrative area of the province.
2021	The 14th Five-Year Plan for Water Ecology Environmental Protection in Guangdong Province	The plan covers the land area of Guangdong Province, with a total area of about 179,800 square kilometers, including seven major water systems: the Xijiang River, the Beijiang River, the Dongjiang River, the Pearl River Delta, the Hanjiang River, the coastal rivers in the eastern part of Guangdong and the coastal rivers in the western part of Guangdong. The base year of the plan is 2020, and the planning period is from 2021 to 2025, and the objectives and requirements for the protection of the water environment are proposed.
2004	Regulations on Prevention and Control of Solid Waste Pollution in Guangdong Province	In order to prevent and control solid waste pollution of the environment, safeguard public health, promote the construction of ecological civilization, and promote sustainable economic and social development, these regulations shall apply to the prevention and control of solid waste pollution of the environment and its supervision and management within the administrative area of the province. Prevention and control of solid waste pollution of the environment, adhering to the priority of protection, the implementation of the principle of reduction, resource utilization, harmlessness, reduce the amount of solid waste generation and hazardous, full and rational use of solid waste and harmless disposal of solid waste, and promote cleaner production and the development of circular economy.
2015	Regulations on the Management of Urban and Rural Domestic Waste in Guangdong Province	These regulations apply to activities such as source reduction, placement, cleaning, collection, transportation, treatment and related management of urban and rural household garbage within the administrative area of the province. Domestic garbage refers to solid wastes generated in daily life or in activities providing services for daily life, as well as solid wastes that are regarded as domestic garbage as stipulated by laws and administrative regulations.
2018	Guidance on strengthening the prevention and control of industrial solid waste pollution	In order to strengthen the prevention and control of industrial solid waste pollution, strengthen the industrial enterprises to regulate the treatment and disposal of solid waste management, resolutely fight the battle of solid waste pollution prevention and control, support the development of the real economy, in accordance with the provincial government's work, is to strengthen the province's industrial solid waste pollution prevention and treatment of the work of the relevant requirements.
2021	The 14th Five-Year Plan for Domestic Waste Disposal in Guangdong Province	Planning to the end of 2025: Harmless treatment capacity: the rate of harmless treatment of domestic waste has reached over 99%; by the end of 2025, the total capacity of harmless treatment of domestic waste will reach over 160,000 tons/day. Resource utilization rate: by the end of 2025, the resource utilization rate of urban domestic waste in the province will be no less than 60%. Incineration capacity: By the end of 2025, the proportion of incineration capacity in the province will reach more than 80%; cities in the Pearl River Delta region will strive to realize "zero landfill" for primary domestic waste; the proportion of incineration capacity for municipal domestic waste in the eastern part of Guangdong, western part of Guangdong, and northern part of Guangdong will reach about 65%, and cities with

Acting year	Name of local legislation	Examples of key elements
		the conditions are encouraged to realize "zero landfill" for primary domestic waste as early as possible. "Zero landfill" Classification of domestic garbage: By 2025, the province's cities above prefecture level and counties with conditions have built a domestic garbage classification and treatment system, the province's domestic garbage classification and collection and transportation capacity basically meets the demand for classification of domestic garbage collection, classification and transfer, and classification and treatment in cities above prefecture level; Guangzhou, Shenzhen, Zhuhai, Foshan, Dongguan, and Zhongshan City have built the integrated system of urban and rural areas with classified treatment of domestic garbage.
2021	Pilot Program for Promoting the Construction of "Zero-Waste Cities" in Guangdong Province	In order to deeply implement Xi Jinping's thought of ecological civilization, promote our province to carry out the pilot construction of "Zero-Waste Cities", explore the construction of the Pearl River Delta Zero-Waste test area, combined with the Shenzhen Municipality to promote the pilot construction of the national "Zero-Waste Cities" experience and the actual situation of the province, to formulate the present work plan. Program. The pilot region includes all cities in the Pearl River Delta (hereinafter referred to as the Zero-Waste pilot region). Municipalities in the eastern part of Guangdong, the western part of Guangdong and the northern part of Guangdong are encouraged to synchronize their pilot work.
2024	Guangdong Provincial Construction Waste Transfer Joint Management Measures	In order to strengthen the supervision and management of construction waste transfer, standardize the province's construction waste disposal activities. These measures apply to the supervision and management of the operation of the joint list of construction waste generation, collection, storage, transportation, utilization and disposal units within the administrative area of the province. The competent Department of Housing and Urban-rural Construction of the People's Government of Guangdong Province shall be responsible for the supervision and management of the operation of the joint list of construction waste transfer in the province.

Table 11 Environmental technical standards for solid waste management

Standard numbe	Standard name	Standard Category
GBJ 4-73	Trial standards for industrial "three wastes" emissions	Solid Waste Pollution Control Standards
GB3552-83	Pollutant Emission Standards for Ships	Solid Waste Pollution Control Standards
GB4280-84	Pollutant Emission Standards for Chromium Salt Industry	Solid Waste Pollution Control Standards
GB4283-84	Pollutant Emission Standards for Yellow Phosphorus Industry	Solid Waste Pollution Control Standards
GB4284-84	Criteria for contaminant control in agricultural sludge	Solid Waste Pollution Control Standards
GB4916-85	Pollutant Emission Standards for the Asphalt Industry	Solid Waste Pollution Control Standards
GB5085-85	Emission Standards for Solid Pollutants in the Nonferrous Metal Industry	Solid Waste Pollution Control Standards
GB5086-85	Non-ferrous metal industrial solid waste leaching toxicity test method standard	Criteria for hazardous waste identification methods
GB5087-85	Standard for corrosive test methods for non-ferrous metal industrial solid wastes	Criteria for hazardous waste identification methods
GB5088-85	Standard for Acute Toxicity Initial Screening Test Methods for Nonferrous Metal Industrial Solid Wastes	Criteria for hazardous waste identification methods
GB8172-87	Agricultural Control Standards for Municipal Waste	Solid Waste Pollution Control Standards
GB8173-87	Criteria for Control of Pollutants in Agricultural Fly Ash	Solid Waste Pollution Control Standards
GB12502-90	Pollution Control Standards for Wastes Containing Cyanide	Solid Waste Pollution Control Standards
GB13015-91	PCB-containing Pollutant Control Standards	Solid Waste Pollution Control Standards
GB15562.2-95	Environmental Protection Graphic Signs Solid waste dumps (landfills)	Other relevant solid waste management standards
GB/T15555.1~12-95	Solid waste Total mercury, copper, zinc, lead and compartments, arsenic, hexavalent chromium, total chromium, nickel, fluoride, corrosivity (leachate determination method)	Criteria for hazardous waste identification methods
GB16487.1~12-96	Environmental control standards for waste imports (provisional): waste bones, smelting slag, wood products waste paper and waste cardboard, waste fabrics waste steel, waste non-ferrous metals, waste motors, waste wires and cables, waste hardware and motors, shipbreaking waste and waste plastics	Other relevant solid waste management standards

Standard numbe	Standard name	Standard Category
GB/T16716-96	Treatment and Utilization of Packaging Waste General Principles	Other relevant solid waste management standards
GB 16889-2008	Pollution Control Standards for Domestic Landfills	Solid Waste Pollution Control Standards
GB 30485—2013	Pollution control standards for cement kiln co-disposal of solid wastes	Solid Waste Pollution Control Standards
GB 39707—2020	Pollution control standards for medical waste treatment and disposal	Solid Waste Pollution Control Standards
GB 18599-2020	Pollution control standards for storage and landfill of general industrial solid wastes	Solid Waste Pollution Control Standards
GB 18484-2020	Pollution control standards for hazardous waste incineration	Solid Waste Pollution Control Standards
HJ1276-2022	Technical specifications for hazardous waste identification marking	Criteria for hazardous waste identification methods
GB 18597—2023	Hazardous Waste Storage Pollution Control Standards	Solid Waste Pollution Control Standards
GB 18485-2014	Pollution control standards for domestic waste incineration	Solid Waste Pollution Control Standards
GB 16889-2024	Pollution Control Standards for Domestic Landfills	Solid Waste Pollution Control Standards
GB18597-2023	Pollution control standards for hazardous waste storage	Solid Waste Pollution Control Standards
HJ 588-2010	Technical Guidelines for Pollution Control of Agricultural Solid Waste	Other relevant solid waste management standards
GB 18598—2019	Hazardous Waste Landfill Pollution Control Standards	Solid Waste Pollution Control Standards
GB 13015—2017	Pollution control standards for PCB-containing wastes	Solid Waste Pollution Control Standards

Table 12 Methodological criteria for the identification of solid and hazardous wastes

Standard number	Standard name	Category
HJ 298—2019	Technical specifications for the identification of hazardous wastes	Criteria for hazardous waste identification methods
GB 34330—2017	Criteria for the Identification of Solid Wastes General	Criteria for hazardous waste identification methods
GB 5085.1—2007	Hazardous Waste Identification Criteria Corrosivity Identification	Criteria for hazardous waste identification methods
GB 5085.2—2007	Hazardous Waste Identification Criteria Acute Toxicity Primary Screening	Criteria for hazardous waste identification methods
GB 5085.3—2007	Hazardous Waste Identification Criteria Leaching Toxicity Identification	Criteria for hazardous waste identification methods
GB 5085.4—2007	Hazardous Waste Identification Criteria Flammability Identification	Criteria for hazardous waste identification methods
GB 5085.5—2007	Hazardous Waste Identification Criteria Reactivity Identification	Criteria for hazardous waste identification methods
GB 5085.6—2007	Hazardous Waste Identification Criteria Toxic Substance Content Identification	Criteria for hazardous waste identification methods
GB 5085.7—2019	Criteria for the Identification of Hazardous Wastes General	Criteria for hazardous waste identification methods

Table 13 Other relevant standards

Standard number	Standard name	Category
HJ 1357—2024	Nomenclature for Environmental Management of Chemical Substances	Other relevant standards
HJ 348—2022	Technical specifications for pollution control in dismantling enterprises of end-of-life motor vehicles	Other relevant standards
HJ 1259—2022	Technical guidelines for the development of hazardous waste management plans and management accounts	Other relevant standards
HJ 1257—2022	Environmental Management of Chemical Substances Chemical Substance Testing Terminology	Other relevant standards
HJ 364—2022	Technical specifications for pollution control of waste plastics	Other relevant standards
HJ 1200-2021	Technical Specification for Application and Issuance of Emission Permit Industrial Solid Waste (Trial)	Other relevant standards
HJ 1229—2021	Technical Guidelines for Screening of Priority Evaluated Chemical Substances	Other relevant standards
HJ 1186—2021	Technical specifications for pollution control of waste lithium-ion power battery treatment (for trial implementation)	Other relevant standards
HJ 519—2020	Technical specification for pollution control of waste lead storage battery treatment	Other relevant standards
HJ 662-2013	Technical specifications for environmental protection of cement kiln co-disposal of solid wastes	Other relevant standards
HJ 2035-2013	Engineering Technical Guidelines for Solid Waste Treatment and Disposal	Other relevant standards
HJ 588-2010	Technical Guidelines for Pollution Control of Agricultural Solid Waste	Other relevant standards
HJ 561-2010	Technical Specification for Performance Testing of Incineration and Disposal Facilities for Hazardous Wastes (including Medical Wastes)	Other relevant standards
HJ 1033-2019	Technical specifications for the application and issuance of sewage licenses Industrial solid and hazardous wastes management	Other relevant standards
HJ 2035-2013	Engineering Technical Guidelines for Solid Waste Treatment and Disposal	Other relevant standards

Table 14 Disposal standards related to kitchen waste

Standard number	Standard name	Category
GB/T 28739-2012	Kitchen Waste Treatment and Utilization Equipment for the Catering Industry	Kitchen waste disposal
GB/T 40133-2021	Technical Requirements for Resource Recovery and Further Processing of Kitchen Waste Oil	Kitchen waste disposal
CJJ 184-2012	Kitchen Waste Disposal Technical Specification	Kitchen waste disposal
DB62/T 4116-2020	Technical regulations for anaerobic digestion of kitchen wastes	Kitchen waste disposal
DB11/T 2018-2022	Technical Specification for Weighing Systems for Food Waste Transportation Vehicles	Kitchen waste disposal
DB62/T 4279-2020	Guidelines for Factory Treatment of Kitchen Waste	Kitchen waste disposal
DB36/T 1694-2022	Technical regulations for intensive breeding of black gadflies on kitchen waste	Kitchen waste disposal

Table 15 Disposal standards related to agricultural and forestry waste

Standard number	Standard name	Category
GB/T 42550-2023	Resource utilization of agricultural waste Disposal and recycling of packaging waste of agricultural production materials	Resource utilization of agricultural waste
GB/T 34805-2023	Agricultural socialization services General requirements for the comprehensive utilization of agricultural waste	Resource utilization of agricultural waste
GB/T 42679-2023	Resource utilization of agricultural waste Comprehensive utilization of biomass resources	Resource utilization of agricultural waste
GB/T 42546-2023	Resource utilization of agricultural waste Recycling of agricultural processing waste	Resource utilization of agricultural waste
GB/T 42681-2023	Circular Economy Performance Evaluation Resource Utilization of Agricultural Waste	Resource utilization of agricultural waste
DB21/T 3419-2021	Agricultural Waste Compost Fertilizer Production Technical Regulations	Resource utilization of agricultural waste
DB62/T 2737-2016	Agricultural waste substrate utilization Cattle (sheep) manure treatment technical regulations	Resource utilization of agricultural waste
DB62/T 2740-2016	Agricultural Waste Substrate Utilization Technical Regulations for Mixing Corn Stover and Cattle Manure Treatment	Resource utilization of agricultural waste

Table 16 National Industry Policy on Construction Waste Disposal

Release time	Publishing department	Policy name	Main Content
February 2023	National Development and Reform Commission and other departments	Guiding Opinions on Integrating Energy Saving, Carbon Reduction and Recycling and Accelerating Product and Equipment Renewal and Upgrading in Key Areas	Promote the use of products and equipment with advanced levels of energy efficiency in green buildings, ultra-low-energy buildings, near-zero-energy buildings and major transportation infrastructure.
December 2023	Central Committee of the Communist Party of China and State Council (CPC)	Opinions on Comprehensively Promoting the Construction of a Beautiful China	Strengthening the management of solid waste and new pollutants. It has accelerated the construction of "waste-free cities" and continued to promote new pollutant control actions, to promote the realization of "waste-free" urban and rural areas and a healthy environment.
February 2024	State Council Office of the People's Republic of China	Opinions on Accelerating the Construction of a Waste Recycling System	Revise the construction waste management regulations and improve the construction waste management system.
March 2024	General Administration of Market Supervision, Central Internet Information Office and other departments	Action Plan for the Implementation of the National Standardization Development Program (2024-2025)	Formulating and revising standards for the resource utilization of construction waste. Accelerate the improvement of green supply chain evaluation standards, such as green procurement, green circulation and green evaluation.
March 2024	General Administration of Market Supervision and other seven departments	Action Program for Upgrading Equipment and Replacement of Consumer Goods by Upgrading Standards	Preparation and revision of evaluation standards for green building materials
March 2024	National Development and Reform Commission, Ministry of Housing and Urban-Rural Development	Work Program to Accelerate the Promotion of Energy Conservation and Carbon Reduction in the Building Sector	Promote energy-saving construction equipment, and coordinate the comprehensive utilization of construction temporary facilities and permanent facilities. Standardize the management of construction sites and promote the classification, treatment and resource utilization of construction waste.

Table 17 Policies related to construction waste disposal industry in some provinces and cities

Release time	Province	Name of policy	Main Content
January 2023	Shanxi Province	Shanxi Province Carbon Peak Implementation Program	Promote the comprehensive utilization of bulk solid waste. Promote the construction of several national demonstration bases for the comprehensive utilization of bulk solid waste. Encourage the use of recycled aggregates and products from construction waste in construction and road projects.
February 2023	Heibei Province	Beautiful Hebei Construction Action Plan (2023-2027)	Promote the comprehensive utilization of bulk industrial solid waste, enhance the level of efficient and high-value utilization of renewable resources, implement the classification and management of domestic waste, strengthen the source reduction and resource utilization of construction waste, and create a characteristic "waste-free" cell project.
February 2023	Shanghai	Shanghai's "Waste-free City" Construction Work Program	Improve the resource utilization system of construction waste. Following the principle of "coordinating in the central city and absorbing in the suburbs", the city will accelerate the optimization and reinforcement of the resource treatment capacity of demolition and renovation wastes of the old port bases and districts such as Pudong, Putuo, Jiading, Jinshan, Chongming, Songjiang, etc. By 2025, the city's resource treatment capacity for demolition and renovation wastes will reach 14.2 million tons/year, and the resource treatment rate will reach about 75%.
June 2023	Beijing, the capital of the People's Republic of China	Beijing's implementation plan for promoting the coordinated development of intelligent construction and new building industrialization	With resource conservation and environmental protection as the core, we will promote the green treatment and recycling of construction waste and improve resource utilization through the coordinated development of intelligent construction and new building industrialization.
March 2023	Shanxi Province	Outline of the Plan for the Construction of Beautiful Shanxi (2023-2035)	Strengthen the comprehensive utilization of solid waste. Comprehensively promote the construction of "zero-waste cities", include industrial solid waste in the management of pollution permits according to law, strengthen source reduction and resource utilization, expand the comprehensive utilization of large-scale industrial solid wastes such as coal gangue, fly ash, tailings, and smelting waste, promote the resource utilization of major agricultural wastes, promote the standardized recycling and treatment of waste electrical and electronic products, promote the classification of domestic waste, accelerate the promotion of new materials such as fully biodegradable plastics, and improve the level of resource utilization of plastic waste. Promote the recycling and treatment of retired solar panels.
April 2024	Zhejiang Province	Zhejiang Province promotes large-scale equipment renewal and consumer	Promote the construction of circular economy standardization pilot projects such as construction waste and battery recycling treatment.

Release time	Province	Name of policy	Main Content
		goods trade-in measures	

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