

# *Research on Legal Safeguards for the Utilization of Wet Garbage as a Resource—a Case Study of Shanghai City*

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**Abstract:** In 2019, Shanghai took the lead in enacting the first local legislation on mandatory classification of domestic waste, known as the “Shanghai Municipal Regulation on Domestic Waste Management.” This legislation has played a crucial role in exploring and practicing waste reduction, resource utilization, and harmless treatment. However, there are still shortcomings in the disposal of wet garbage, including insufficient disposal capacity, immature resource utilization technologies, and overall low level of resource utilization. At the institutional level, there are also issues such as a rigid classification system, lack of targeted institutional design for wet garbage, and inadequate incentives for innovation and promotion of market entities. It is necessary to improve the legal safeguards for the resource utilization of wet garbage by focusing on four aspects: institutional system construction, market system construction, technology system construction, and regulatory system construction.

## **1. Introduction**

Waste classification is an important measure for protecting the ecological environment and improving resource utilization efficiency. In January 2019, Shanghai enacted the first local legislation on mandatory classification of domestic waste, known as the “Shanghai Municipal Regulation on Domestic Waste Management.” It implemented a four-category classification system for recyclables, hazardous waste, dry waste, and wet waste. In recent years, Shanghai has made significant efforts in waste reduction, resource utilization, and harmless treatment of domestic waste, accumulating considerable experience in the resource utilization of wet waste. Now that waste management has passed its initial stages, the next challenge for Shanghai is to continue leading the way in urban management, achieve the three objectives of waste management, and realize a new urban development model of a “zero-waste city.” This article intends to focus on wet waste as the subject of observation, summarizing the current status and shortcomings of its resource utilization, considering the existing institutional conditions and the requirements of building a “zero-waste city,” and proposing improvements and optimizations in the legal safeguards for the resource utilization of wet waste. The aim is to contribute to the future construction and development of Shanghai's urban areas.

## 2. Current Status and Issues of Wet Waste Disposal and Resource Utilization

### 2.1 Insufficient Facilities and Capacity for Wet Waste Disposal

Wet waste disposal can be categorized into centralized and on-site disposal methods. To cope with the increasing volume of wet waste generation, Shanghai has actively promoted the construction and renovation of facilities for wet waste resource utilization and treatment during the “13th Five-Year Plan” period. Regarding centralized treatment facilities, the number of wet waste treatment plants in Shanghai has nearly doubled during this period. Currently, Shanghai is actively advancing the construction of two renewable energy utilization centers in Baoshan and Pudong seaside areas, and the preliminary work has commenced for the planned construction of seven new wet waste treatment facilities. However, there is still a capacity gap in wet waste disposal in the short term<sup>[1]</sup>.

In terms of on-site treatment facilities, efforts are being made to establish wet waste on-site treatment facilities in government institutions, vegetable markets, farmers' markets, shopping malls, supermarkets, and residential communities. However, research indicates that existing on-site wet waste treatment equipment requires high initial investment with low returns, significant daily operational and maintenance expenses, and is unable to achieve a balance between income and expenditure in the short term. Market entities and residential property management companies generally lack motivation in this regard. The development of small-scale, distributed wet waste treatment equipment is progressing slowly, and existing wet waste treatment facilities on the market consume substantial water and electricity resources, generate significant noise, and emit unpleasant odors during operation. Additionally, there are challenges such as inadequate individual processing capacity and difficulty in pollution control among the installed equipment.

### 2.2 Insufficiently Mature Technology for Wet Waste Resource Utilization

Domestic wet waste treatment methods include anaerobic digestion, aerobic fermentation for composting, feed conversion technology, insect farming technology, and dehydration-assisted incineration technology. In Shanghai, anaerobic digestion and aerobic fermentation for composting technologies are widely employed. Anaerobic digestion technology is suitable for large-scale wet waste treatment and can generate biogas as a clean energy source. However, it is susceptible to toxicity inhibition from intermediate metabolic byproducts such as volatile organic acids, resulting in low efficiency and poor gas production. Moreover, the disposal and subsequent treatment of digestate and digestate effluent pose challenges. The products of aerobic fermentation for composting technology can be used in agriculture, gardening, and green spaces as soil amendments to increase organic matter content in infertile soil. However, inconsistent feedstock composition leads to poor quality compost products and limited market outlets, making it difficult for large-scale promotion. Feed conversion technology and insect farming technology are still in the early stages of development, requiring high initial investment, and their process stability has not been verified over the long term. Dehydration-assisted incineration technology does not demonstrate comprehensive resource utilization and only serves wet waste disposal purposes. Overall, even relatively mature anaerobic digestion and aerobic fermentation for composting technologies have some technical limitations.

## **2.3 Overall Low Level of Wet Waste Resource Utilization**

### **2.3.1 Insufficient product form and market channels**

At present, the direction of Shanghai's wet waste treatment and resource utilization is mainly concentrated in biogas production and power generation, resulting in relatively limited product form and marketing channels.

Through research, it has been found that obtaining a fertilizer registration certificate for wet waste digestion is challenging due to factors such as land characteristics and environmental assessments. As a result, the pathway to produce organic fertilizers from wet waste digested materials has not been fully determined, and the market acceptance of recyclable products is relatively low, resulting in a lack of market channels. In addition, the avenues for utilization of wet waste products are relatively limited. Fertilizers produced from wet waste can only be used in industries such as landscaping and greening, and cannot directly enter the food-related production chain, thus narrowing the market. Currently, organic fertilizers that can be purchased through Shanghai's Ecological Compensation Fund do not include products derived from wet waste<sup>[2]</sup>.

### **2.3.2 Lack of Standards for Resource Utilization Products**

There is a lack of long-term supervision and evaluation regarding the safety, stability, and cumulative effects of wet waste resource utilization products. In the absence of safety assessments and relevant regulatory standards for resource utilization products, there are two main issues. Firstly, the products themselves may vary in quality and performance. Secondly, the lack of confidence due to the absence of clear safety standards may lead product users to prefer other products with more explicit safety assurances.

### **2.3.3 Challenges for the Survival and Development of Resource Utilization Enterprises**

Currently, many resource utilization enterprises for wet waste face significant challenges in their survival and development, relying heavily on government funding support and policies. Some resource utilization enterprises struggle to meet the criteria for entry into circular economy industrial parks due to low production value, tax contributions, and inadequate land utilization performance evaluations. Additionally, certain resource utilization enterprises still face significant tax burdens. Although these enterprises are eligible for a simplified 3% value-added tax rate, the lack of value-added tax invoices from some waste collectors results in a relatively high overall tax burden for these companies.

## **3. Current Institutional Conditions and Insufficiencies in the Utilization of Wet Waste Resources**

### **3.1 Rigid Classification System and Lack of Synergistic Effects with Backend Processing Changes**

Shanghai advocates a “four-category” classification system based on “wet waste, dry waste, recyclables, and hazardous waste”<sup>0</sup>. However, when these four categories are placed at the same level of classification, there is a conceptual overlap. “Dry” and “wet” serve as primary classification criteria for waste, while “recyclables” and “hazardous waste” are secondary classifications of “dry waste” based on the criteria of “recyclability” and “hazardousness.” This classification system is not consistent with the classification and disposal standards for waste resource utilization, which hinders waste sorting.

Furthermore, it has been found through research that some waste incineration power generation projects can co-process wet waste. Previously, due to insufficient waste incineration technology, many incinerators were unable to maintain temperatures above 850 degrees Celsius, resulting in the generation of large amounts of harmful gases, making it impossible to co-process wet waste. With improved waste classification and the continuous enhancement of incineration technology and equipment performance, many waste-to-energy projects now generate more than 400 kilowatt-hours of electricity per ton of waste, with furnace temperatures exceeding 1100 degrees Celsius. Co-processing wet and dry waste not only reduces the cost of treating wet waste but also improves environmental benefits. Therefore, with the promotion of waste resource utilization, the “four-category” classification system is no longer synergistic with changes in backend processing. It is necessary to consider new classification criteria at an appropriate time.

### 3.2 Lack of Targeted Institutional Design for Wet Waste

Currently, Shanghai has established a comprehensive institutional chain for the treatment of municipal solid waste, with national legislation and policies as guidelines, local regulations as the main body, local government regulations as support, and various normative documents from departments and district governments as important supplements, forming a complete system of institutional safeguards.

In existing normative documents, most of them provide general provisions on wet waste in a few articles. For example, Article 57 of the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste states that the environmental sanitation authorities of local people's governments at or above the county level are responsible for organizing the resource utilization and harmless treatment of kitchen waste. Units and other producers and operators that generate and collect kitchen waste should hand over the kitchen waste to units with corresponding qualifications for harmless treatment. It is prohibited to feed kitchen waste that has not undergone harmless treatment to livestock and poultry in livestock farms and breeding communities. The Shanghai Municipal Regulations on the Management of Municipal Solid Waste also contain specific provisions in Articles 20, 33, 38, etc., regarding on-site treatment, classification disposal, and the promotion of wet waste resource utilization by relevant government departments. In recent years, Shanghai has paid more attention to wet waste disposal and has issued three normative documents specifically related to wet waste, as shown in Table 1. However, overall, the number of normative documents directly related to wet waste treatment and resource utilization is relatively small, and a complete, specialized, and targeted institutional system has not yet been formed.

Table 1: Shanghai Wet Waste Regulatory Documents

Source	Release Date
Notice from Shanghai Greenery and Urban Administration Bureau and Shanghai Development and Reform Commission Regarding Further Utilization of Price Leverage to Promote Source Reduction of Wet Garbage (Kitchen Waste)	2020
Notice from Shanghai Greenery and Urban Administration Bureau Regarding Relevant Matters to be Considered in the Construction of Local Wet Garbage Treatment Facilities.	2018
Implementation Plan for Subsidy Policy on Construction of Wet Garbage Resource Utilization Facilities during the “14th Five-Year Plan” Period in Shanghai.	2022

### **3.3 There is a Lack of Innovative Measures to Promote and Incentivize Market Entities.**

Currently, the classification and resource utilization of household waste in Shanghai heavily rely on financial subsidies, and a complete industry chain and well-functioning market have yet to be established, including for wet garbage disposal. It is necessary to establish an interconnected and mutually beneficial industry chain from the source of wet garbage to the intermediate and disposal stages, which can generate certain social and economic benefits. In addition to traditional tax incentives and government financial or credit support, there is a need for more effective exploration and innovation at the institutional level to promote and incentivize market entities<sup>[4]</sup>.

## **4. Improvement and Optimization of Legal Safeguards for the Utilization of Wet Garbage Resources**

“A Waste-Free City” is guided by the principles of innovation, coordination, green development, openness, and sharing. It aims to promote a green development approach and lifestyle, continuously reduce the generation of solid waste at the source, promote resource utilization, minimize landfilling, and minimize the environmental impact of solid waste. “A Waste-Free City” focuses on the entire solid waste management system and adopts a macroscopic and systematic approach to waste treatment. Wet garbage should be placed within this holistic system and collaborative concept, closely integrated with the indicators and framework of “A Waste-Free City,” and further improve and optimize the institutional safeguards.

### **4.1 Institutional System Construction**

#### **4.1.1 Establishing and Improving the Regulatory Framework for Wet Waste Disposal**

This primarily involves the formulation and enhancement of local regulations, policies, and relevant planning documents pertaining to wet waste disposal. Considering the local legislative authority of Shanghai, the following specific approaches could be considered: Firstly, consolidating the existing local regulatory documents related to wet waste disposal and compiling them into a unified and specialized document specifically focused on “wet waste.” Secondly, revising the “Shanghai Municipal Solid Waste Management Regulations” to include a dedicated chapter that regulates the disposal and resource utilization of wet waste<sup>[5]</sup>.

#### **4.1.2 Centralize the Existing Wet Waste Disposal Measures with “Synergy” as the Core Principle.**

Synergy between wet waste and other types of household waste disposal: The traditional approach to solid waste management has focused on waste classification. The “Solid Waste Pollution Prevention and Control Law of the People's Republic of China” has dedicated chapters for industrial solid waste, household waste, construction waste, agricultural solid waste, and hazardous waste, each with specific regulations based on their composition, physical, and chemical characteristics, and corresponding disposal methods. However, as waste management technologies have advanced, there has been a trend of synergistic disposal of multiple types of solid waste. For example, the “Beijing Municipal Solid Waste Management Regulations” explicitly include construction waste within its scope of application. Guangzhou incorporates home renovation waste, green waste, animal carcasses, and feces into its household waste management scope. Shenzhen and Chongqing utilize the concept of “solid waste treated as household waste” in their municipal solid waste management regulations. It is evident that strict adherence to rigid boundaries between waste categories is unnecessary. According to Article 4, Section 2 of the “Shanghai Municipal Solid Waste

Management Regulations,” “The specific classification standards for household waste can be adjusted based on the level of economic and social development, the characteristics of household waste, and the needs of disposal and utilization.” This provision allows for institutional flexibility in the synergistic disposal of wet waste and other household waste. The overall adjustment approach is to separate recyclable and hazardous waste, and the rest can be treated through incineration. Please refer to Figure 1 for a specific roadmap.

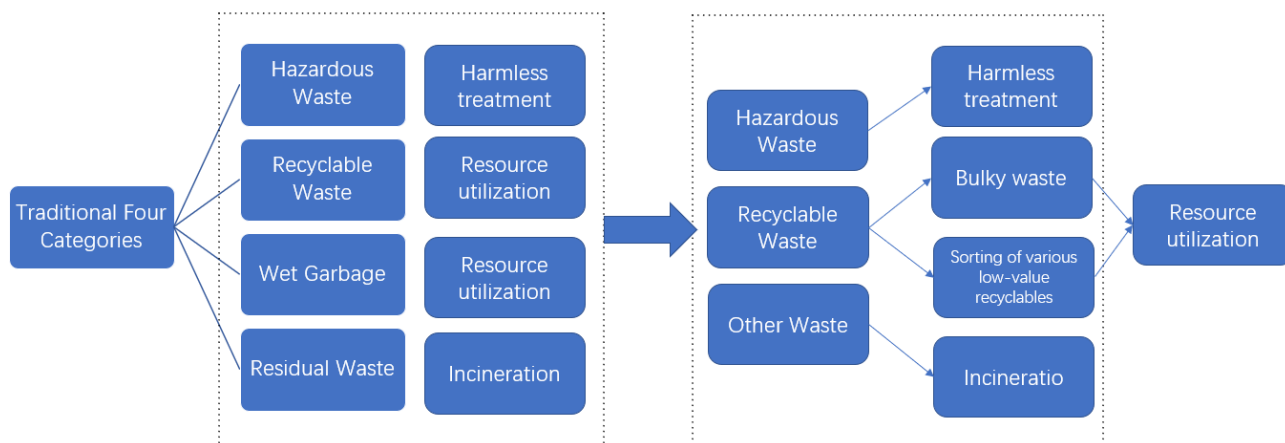


Figure 1: Roadmap for Adjusting Waste Classification and Resource Utilization

Secondly, there should be coordinated actions among the stakeholders involved in wet waste management. Encouraging and promoting collaboration and resource sharing between wet waste resource utilization facilities and nearby municipal solid waste incineration power generation projects, as well as construction waste resource utilization projects, is essential. Integration should occur within the larger industrial park system, encompassing the flow of energy, materials, and information. This integration would enable steam sharing, biogas utilization, joint treatment of wastewater and waste residue, and comprehensive sharing of management and information data throughout the entire clean production process.

Thirdly, there should be regional collaboration in the Yangtze River Delta for resource utilization. Firstly, the Yangtze River Delta can achieve cascading utilization of wet waste between regions. Due to the poor stability of the anaerobic digestion by-products, such as sludge and digestate, they are not suitable for direct use as organic fertilizers in agriculture. By assessing the biological stability of these by-products and exploring multiple avenues for on-site or off-site utilization, such as in landscaping, flowerpot substrates, etc., an effective and circular wet waste treatment chain can be established. Secondly, it is necessary to promptly study and establish a cooperative mechanism for resource utilization industries in the Yangtze River Delta. This mechanism should focus on areas such as recycling systems, industrial bases, standard systems, utilization compensation, and policy coordination. The aim is to establish a normalized and long-term cooperative mechanism to ensure the stable disposal and utilization of environmentally friendly treatment and recyclable materials within the region, including the disposal of waste products that cannot be recycled within the city or are not suitable for recycling.

#### 4.1.3 Enhancing Government Coordination Mechanisms

Article 5 of the “Shanghai Municipal Household Waste Management Regulations” stipulates that the municipal people’s government should strengthen its leadership in managing household waste in the city and establish a comprehensive coordination mechanism for household waste management

to coordinate and oversee the management work. It further specifies the responsibilities of each department and requires them to implement the regulations in a coordinated manner according to their respective duties. Article 6 designates the district people's government as responsible for household waste management within their jurisdiction and establishes corresponding comprehensive coordination mechanisms. It also clarifies the specific responsibilities of district functional departments, township governments, and neighborhood offices. Building upon existing experience, it is necessary to continue advancing and deepening this coordination mechanism. Additionally, intergovernmental coordination mechanisms are needed for regional collaboration in the Yangtze River Delta, and exploration should be undertaken to establish and improve such mechanisms between regional governments.

## **4.2 Market System Construction**

### **4.2.1 Innovative Government Financial Regulation Measures**

In addition to continuing to enhance the role of traditional fiscal regulation measures, including increasing government investment, implementing tax exemptions, and actively utilizing government procurement projects, there is also a need for exploration and innovation. In accordance with the principles of “district-based approach, appropriate support from the municipal level, and encouraging pilot initiatives,” the implementation plan for the “14th Five-Year Plan” subsidy policy for the construction of wet waste resource utilization facilities in Shanghai adopts a reward mechanism linked to the progress of the projects, providing designated subsidies based on different stages of construction to support the accelerated development of wet waste resource utilization facilities in each district.

Furthermore, product policy support should be introduced to facilitate the integration of the industrial chain and encourage the application of products in areas such as landscaping, greening, and forestry planting. Efforts should be made to break down industry barriers, support the development of the resource utilization industry chain, improve the comprehensive waste classification system, accelerate the cultivation of leading recycling enterprises, optimize the layout of recyclable resource utilization industries, and establish an interconnected platform for recycling resources and end-stage resource utilization enterprises. Encouraging the introduction of relevant policies for the use of wet waste fertilizer products in soil improvement projects in the city, and expanding the scope of fertilizer product utilization.

### **4.2.2 Actively Utilizing Financial Regulation Measures**

We will actively use green loans to support energy conservation and environmental protection industries, clean production industries, clean energy industries, ecological and environmental industries, green upgrading of infrastructure, and green services. In addition, the issuance of green bonds is encouraged to support qualified green industries, green projects or green economic activities according to specified conditions.

### **4.2.3 Establishing Enterprise Credit Evaluation Mechanism**

Currently, Shanghai has proposed the innovative establishment of a dynamic and updated “white list” protection system for resource recycling enterprises. For enterprises included in the “white list,” their stable operation and development are ensured, and support is provided for their transformation and upgrading efforts.

## **4.3 Technological System Construction**

### **4.3.1 Improving Standards for the Utilization of Wet Garbage Resources**

First, establish a system for security evaluation of resource-using products. At present, Shanghai has established a relatively comprehensive security evaluation procedure and method in the country by publishing the local "security evaluation measures for organic fertilizer evaluation materials (kitchen waste) (test)".

We will promote the two companies that have obtained the soil conditioner registration certificate to apply for the safety assessment of organic fertilizer products, and will issue the organic fertilizer registration certificate as soon as possible, so as to provide effective scientific research and data support for the application and promotion of more same types of technologies.

Second, the specific evaluation and certification criteria for agricultural fertilizers derived from wet waste are refined and clarified, strengthening guidance on raw material quality control, production process, product quality and other aspects, and assisting more companies in OB.

### **4.3.2 Promoting r&d and Commercialization of Key Technologies, Processes, and Equipment for Wet Garbage Resource Utilization**

First, the key technical level of wet waste treatment and utilization has been significantly improved. It is necessary to guide the research and application of new processes, technologies, materials, and equipment in the wet garbage treatment and utilization industry, establish a repository of key technological equipment for wet garbage treatment and utilization, and continuously expand the utilization and application scope of new equipment, accelerating research on high-value utilization of biogas residue and new biotransformation technologies such as "black soldier fly" to deal with wet waste.

The second is to smooth the way out of the product. It is important to explore the use of wet garbage resource utilization products in coastal soil improvement and high-standard farmland construction, pilot the industrialization model of centralized disposal for agricultural use of wet garbage resource utilization, promote the widespread application of wet garbage resource utilization products, and establish a complete industry chain for wet garbage resource treatment.

Third, there is a need to gradually establish distribution channels for the products. Additionally, it is important to explore the promotion and application of soil conditioners and organic fertilizer products in agriculture, forestry, green areas, and other suitable fields.

## **4.4 Establishment of Regulatory Systems**

### **4.4.1 Enhancing Information-Based Regulation**

Information technology is the trend and will empower precise monitoring in urban management. Efforts should be made to establish and improve an information-based regulatory service system that covers general industrial solid waste, hazardous waste, construction waste, agricultural solid waste, and municipal solid waste management data. By integrating relevant data from ecological environment, housing and urban-rural development, agriculture and rural areas, health and sanitation departments, the system aims to achieve comprehensive information-based traceability of relevant processes. It promotes the construction of solid waste management information systems in cities and breaks down the information barriers among multiple departments involved in solid waste management<sup>[6]</sup>.



#### 4.4.2 Timely Resolution of Wet Waste-Related Petitions, Complaints, and Reports

We need to promote relevant departments to do a good job in wet garbage related letters, complaints and report cases.

First, we need to smooth the channels of letters and visits, ensure that all kinds of complaint hotlines and 24-hour duty work system, and through the WeChat reporting platform and other channels to accept the public complaints, to ensure that the complaints are timely accepted.

The second is to ensure timely and effective handling of accepted cases.

### 5. Conclusion

The complexity of wet waste composition determines that it is difficult to achieve efficient and high-value processing and utilization using a single existing treatment technology. Relying on long-term government subsidies for development is also not sustainable. Considering the current status of wet waste treatment and development, the development trend lies in the comprehensive application of multiple treatment and utilization technologies, achieving synergistic treatment of wet waste and other household waste, and promoting regional collaboration in the Yangtze River Delta. It is necessary to accelerate the elimination of outdated equipment and outdated processes in wet waste treatment facilities, and effectively address issues related to the daily operation, on-site management, and space reservation of on-site wet waste treatment facilities.

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