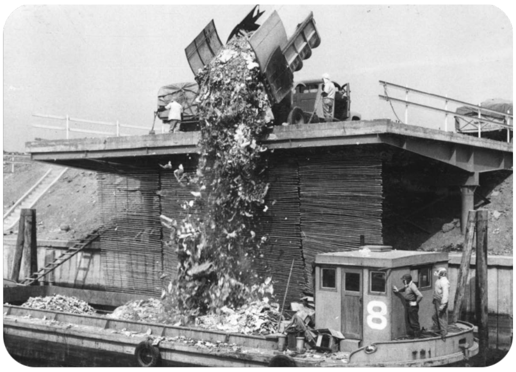
Japan International Cooperation Agency

Japan's Experiences on Waste Management



March 2022

Yachiyo Engineering Co., Ltd.
Japan Environmental Sanitation Center

GE
JR
23-046

Cover Photos

Upper left:	Suginami Incineration Plant (Tokyo Metropolitan Government Bureau of Environment)
Upper right:	Separate Discharge of Recyclables in Omorideragou Town in 1977 (Tokyo Metropolitan Government Bureau of Environment)
Bottom left:	Municipal Waste Collection around 1957 (Tokyo Metropolitan Government Bureau of Environment)
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Preface

Proper management of waste generated from the economic and social activities is essential for maintaining people's health and a hygienic living environment, and its importance has been recently reconsidered in response to the global spread of COVID-19. In addition, the realization of a sound material-cycle society through the 3Rs (reduce, recycle, reuse), contributes to solving global environmental problems such as reduction of greenhouse gas emissions and conservation of natural resources through reduction of marine plastic waste and efficient use of resources. However, in many developing countries, the amount of waste is rapidly increasing and its compositions are becoming more complex due to population growth, urbanization, and changes in consumer behavior. There are substantial number of cases in which prioritizing economic growth has resulted in environmental pollution and health hazards.

In Japan as well, inappropriate waste management has led to the deterioration of public health since the period of rapid economic growth, resulting in the occurrence of social problems such as "Pollution" and the "War on Waste." However, administrative organizations such as local governments and ministries have taken the lead in overcoming various problems step by step, in cooperation with various stakeholders, especially the civil society and private companies. The experience and knowledge accumulated in the process of establishing the current comprehensive waste management system can provide useful insights for developing countries that are now facing the same waste problems as what Japan experienced in the past.

In July 2021, the Japan International Cooperation Agency (JICA) launched the "JICA Clean City Initiative" as part of its Global Agenda, a business strategy to comprehensively improve urban sanitation. One of the pillars of the initiative is "improving waste management and realizing a sound material-cycle society." These efforts also contribute to the achievement of Goal 11 "Sustainable Cities and Communities" and Goal 12 "Responsible Consumption and Production" of the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015.

In this study, while walking through the historical background and the socioeconomic conditions in Japan, we have summarized the policy measures and technology which was introduced in the past to improve waste management and extracted lessons that may be useful in solving current issues in developing countries. Furthermore, the characteristics of waste challenges faced by developing countries, success factors, and lessons learned were also analyzed, based on JICA's own experience of cooperation in the field of waste management. With the results of these surveys, this text was created with the intention of it being used by people in various positions, including administrative personnel in developing countries, those involved in waste management, students majoring in environmental management, and those involved in international cooperation.

In compiling this survey, we invited Mr. Hidetoshi Kitawaki, Professor of Faculty of Global and Regional Studies, Toyo University, and Mr. Hideto Yuda, Chairman of the Japan Education Center of Environmental Sanitation, as advisors, and asked Mr. Mitsuo Yoshida and Mr. Shiro Amano, senior advisor of Global Environment Department of JICA, as supervisory committee members. With the cooperation of waste professionals in Japan and overseas, we collected data, visited sites, conducted interviews, and reviewed series of studies. We would like to express our sincere gratitude to all those who cooperated in this study.

We hope that this text and the video materials which we have prepared will help solve waste management problems in developing countries.

March, 2022

Director General, Global Environment Department

Japan International Cooperation Agency

Eiji Iwasaki

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Japan’s Experiences on Waste Management: Overview

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1 Introduction

This training material is intended to effectively utilize the knowledge, technology, and lessons accumulated in Japan’s history of improving waste management and building a sound material-cycle society in developing countries facing various challenges related to waste management.

This section firstly provides an overview of waste management as targeted by the Sustainable Development Goals (SDGs) and Japan’s experience, in light of Goals 11 and 12 of the SDGs, and then explains how this material can be used.

The next section reviews the history of waste management in Japan and outlines the various measures taken by Japan to establish its current waste management system from the perspectives of “planning”, “legislation”, “policy”, and “technology” in Topics 1 through 4. Topics 5 through 7 introduce the themes and trends that are increasingly posing challenges to the waste management sector, the efforts of the Japanese municipalities to overcome these challenges, and case studies of international cooperation projects provided by Japan to developing countries.

Each Topic

Topic 1：Waste Management Facts and Plans
Topic 2：Legislation and Government Policy Pertaining to Waste
Topic 3：Administrative Organization and Finance
Topic 4：Waste Management Technologies
Topic 5：Modern Trend of Waste Management
Topic 6：Efforts of the Municipalities in Japan
Topic 7：Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects

2 Waste Management as Targeted by the SDGs and Japan's Experience

The Sustainable Development Goals (hereinafter "SDGs") are international goals set forth in the "2030 Agenda for Sustainable Development" adopted at the United Nations Summit in September 2015. The SDGs consist of 17 goals and 169 targets to achieve a sustainable and better society by 2030. The SDGs are universal, regardless of whether they are being addressed in developing or developed countries, and the goal is to ensure that no one on earth is left behind in the process of implementation. The goals and targets of the SDGs aim to achieve integrated improvements in sustainable development in three dimensions: environmental, economic, and social.

Goal 11 of the SDGs is to "Make cities and human settlements inclusive, safe, resilient and sustainable" and Target 11.6 of that goal is set as: "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". In Japan, each local government is responsible for waste management in its area of jurisdiction as part of its administrative responsibilities to maintain a sanitary living environment. The financial resources for waste management are covered by taxes, waste services fees collected from waste generators, or subsidies from the central government.

Waste management in a region operates on the basis of the understanding of waste generators and residents on the importance of waste management. In particular, the waste collection service is a familiar point of contact between the administration and residents, and is provided to all residents living in the area of jurisdiction of the local government. Although many of these services are outsourced to the private sector, the local government manages the quality of the waste collection work and the collection and transport private companies. High quality waste collection services are provided to the residents by establishing a waste collection system based on consensus making and respect of the opinions of the individual residents and the community. In response, residents have established a relationship of trust by adhering to the prescribed waste separation methods, discharge times and locations, etc. Through such mutual efforts between the local government and residents, a sanitary living environment is maintained.

Regarding Goal 12 of SDGs "Ensure sustainable consumption and production patterns," Target 12.4 of this goal is set as follows: "By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment". In Japan, administrative efforts have been made to reduce environmental pollution and environmental impact throughout the product life cycle through Extended Producer Responsibility (EPR), and monitoring illegal dumping, mainly to ensure that industrial waste-generating business operators are aware of their responsibilities and held accountable. In addition, through research and development of incineration and landfill technologies, treatment and disposal methods that reduce environmental burden have been actively introduced.

SDGs' Target 12.5 states that "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse". In connection with this target, Japan has been vigorously promoting efforts toward sustainable production and consumption.

In the process of achieving rapid economic growth, economic and social activities characterized by mass-production and mass-consumption a mass-waste society emerged, and the frequent occurrence of illegal dumping and the shortage of landfill sites became serious issues. In response to these issues, from the late 1990s to the early 2000s, various laws were enacted to promote the formation of a sound material-cycle society, the 3Rs (reduce, reuse, recycle), heat recovery, and development of appropriate treatment and disposal methods. As a result, the amount of waste generation per capita has decreased from 1.185 kg/person/day in FY[1]2000 to 0.918 kg/person/day in FY 2019. Additionally, the recycling rate reached approximately 20% in FY 2007, up from approximately 14% in FY 2000, and has remained at the same level since then.

Thus, the Japanese experience in waste management is considered to contain many useful suggestions for achieving the SDGs in developing countries.

[1] In Japan, Fiscal Year (FY) starts from April and ends in March. For example, FY 2019 means from April 2019 to March 2020.

3 Purpose and Utilization of the Training Material

(1) Purpose of the Training Material

Japan has a history of facing and overcoming various difficulties before establishing its current waste management system.

Waste management in Japan began as a public health measure, and has continued to evolve over a long period of time into the current waste management, while meeting the demands of each time period against the backdrop of the social conditions of that period, such as the preservation of the living environment and the establishment of a sound material-cycle society. In recent years, Japan has been working on waste management with the aim of making further progress toward the promotion of a sound material-cycle society and the establishment of a low-carbon society.

Furthermore, in order to achieve the goals of the SDGs, Japan is actively working on various issues both in the domestic and international arenas, including the 3R Initiative and the Osaka Blue Ocean Vision. In Africa, Japan is working to build proper waste management throughout the continent, including the establishment and operation of the “African Clean Cities Platform” in collaboration with relevant organizations to promote knowledge sharing for improved waste management.

This training material not only introduces the actual state of waste management in Japan, but also explains the history and experiences that Japan has accumulated. The training material will also present how Japan tried to solve the problems the waste management sector confronted in each period and what measures were taken.

For many developing countries currently facing problems similar to those experienced by Japan in the past, Japan's experience, knowledge, and lessons learned are expected to provide them with useful suggestions. Obviously as circumstances differ from country to country and region to region, the same measures taken in Japan may not necessarily be the best solution for other countries. The purpose of this training material is to be used as a guideline for developing countries to consider how to tackle and solve the waste problems in their countries, based on the lessons learned from Japan's experience.

(2) Utilization of this Training Material

In order to provide a comprehensive study of the history of waste management in Japan to serve as reference to developing countries, the seven Topics listed below are included in this training material.

Each Topic begins with an overview of relevant and important findings, technologies, lessons learned, etc., followed by an explanation of specific experiences and approaches, as well as basic information. Columns are also included to introduce case studies and technologies that may be useful to developing countries.

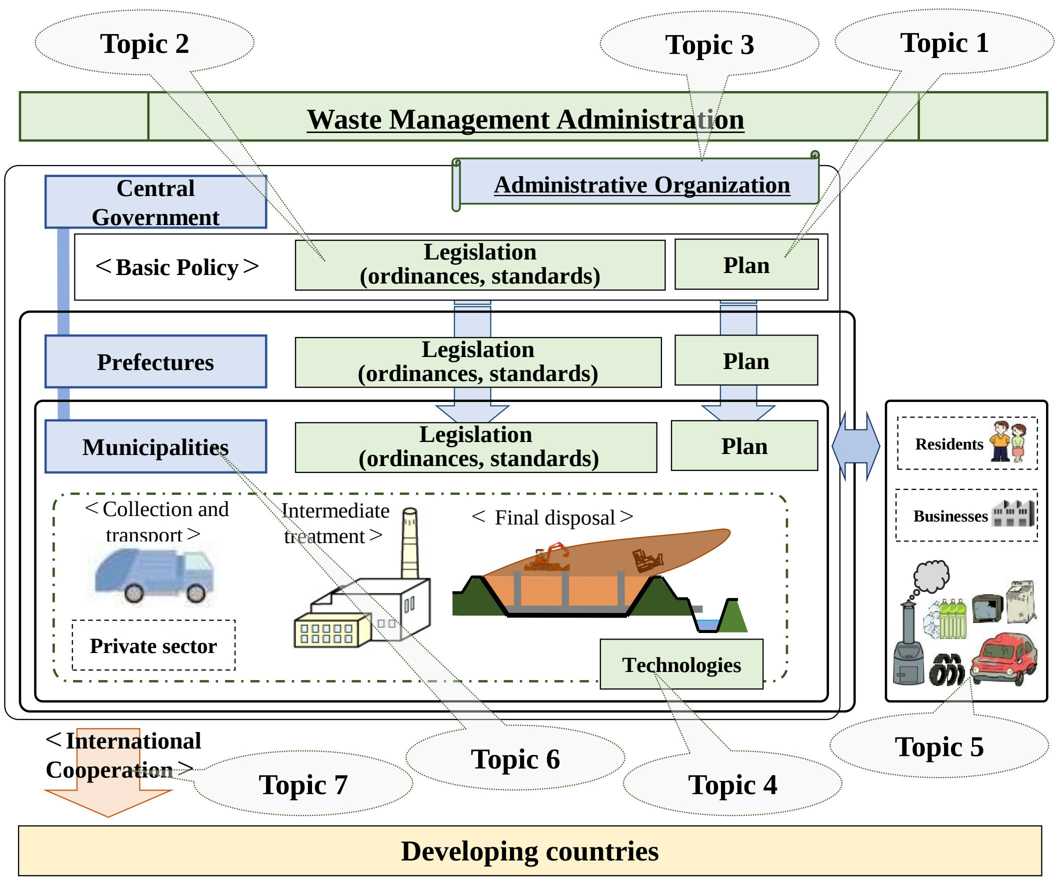


Figure 1　Schematic Diagram of Topics Introduced in the Training Material

Important Points for each Topic

Topic1 : Waste Management Facts and Plans

To learn the importance of having an accurate understanding of the actual status of waste management and planning based on quantitative data

Topic 2 : Legislation and Government Policy Pertaining to Waste

To learn approaches and efforts to improve the legal systems in developing countries

Topic 3 : Administrative Organization and Finance

To learn about waste management systems and roles/ responsibilities, and measures that contribute to securing financial resources

Topic 4 : Waste Management Technologies

To learn about the characteristics and utilization of various technologies related to waste collection and transport, intermediate treatment, and final disposal

Topic 5 : Modern Trend of Waste Management

To learn the efforts, issues and important points regarding responses and measures for key waste management themes

Topic 6 : Efforts of the Municipalities in Japan

To learn about the efforts and experiences of Japanese local governments

Topic 7 : Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects

To learn about Japanese experiences and technologies applied in JICA projects and the lessons learned from each project

Items covered in the training videos are marked with the icon  .

4 Waste Management Facts and Plans (Topic 1)

This Topic introduces the actual status of waste management in Japan and the various plans that have been formulated, and teaches the importance of understanding the actual status of waste management and formulating plans based on quantitative data. In order to quantitatively grasp the actual status of waste management represented by the waste management flow from discharge to recycling and final disposal, the relevant data is collected and accumulated every year, and various plans are discussed based on the data analysis results. Numerical targets in the plans will be considered and set based on reliable data and with clear definitions.

(1) Present Status of Waste Management in Japan

1) Definition and Categorization of Waste

The *Waste Management and Public Cleansing Law* (*Waste Management Act*) of Japan defines waste, which is unwanted matter in a solid or liquid state (excluding gases), and earth and sand are outside the scope of the *Waste Management Act*. Categories of waste in Japan is shown in Figure 2.

Note that this text generally deals with municipal waste. Additionally, the term “waste” is used to mean municipal waste unless otherwise specified. However, the term may include industrial waste when policies, laws, hazardous waste, dioxin-related problems, and the like are discussed in the relevant text.

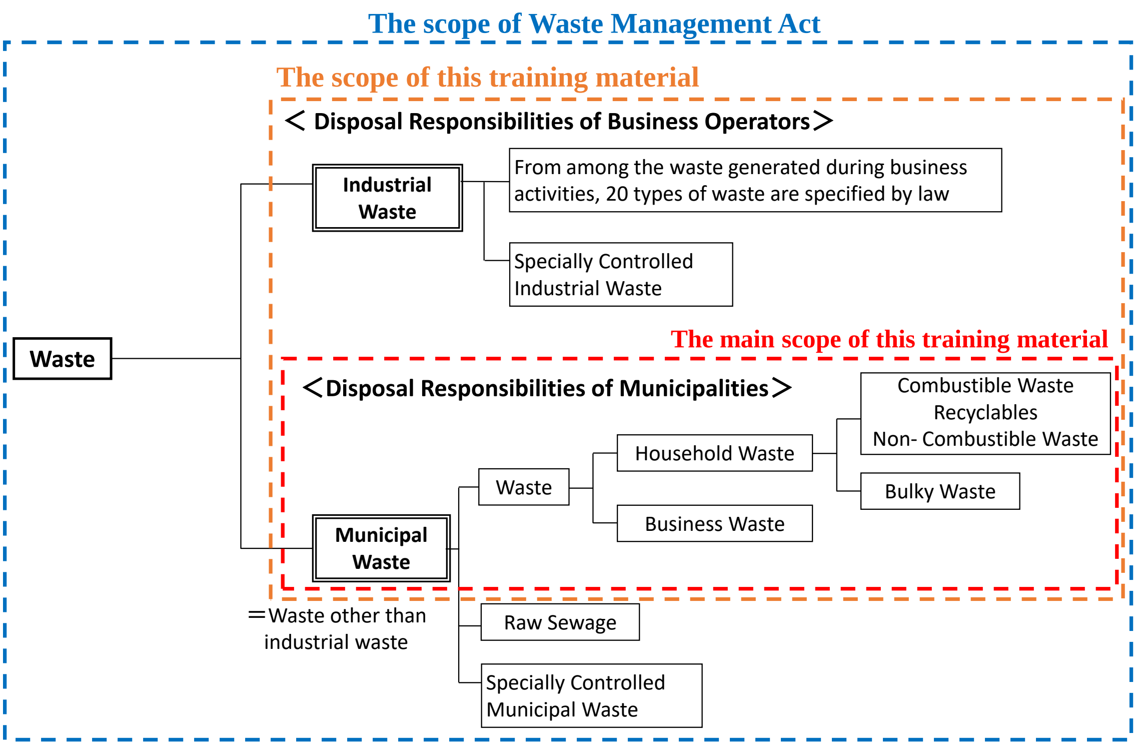


Figure 2 Categories of Waste in Japan

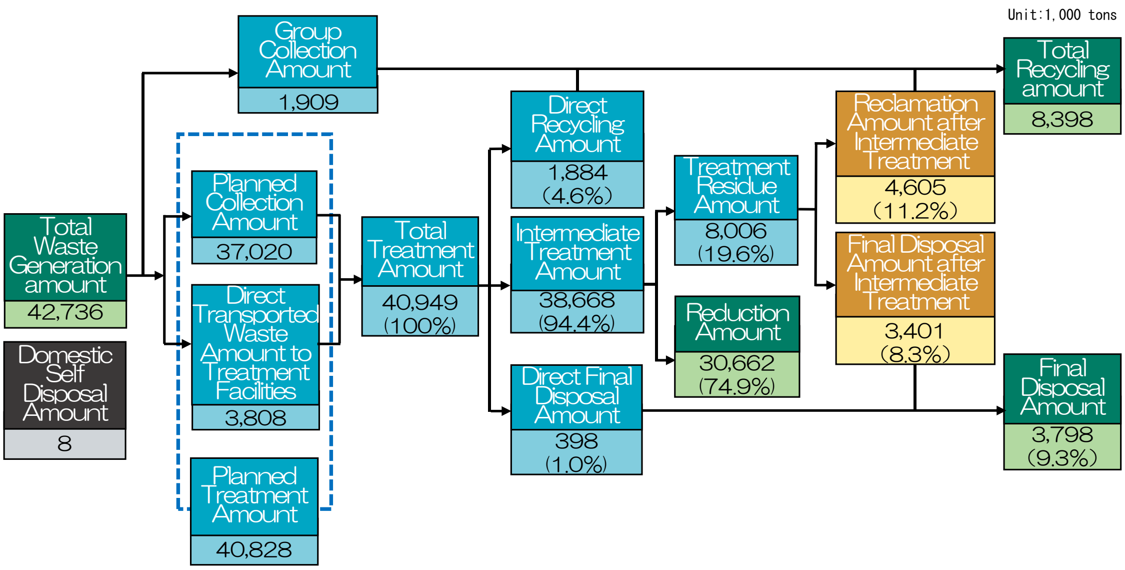
2) Waste Management Conditions

(a) Waste Generation Amount

During Japan's period of high economic growth (1960s and 1970s), factors such as rising incomes and changes in consumer behavior drove the development of an economic structure based on mass production and mass consumption, causing both municipal and industrial waste to rapidly increase and diversify. Later, during the bubble era[2] (late 1980s and early 1990s), the amount of waste increased swiftly as consumption and production activities expanded further. However, the total amount of waste generated and the unit generation rate per person per day have trended downward since 2000, in part due to the efforts to develop a sound material-cycle society. Accordingly, the total amount of waste generated is also changing in response to social and economic changes.

(b) Waste Management Flow

The Ministry of the Environment and municipalities regularly prepare waste management flows that visualize the path waste travels from discharge to recycling and final disposal. This waste management flow makes it possible to develop an appropriate understanding of the relationships between amounts of waste at the different stages of treatment, recycling, and disposal, which is useful for understanding the status of waste and formulating plans.



Source : Ministry of the Environment Website "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 3 Waste Management Flow in Japan (FY 2019)

[2]The bubble era refers to the economic boom in Japan, especially in the late 1980s and very early 1990s, when asset prices soared. The name is derived from the way asset prices expanded like a bubble and burst under certain circumstances.

(2) Waste Collection and Transport/ Intermediate Treatment/ Final Disposal

Discharged waste is collected using collection vehicles, which transport the waste to treatment plants or transfer facilities. Collection vehicles are commonly referred to as “packers” in Japan.

Collected waste is transported to intermediate treatment plants. There are many types of intermediate treatment plants for different wastes; examples include incineration plants, bulky waste treatment plants, and composting plants.

In FY 2019, the total treated waste amount[3] was 40.95 million tons, of which 32.94 million tons, or roughly 80%, underwent incineration treatment (direct incineration amount).

Recycling is the recapture and reuse of resources that have been discarded (here, recycling means material recycling, in which materials are reused as raw materials, and does not include thermal recycling[4], in which thermal energy is recovered and utilized). In Japan, the recycling rate is defined as the percentage the total recycled waste amount (Direct recycling amount + Group collection amount[5] + Recovery amount after intermediate treatment) of the total treated waste amount (Total treatment amount + Group collection amount).

Source: Ministry of the Environment “Solid Waste Management and Recycling Technology of Japan” (2013)

Photo 1 Waste Collection by Compactor

Source: Yachiyo Engineering Co., Ltd.

Photo 2 Funabashi North Incineration Plant

$$\text{Recycling Rate (\%)} = \frac{\text{Direct Recycling Amount} + \text{Group Collection Amount} + \text{Recovery Amount after Intermediate Treatment}}{\text{Total Treatment Amount} + \text{Group Collection Amount}} \times 100$$

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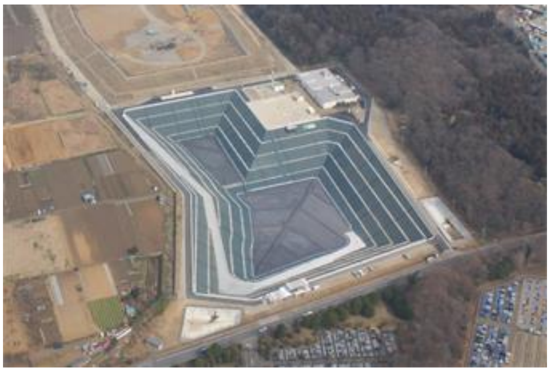
[3] Total treatment amount = Intermediate treatment amount + Direct final disposal amount + Direct recycling amount

[4] In the EU, the concept of energy recovery is used to distinguish it from thermal recycling, and recovery of thermal energy is not included in recycling.

[5] All the Group collection waste is considered to be thoroughly sorted at source and composed only of recyclables.

"Final disposal" means that waste is ultimately disposed into landfill sites at the last stage of the waste management flow. The final disposal amount is the sum of the amount of waste sent directly to final disposal without intermediate treatment (direct final disposal amount) and the amount of waste sent to final disposal after intermediate treatment (final disposal amount after intermediate treatment).

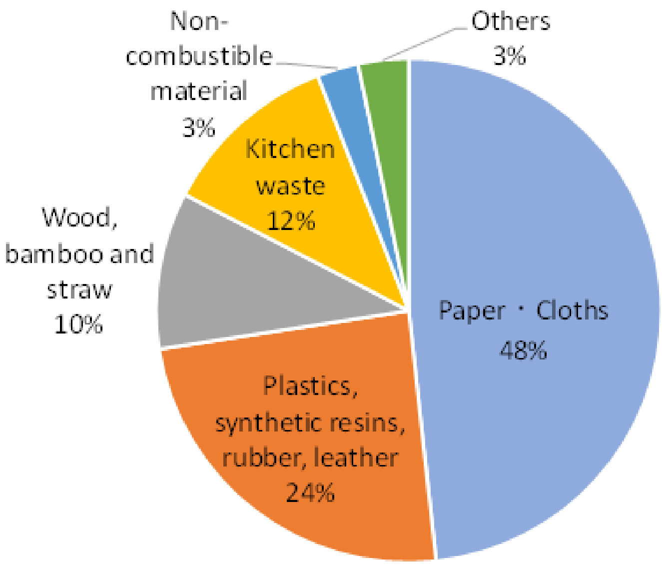


Source: Sagamihara City "Landfill site for municipal waste in Sagamihara City" (2019)

Photo 3 Landfill of Sagamihara City

(3) Waste Composition

Understanding the waste composition incoming to intermediate treatment facilities and final disposal facilities is essential for considering recycling methods and feasibility of introducing incineration facilities, as well as for determining of facility specifications. In particular, obtaining the values of moisture content, ash content, and combustible content (these are called the three components of waste) leads to knowing the combustibility of the waste. Knowing the unit volume capacity is also important for the remaining life of the landfill site and designing the waste pit of the facility.



Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 25, 2022)

Figure 4 Result of Waste Composition (Dry Weight Base) (2019)

(4) Waste Management Plans

1) Management of Waste-Related Data

In Japan, the Ministry of the Environment publishes the results of an annual survey on the state of municipal waste management. Since the 1970s the Ministry of the Environment has been conducting a survey in the form of a questionnaire to municipalities and associations for the purpose of obtaining basic data on municipal waste administration. The central government then collects and accumulates the data from municipalities to build a nationwide database, which is characteristic of data management in Japan.

The survey items are broadly divided between the conditions of facility operation and the conditions of treatment. The data obtained is aggregated by municipalities in each prefecture, and the statistical tables are available to the public. This data fulfills an important role in examining and setting specific priority targets, achievement indicators, and other criteria when formulating plans for waste management.

In the course of carrying out waste management, municipalities continuously collect a variety of data and use it to formulate policies and plans for the future.

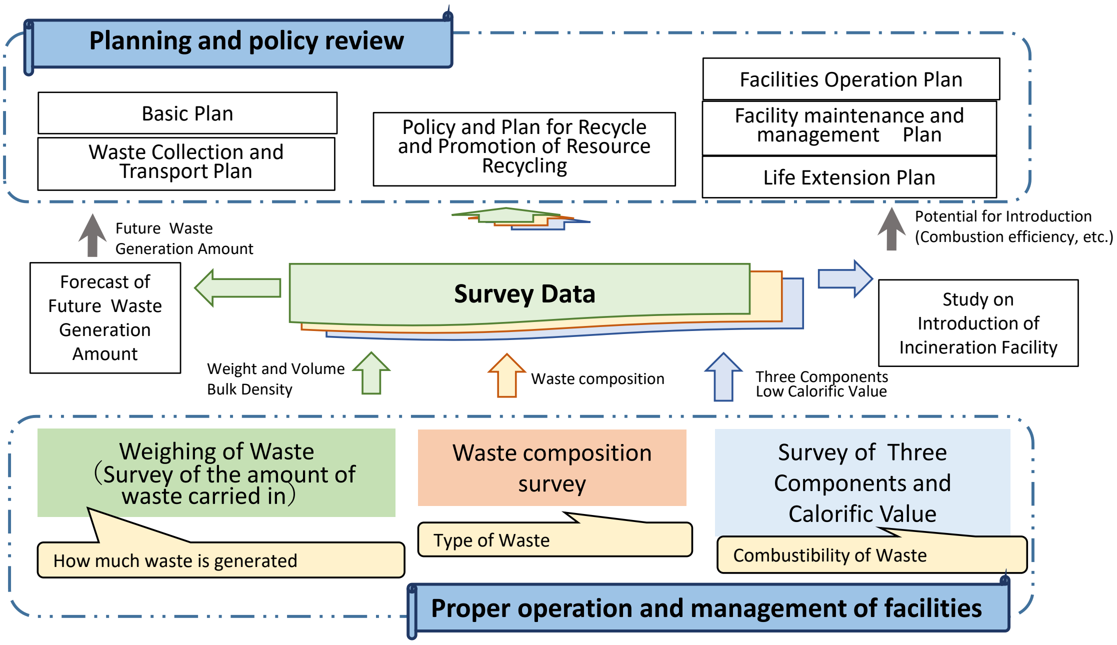


Figure 5 Examples of Utilization of Waste Survey Data

2) National-Level and Municipality Level Waste Management Plans

Plans and facility development for waste management at the national and municipal levels are shown in Table 1.

Table 1 Waste Management Plans

Level	Plan	Description
National-level waste management plans	Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society	The plan was established to comprehensively and systematically promote measures for forming a sound material-cycle society based on the *Basic Act on Establishing a Sound Material-Cycle Society*.
	Waste Management Facility Development Plan	The plan defines the targets and outline of the waste management facility development project for the planning period, based on the *Waste Management Act*.
Plan for waste management at the municipality level	Municipal Waste Management Plan	Based on the *Waste Management Act*, the municipality establishes a plan for municipal waste disposal in the area of the municipality in order to properly dispose of general waste while preserving the living environment and improving public health, which are the objectives of the Act.
	Municipal Separate Collection Plan	Set by municipalities for implementing separate collection of waste containers and packaging based on the *Containers and Packaging Recycling Act* and the *Plastic Resource Recycling Promotion Act*.
	Inter-Municipal Waste Treatment Plan	The prefecture and the municipalities in its jurisdiction collaborate to formulate an inter-municipal waste treatment and consolidation plan.
Plan for the development of waste-related facilities	Technical guidelines for environmental impact assessment	Based on the *Environmental Impact Assessment Act* and the *Waste Management Act*, technical guidelines for environmental impact assessment to ensure that environmental impact assessment and post-implementation studies of waste treatment facilities are properly conducted based on scientific knowledge.
	Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities)	The purpose of this plan is to extend the service life of waste treatment facilities by introducing the concept of stock management, proper daily operation and management, appropriate annual inspections and maintenance, and plan for periodic renewal of major facilities and equipment.

5 Legislation and Government Policy pertaining to Waste (Topic 2)

This Topic introduces how legislation and policies have been developed to respond to various waste management issues - such as improvement of public health, preserving living environments, and establishing a sound material-cycle society - arising from economic growth, industrialization, urbanization, and changing lifestyles in the process of building a modern society.

The efforts and approaches to systematically develop the basic laws, laws for individual issues and plans at the national and municipal levels in response to changes in social conditions, are introduced here. These can be useful as references for the development of legal systems in developing countries.

(1) History of Waste Management in Japan

Since the late 19th century, the social environment in Japan has changed as modernization progresses, and residents' lifestyles and living environments have changed accordingly. Although Japan has successfully created a highly convenient society, it has also confronted many waste management-related issues from one era to the next. "Waste management" is also referred to as "waste treatment" in the law, and the two are synonymous.

Table 2 Changes in the Social Situation in Japan and Issues and Legislation related to Waste Management

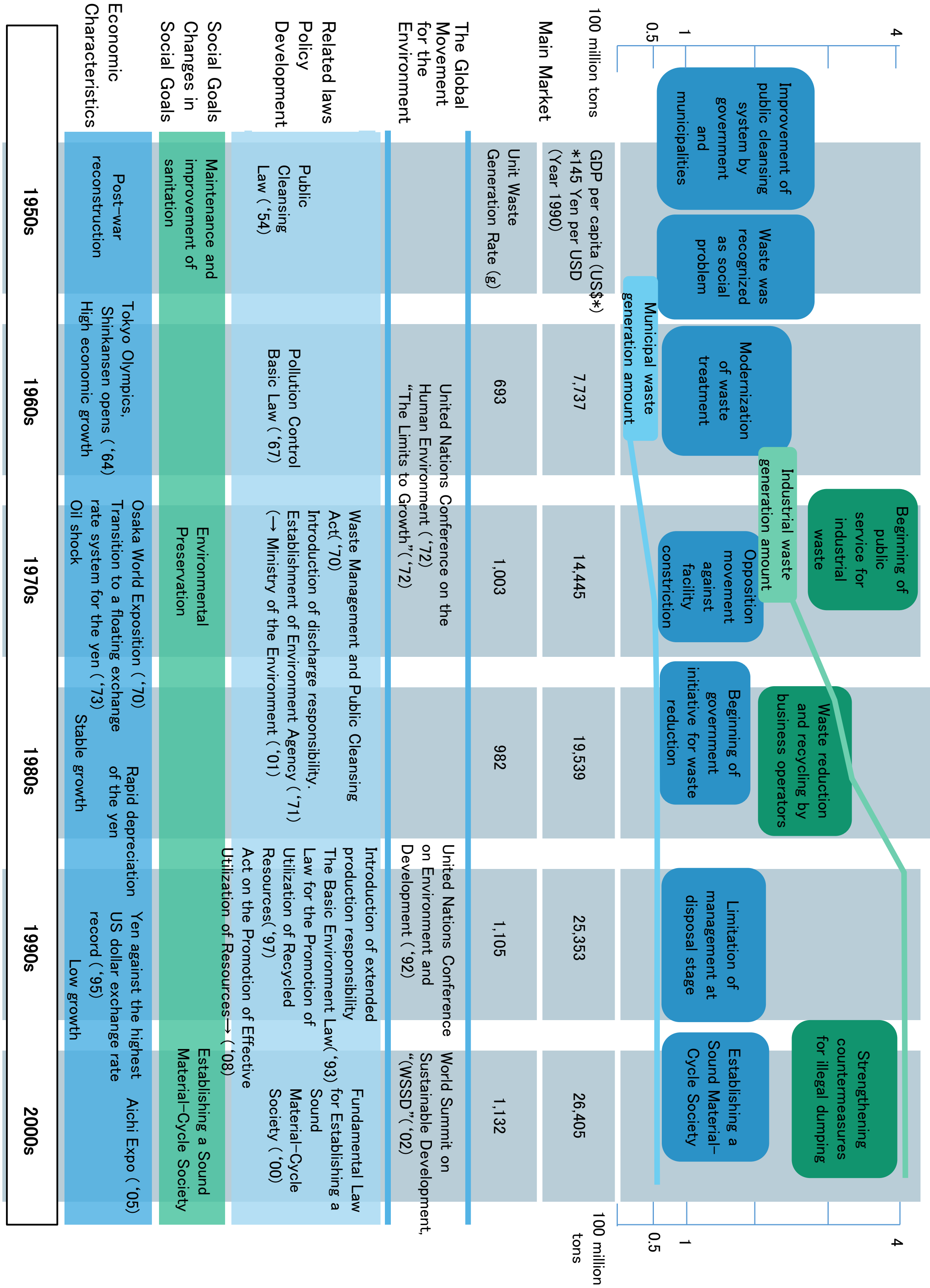
Period	Major Issues	Laws Enacted
Post-war period to the 1950s	• Waste management for environmental sanitation • Maintenance of a healthy and comfortable living environment	• Public Cleansing Act (1954)
1960s to 1970s	• Increase in the amount of industrial waste and emergence of pollution problems as a result of rapid economic growth • Waste management for environmental protection	• Act on Emergency Measures concerning the Development of Living Environment Facilities (1963) • Waste Management Act (1970) • Revision of the Waste Management Act (1976)
1980s	• Promotion of the development of waste management facilities • Environmental protection required for waste management	• Wide-area Coastal Environment Development Center Act (1981) • Private Sewerage System Act (Johkasoh Law) (1983)
1990s	• Waste generation control and recycling • Establishment of various recycling systems • Management of hazardous substances (including dioxins) • Introduction of a proper waste management system to cope with diversification in the type and nature of waste	• Revision of the Waste Management Act (1991) • Act to Promote the Development of Specified Facilities for the Disposal of Industrial Waste (1992) • Japanese Basel Act (1992) • Basic Environment Law (1993) • Containers and Packaging Recycling Law (1995) • Revision of the Waste Management Act (1997) • Home Appliance Recycling Law (1998) • Law Concerning Special Measures against Dioxins (1999)
2000-	• Promotion of 3R measures aimed at the establishment of a sound material-cycle society • Enhancement of industrial waste management • Enhancement of illegal dumping regulations	• Basic Act for Establishing a Sound Material-Cycle Society (2000) • Construction Material Recycling Law (2000) • Food Waste Recycling Law (2000) • Revision of the Waste Management Act (2000) • Act on Special Measures concerning Promotion of Proper Treatment of PCB Wastes (2001) • End-of-life Vehicle Recycling Act (2002) • Act on Special Measures concerning Removal of Environmental Problems Caused by Specified Industrial Wastes (2003) • Revision of the Waste Management Act (2003 to 2006, 2010) • Small Home Appliance Recycling Act (2013) • Revision of the Waste Management Act (2015, 2017, 2020) • Plastic Resource Recycling Promotion Act (2022)

Public health improvement

Pollution problems and living environment protection

Establishment of a sound material-cycle society

Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2017)



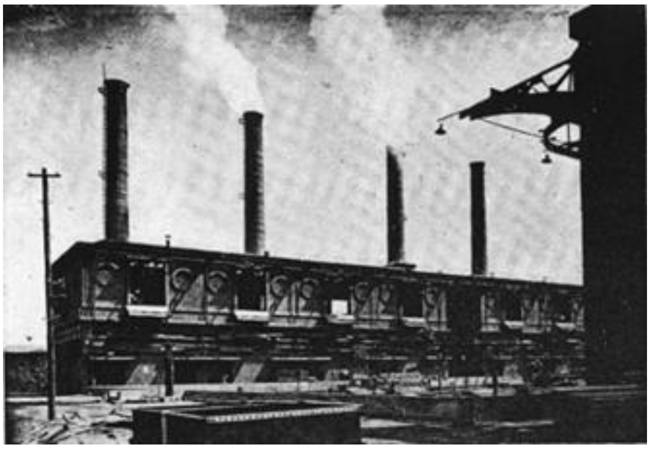
Source: Based on the Ministry of the Environment "Japan's Experience in Promotion of the 3Rs" (2005)

Figure 6 History of Waste Management in Japan

(2) Legislation Pertaining to Waste Management

1) Changes in Legislation Pertaining to Waste Management

The first law pertaining to waste was the *Waste Cleaning Act* (1900). In light of the subsequent worsening of public health problems caused by the rapid increase in municipal waste associated with postwar economic development and increasing urban population density, the *Public Cleansing Act* was enacted in 1954 for the purpose of improving public health, and the *Waste Cleaning Act* was repealed.



Source: Tokyo Metropolitan Archives

Photo 4 Fukagawa Incineration Plant – Technology of the Time did not Provide Adequate Exhaust Gas Treatment (Completed in 1933)

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 5 Transport Vehicle that were Often Used-circa 1961

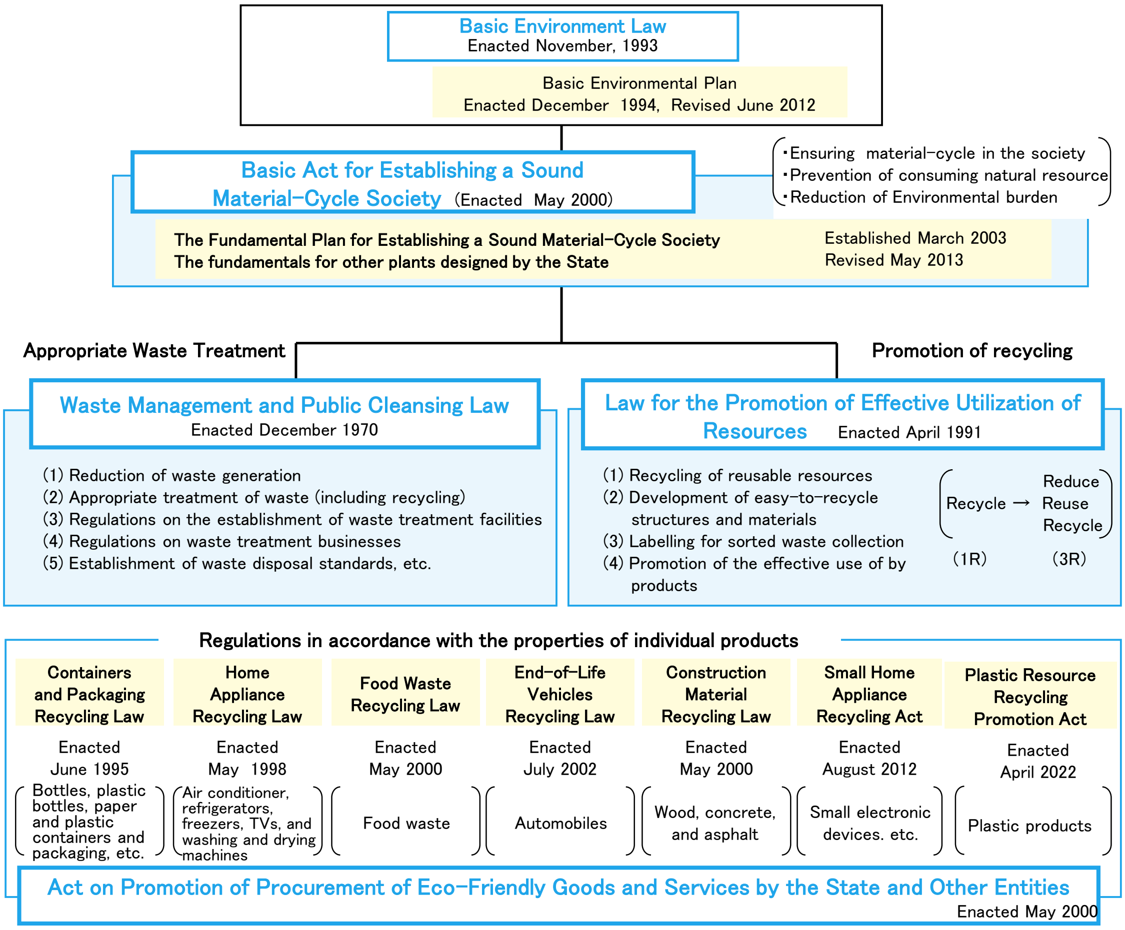
As Japan entered its period of high economic growth in the 1960s, the further increase and diversification of municipal waste, pollution caused by hazardous waste, and other social problems prompted the 1970 repeal of the *Public Cleansing Act* and concurrent enactment of the *Waste Management Act*. This concurrent act details requirements to conserve living environments in addition to improving public health as stated in the former *Public Cleansing Act*.

In the 1970s, the social structure based on mass production, mass consumption, and mass disposal continued to progress as Japan sought greater material wealth. Consequently, the amount of waste generated continued to increase and the remaining capacity of landfill site was shortened. These and other problems made it necessary to concentrate efforts toward radical solutions. Given that the focus of policy had shifted to reducing amounts of waste generated and recycling, the *Waste Management Act* was amended. Furthermore, the *Basic Act for Establishing a Sound Material-Cycle Society* and other laws on recycling were enacted in due order, and a shift toward forming a sound material-cycle society was promoted.

2) Legal Structure to Waste Management

The legal laws and regulations pertaining to waste management was established to support the formation of a sound material-cycle society, and comprises the *Basic Act for Establishing a Sound Material-Cycle Society* - which sets out the basic philosophies and approaches to forming a sound material-cycle society based on the *Basic Environment Law*, which sets out the core elements of environmental policies - and the individual laws that embody the acts.

Many laws have been established toward the formulation of a sound material-cycle society. The *Waste Management Act* aims to preserve living environments and improve public health through efforts such as waste minimization and proper treatment of waste. The *Law for the Promotion of Effective Utilization of Resources* (the *Effective Resource Utilization Promotion Act*) aims to ensure the effective utilization of resources, reduce the generation of waste, and conserve the environment. The seven laws on recycling were enacted to correspond to the properties of individual items. The *Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities* (the *Act on Promoting Green Purchasing*) aims to establish a society capable of sustainable development by having public agencies take the lead in promoting the procurement of products and services that help reduce environmental impact.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 7　Legal Framework for a Sound Material-Cycle Society

(3)　Policies Pertaining to Waste Management

In Japan, the Ministry of the Environment has taken the lead in adopting important measures to respond to issues such as proper waste treatment, pollution control and efficient waste management.

Table 3　Policies Pertaining to Waste Management

Policies	Description
Standards and Guidelines for Proper Waste Treatment	The Ministry of the Environment has established technical standards and guidelines for waste treatment plants, landfill sites, and other facilities in line with the related laws in order to respond to pollution problems, implement proper waste treatment, and achieve other goals. Japan has made efforts to resolve those problems using technical methods with technical and financial support from the Ministry of the Environment.
Thermal Recovery	The utilization of energy from incineration power generation is promoted because of the enhanced caloric content of waste associated with changes in lifestyles, and the improvement in power generation efficiency brought about by technical innovations.
Pollution Countermeasures (for Dioxins, etc.)	When pollution and other problem that threaten human life and health occur, the necessary laws are established and comprehensive countermeasures are implemented through technical and regulatory methods based on the results of the experts' investigations.
Inter-municipal Waste Disposal	Against a backdrop that includes the need to secure a certain scale of treatment capacity to promote efficient and proper waste treatment, dioxins countermeasures, and waste power generation, Japan has promoted inter-municipal waste disposal as a national policy, and has achieved a certain degree of success.
3R Promotion	In order to reduce consumption of natural resources and minimize waste, Japan has long engaged in efforts related to the 3Rs, including reducing waste, reusing unwanted articles, sorting recyclables, and group collection (voluntary resource collection systems run by local residents and others). Furthermore, amid a growing awareness of the importance of establishing a society capable of sustainable development, efforts toward establishing a sound material-cycle society have been promoted, namely through the enactment of the *Basic Act for Establishing a Sound Material-Cycle Society* in 2000.

6 Administrative Organization and Finance (Topic 3)

This Topic explains an overview of the administrative structure centered on the central government, the roles and responsibilities of each entity involved in waste management, including local governments, private companies, and residents, as well as the financial structure.

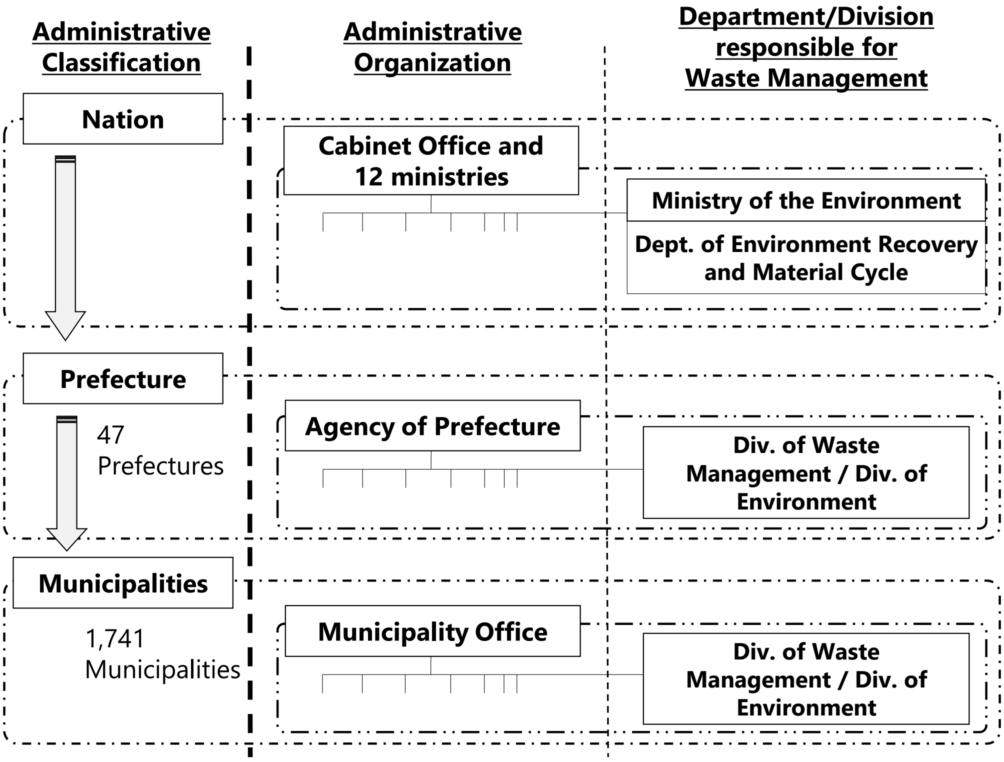
For proper waste management, it is important to establish a system that systematically covers the entire country based on administrative classifications such as central, prefectural, and municipal governments, and to ensure that each entity involved is aware of its roles and responsibilities. This Topic also provides an overview of the system of subsidies to local governments and fee collection based on the principle of responsibility of waste-generating business operators, and introduces measures which may be referred to by developing countries in their efforts to secure financial resources for their waste management.

(1) Government Organizations Involved in Waste Management

1) The Structure of Government Organizations

Under the central government of Japan there are 47 geographic administrative areas referred to as prefectures, major cities and districts. Within these prefectures there are different types of municipalities and special cities, and each of the prefectures, cities, towns, villages and special cities have their own administrative organization. These are the local governments responsible for administration within their administrative areas. (Special cities and municipalities number 1,741 (2020), of which 23 are special cities, 792 cities, 743 towns, and 183 villages).

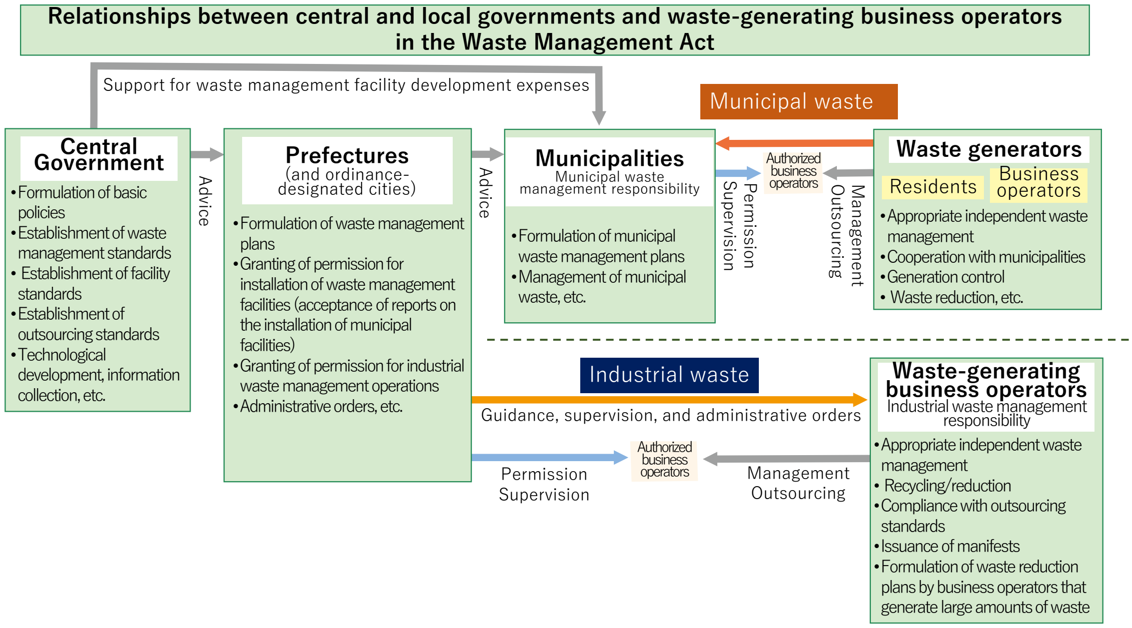
Japanese government agencies are made up of the Cabinet Office and 12 government ministries, of which the Ministry of the Environment is responsible for central management of the waste management system. Divisions have been set up in many prefectures and municipalities (in this text municipalities include special wards) to manage waste, and the respective responsibilities of the various levels of government agencies are determined by law.



Note: The 1,741 municipalities include cities designated by government ordinance that are at the prefectural level.

Figure 8 Waste Management System in Japan

The main waste management responsibilities of the central government, prefectures, and municipalities, together with the responsibilities of waste-generating business operators and individuals generating waste are shown in below. In addition to the responsible government agencies, both business operators and citizens generating waste also have roles to fulfill in waste management from their respective positions.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 9 Division of Waste Management Responsibilities amongst Various Entities

2) Government Waste Management Services

Under the *Waste Management Act* municipalities are designated as the management entities for municipal waste operations. Thus, waste management is one of the important services municipalities must provide for citizens within the administrative area under their jurisdiction.

In addition to waste collection and the various work processes leading to final disposal, municipalities are also responsible for public awareness directed to citizens. Many municipalities have a specialized division dealing with waste management, but in the case of collection, transport and managing the operation of facilities, some municipalities do this work directly and some by outsourcing part of it to the private sector.

Also, some municipalities with relatively low populations join with other nearby municipalities and set up joint waste management (referred to hereafter as "Clean Association"). Thus, specialized associations are set up to provide government waste management services so that the municipalities can carry out their responsibility to provide waste management in an efficient way. These Clean Associations provide the government waste management services for all the administrative areas under the jurisdictions of the member municipalities. The parts of the work done directly by each municipality differs depending on each municipality's population size and area characteristics, however each municipality is responsible for the overall waste management under its jurisdiction.

3) Waste Management through Outsourcing and Collaboration with the Private Sector

In many municipalities in Japan, the government administrators outsource part of the waste management service to the private sector for which the government is responsible for, such as the collection and transport of waste or the operation of facilities.

Municipalities must set up fairly large organizations within their administrations to provide citizens directly with waste management government services, and they have to ensure the necessary personnel and budget to do the work. They also need to secure and implement budgets on an ongoing basis for the operation and maintenance of equipment and facilities. For these reasons, in order to supply services for waste collection and transport efficiently and economically, many municipalities outsource waste collection and transport services to private sector collection and transport businesses. Many municipalities outsource the operation and management of their own waste treatment facilities (incineration facilities, recycling facilities, etc.) and final disposal sites to the private sector in order to ensure stable operation and management by highly skilled engineers.

4) Residents Participation and Consensus Building

Proper waste treatment depends on the cooperation of residents in properly sorting and discharging waste. Each municipality clarifies the roles of residents, business operators, and the government in its ordinances and basic plans, and stipulates what each of them should respectively do.

When constructing waste treatment plants or landfill sites, it is essential to consider residents living near the planned locations of the plants and sites. Opposition from local residents or environmental groups could arise if sufficient consideration and explanation are not given to them, hindering the progress of projects. In order to establish proper waste management systems, it is important for residents, business operators, and governments to understand their respective roles, and for the three parties to work together as one.

(2) Waste Management Utilizing the Private Sector with Private Finance Initiative (PFI)

PFI (Private Finance Initiative) is one way of implementing public works, such as constructing facilities and their operation and management, using private sector finance and technical knowhow.

Special Purpose Companies (SPCs) are companies established to carry out one particular PFI project. SPCs use their earning power from the project as collateral to gain financing, using a funding method known as project finance, and they carry out the project by financing part of the construction and other costs by loans from financial organizations. Also, SPCs are compensated for the services they provide, being paid for construction funding and management costs by local governments.

(3) Finances Concerning Waste Management

In FY 2019, the total expenditure was JPY 2,319.4 billion, comprising waste management expenses of about JPY 2,088.5 billion and human waste management expenses of about JPY 230.8 billion.

Concerning the revenues breakdown for waste management in the municipalities of Japan in FY 2019, the costs of waste management were covered by revenue of about JPY 1,383.3 billion (about 66% of the total revenue) which came from general finances, with other sources contributing 5-15% each including fee income contributing JPY 272.5 billion (13%). Concerning the expenditure breakdown, the operation and maintenance costs for intermediate treatment was about JPY 680 billion , taking up the largest share (33%), followed by the operation and maintenance cost for collection and transport of about JPY 600 billion (29%) and the facilities construction and improvement cost of JPY 415 billion (20%).

The major portion of waste management costs, 66% is covered by general finances, and waste treatment facility improvement costs, which requires large funds, are financed by grants or subsidies and local government bonds

Grant Program for Establishing a Sound Material-Cycle Society

The Grant Program for Establishing a Sound Material-Cycle Society is essential to municipalities improving waste treatment facilities in their districts. Improvement of waste treatment facilities are large projects that municipalities implement only every few decades and temporarily pose a huge financial burden on them. As such projects are important for the formation of a sound material-cycle society, the central government has created this grant program to provide not only technological support but also financial support necessary for such facility development.

Fee Collection Methods by Local Governments and Fee Bearing by Residents and Business Operators

While water supply service adopts the independent accounting system of consumption as the principal financial revenue in the form of “water charges” collected from residents, in the case of municipal waste management service the expenses are covered by taxes (such as resident taxes) as principal financial revenues.

With the aim of promoting the reduction of waste generation and reuse, the government examined how waste should be managed by municipalities to create a sound material-cycle society. In 2010, The “Basic Policy for the Comprehensive and Systematic Promotion of Measures for the Reduction and Other Appropriate Disposal of Waste” was revised. This basic policy identified that the roles of municipalities should be to “promote charging fees for municipal waste management, in order to minimize waste and promote recycling by utilizing economic incentives, to advance fairness of burden sharing in proportion to generated-waste amounts, and to build residents’ awareness”. In response to this basic policy, each municipality is either already charging fees for waste management services, or considering to do so.

In line with the principle of “extended producer responsibility”, the *Containers and Packaging Recycling Law* has established a mechanism that obliges business operators to bear recycling-related expenses for waste containers and packaging. As it is difficult for municipalities to conduct proper treatment or to recycle large and heavy home appliances, the *Home Appliance Recycling Law* provides a mechanism by which waste-generators bear waste collection and transport fees as well as recycling fees when discharging their own home appliances. Regarding automobiles, the *End-of-Life Vehicle Recycling Law* provides a mechanism by which, in general, automobile owners should bear recycling fees when purchasing their own automobiles.

Table 4 shows laws and regulations providing for expense sharing mechanisms.

Table 4 Expense Sharing Mechanisms by Laws and Regulations and their Expected Impacts

Law and regulations / Targeted products	Financial revenues secured (Use of financial revenue)	Expense bearers	Expected impacts
Containers and Packaging Recycling Law / Containers and Packaging	Outsourcing Fees for collection, transport and recycling (recycling and merchandising) of containers and packaging	Designated business operators (retailers, manufacturers, etc.)	Reduction of waste, life extension of landfill site, promoting of recycling
Home Appliance Recycling Law / Four Items of Home appliances	Fees for collection, transport and recycling of Home Appliances	Waste-generators of used home appliances	Reduction of illegal dumping of used home appliances, reduction of waste, life extension of landfill site, promotion of recycling
End-of-Life Vehicle Recycling Law / End-of-life vehicles	Recycling fees for end-of-life vehicles	Vehicle owners	Reduction of illegal dumping of end-of-life vehicles, reduction of wastes, life extension of landfill site, promotion of recycling
Waste discharged from household	Forming part of financial revenue for waste management (used for public awareness building, etc.)	Residents	Reduction of wastes, life extension of landfill site, ensuring fairness of expense sharing, raising residents’ awareness, building awareness and technology capacities of business operators, securing part of financial resource necessary for waste management

7 Waste Management Technologies (Topic 4)

This Topic provides an overview of the various technologies for collection and transport, intermediate treatment, and final disposal, as well as the evolution of these technologies. In developing countries it is important to select and appropriately apply technologies that meet the conditions of the target region, and satisfy the demands for efficient collection and transport, appropriate waste treatment, and sanitary landfill disposal. Therefore, in addition to introducing the characteristics of each technology, this Topic also discusses effective utilization methods and key points in operation and maintenance.

(1) Waste Discharge, Collection and Transport

1) Collection Methods

Storage and Discharge of Waste

Waste is generated every day from each household and it is important to collect the waste generated effectively and efficiently to secure the sanitary condition of each household and its surrounding area. For this reason, in principle, it is important for residents to collect the waste that is generated in each household, and store the waste inside the house until it is time to discharge it to the designated location at the specified time according to the predetermined collection plan.

Source: Yachiyo Engineering Co., Ltd.
Photo 6 Station Collection

Door-to-door Collection and Station Collection

Waste collection services that are provided by the municipality are mainly carried out by door-to-door collection or station collection methods. In the door-to-door collection method, waste is discharged in front of each household which is then collected. In the station collection method, a specific location is set as a waste discharge station and a number of households discharge their wastes there for collection.

Source: Yachiyo Engineering Co., Ltd.
Photo 7 PET Bottle Separated and Discharged by Residents in Tokyo

Source Separation and Separate Collection

It is extremely important to separate waste at the source of generation (source separation) in order to promote recycling. In each municipality, the categories for separation are determined according to the characteristics and actual condition of the region. On the other hand, since an increase of the number of categories for waste materials separation requires development of a system for sorting and increases the burden on the residents, further cooperation of residents becomes necessary.

Source: Yachiyo Engineering Co., Ltd.
Photo 8 Bins and Cans Separated and Discharged by Residents in Tokyo

Resource Recovery

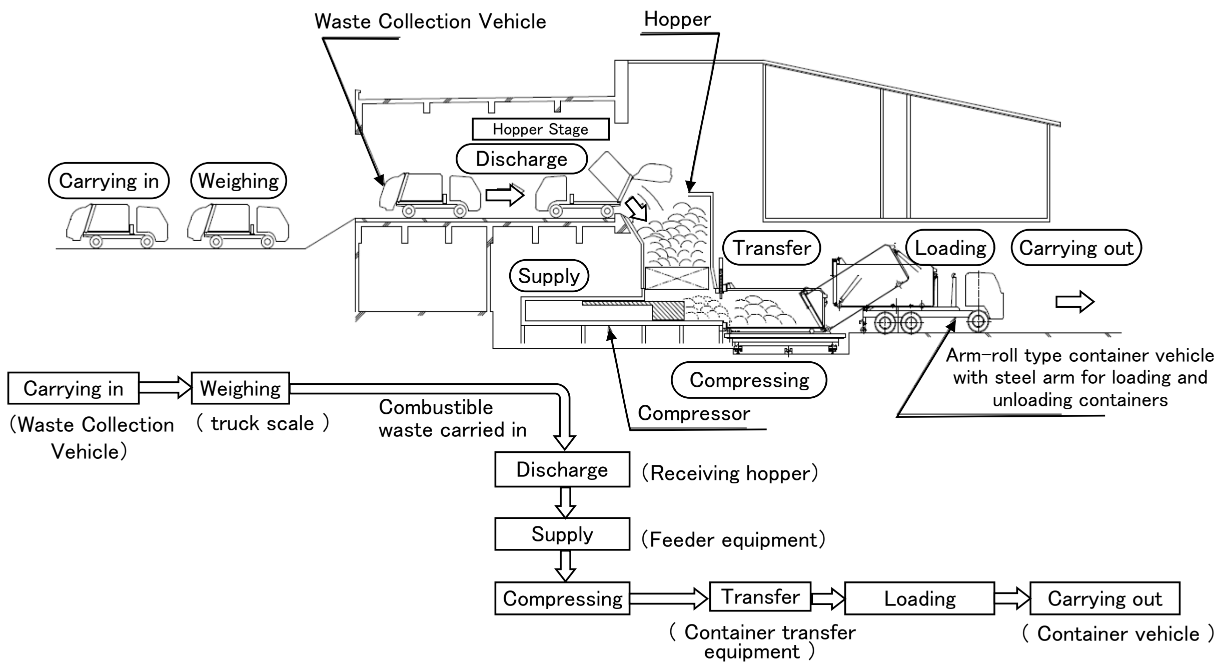
In addition to source separation and separate collection that are implemented by municipalities, community group collection is exercised as a recycling activity, where a voluntary association of community residents such as a neighborhood association and a children's group voluntarily collects recyclable waste and delivers it to a recycle business operator.

2) Maintenance Management of Waste Collection and Transport Vehicles

Collection vehicles must be constantly kept in good condition to operate them stably and continuously according to the collection plan. For this reason, regular and appropriate vehicle inspection and maintenance is very important. To maintain vehicles in good condition, it is desirable to apply the concept of preventive maintenance and inspection that prevents faults occurring during operation, and that not simply takes measures swiftly to rectify the faults that are detected as a result of inspection or occur during collection operation.

3) Transfer Station

A transfer station is a facility where waste is transferred from a small or a medium-size collection vehicle to a large transport vehicle, either with or without compression of the waste, in order to allow the collection truck to speedily return to its collection activities. The transfer station operation thereby enhances the efficiency of waste collection and transport for urban areas where waste is to be collected across wide areas. Figure 10 shows an example of a transfer station processing flow (compactor/container type).



Source: Ministry of the Environment "Guidance for application for subsidy for establishing a Sound Material-Cycle Society (For Facility)" (2021)

Figure 10 Example of Process at Compactor/Container Type Transfer Station

(2) Intermediate Treatment

1) Transition of the Intermediate Treatment Technologies

Since Japan has a small land and the usable land area is limited, reduction of waste amount is extremely important. Therefore, incineration has historically been considered an effective treatment method and was mandated under the amendment of the *Waste Cleaning Act*, in 1930. However, even with this mandate the burning of waste in open fields and the dumping of waste into rivers continued to be frequent occurrences, and in reality incineration technologies were not introduced as centralized intermediate treatment.

Source: Tokyo Metropolitan Government

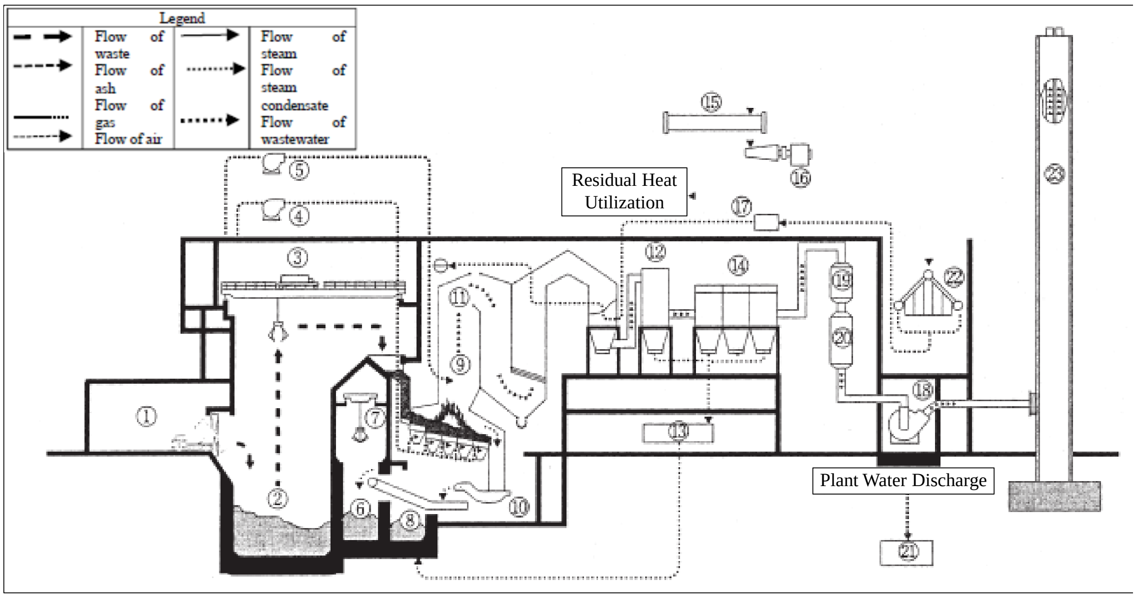
Photo 9 Shin-Koto Incineration Plant

From the period of the 1960s', the treatment of the increased waste amount that was associated with the rapid economic growth, the improvement of the living environment, and enhancement of public sanitation became serious issues. In order to resolve these issues and from the perspective that incineration of waste is very effective in sanitary treatment of waste and reduction of the waste amount, the development of intermediate treatment facilities using incineration technology was promoted.

Under this development policy, the introduction of a waste incineration facility was promoted in all urban areas through the provision of technical and financial support based on the laws and plans established by the central government, and promising results were achieved for sanitary treatment and amount reduction of waste. At the same time, in response to the pollution issues caused by waste incineration, the central government established the Facility Technical Standards Including Exhaust Gas Treatment (1971) for proper waste treatment by intermediate treatment facilities. Since then, the incineration technology has significantly progressed to become a highly reliable waste treatment method, through the process of responding to new and updated standards, regulations, and structural guidelines (1979) and performance guidelines (1998) which ensured the necessary countermeasures against dust, dioxins, organic pollutant, and mercury.

2) Incineration Technologies

Figure 11 shows an example of the structure of an intermediate treatment facility that utilizes stoker-type incineration technology.



(1) Platform	(9) Incinerator	(17) Steam condensate Tank
(2) Waste pit	(10) Ash extruder	(18) Induced draft fan (IDF)
(3) Waste crane	(11) Boiler	(19) Steam type gas re-heater
(4) Forced draft fan (FDF)	(12) Cooling tower	(20) Catalytic reaction tower
(5) Secondary positive blower	(13) Fly ash treatment device	(21) Wastewater treatment facility
(6) Ash pit	(14) Filter type dust collector	(22) Steam Condensers
(7) Ash crane	(15) Steam receiver	(23) Stack
(8) Induced fan at ash pit	(16) Turbine generator	

Source: JICA "Guideline for Promoting Waste to Energy Facility Projects" (2017)

Figure 11 Example of Waste Incineration Plant with a Stoker Furnace

Other Uses of Incineration Technology

Use of Waste Heat	The thermal energy that is generated by combustion in an incineration facility is used for heating, and hot water supply within the facility in the forms of air, steam, and hot water. The energy is stored and distributed to the local residents as an energy source for hot water for swimming pools in recreational centers, social welfare facilities, and community centers of the region, in addition to heating inside the incineration facility.
Incineration Power Generation	Steam is created by the waste heat that is generated during the incineration of waste. The steam is then utilized to turn a turbine, a device that converts thermal energy into kinetic energy and uses it as power to generate electricity

3) RDF/RPF Conversion Technology

RDF (Refuse Derived Fuel) is a solid fuel that is produced from combustible waste - kitchen waste, paper waste, plastic waste, and so on. The combustible waste is solidified through the processes of shredding, sorting, drying, and molding. RDF can be stored for a comparatively long period of time due to its low biodegradability and can be transported more easily than waste due to its reduced amount and molding into more usable shapes.

Stable combustion is another major feature of RDF because of its generally constant shape and heat value.

RPF (Refuse derived Paper and plastics densified Fuel) is a solid fuel that is manufactured mainly from paper and waste plastics discharged in industrial waste and specifically selected municipal waste, that are difficult to recycle as raw materials. RPF can be used as a fuel in the same way as RDF, however, since RPF is produced from selected waste, it is characterized by having less foreign matter content, lower moisture content, and higher heat value (5,000kcal/kg or more).

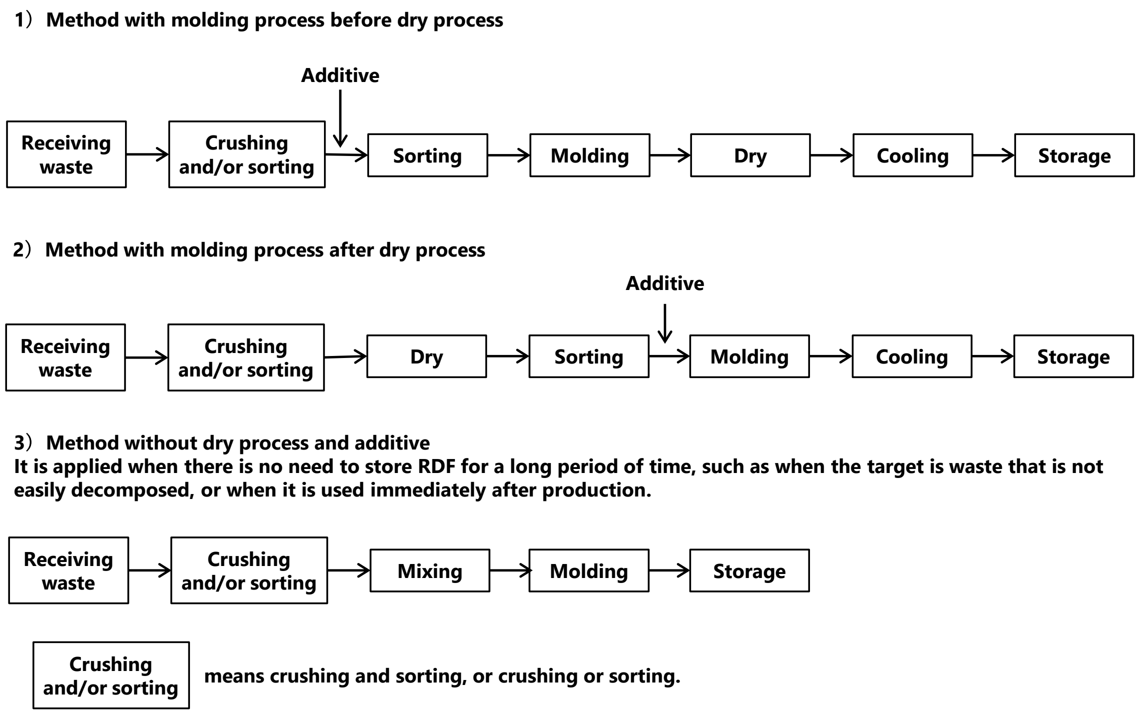
Photo 10 RDF

Photo 11 RPF

Source: Study Group on Appropriate Management of RDF "Report of Study Group on Appropriate Management of RDF (2003)" (RDF) (Photo 10)

Source: Japan RPF Association Website "What is RPF?" https://www.jrpf.gr.jp/rpf-1 (accessed January 10, 2022) (Photo 11)

Figure 12 shows the treatment methods at the intermediate treatment facility where RDF/RPF conversion technology is applied.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 12 Treatment Process of RDF Facility

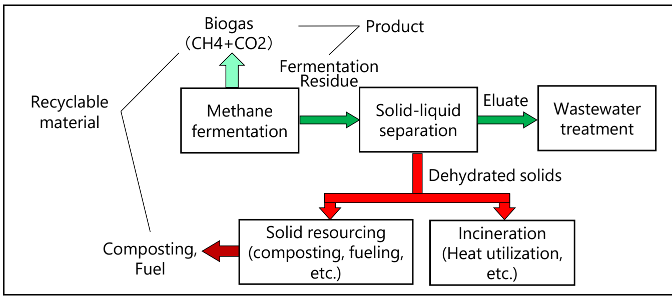
4) Organic Waste Recycling Technology

(a) Overview and Types of Technologies Related to Organic Waste Recycling

Biomass refers to organic resources from animals and plants, excluding fossil fuels. It is a sustainable and renewable resource that can be utilized as renewable energy and may be produced as long as there is life and solar energy. In Japan, utilization of biomass is being promoted according to the regional characteristics, and promoting the utilization of biomass included in organic waste is part of Japan's efforts to construct a sound material-cycle society.

(b) Overview of Methane Gasification Technology

Methane gas facilities ferment the organic waste that is acquired by separate collection and from mechanical sorting of collected mixed waste, and recover the biogas from the produced methane. Figure 13 shows the process.



1. Biogas and fermentation residue are produced from methane gasification.
2. Dehydrated solids are used as fertilizer, etc. Or, after drying into solids, they can be incinerated.
3. Fermentation residue is used as liquid fertilizer, after disinfection. Or, after dehydration, the eliminated liquid is treated as wastewater.

Source: Ministry of the Environment Website "Methane Gasification Technology"
https://www.env.go.jp/recycle/waste/biomass/technical.html (accessed January 20, 2022)

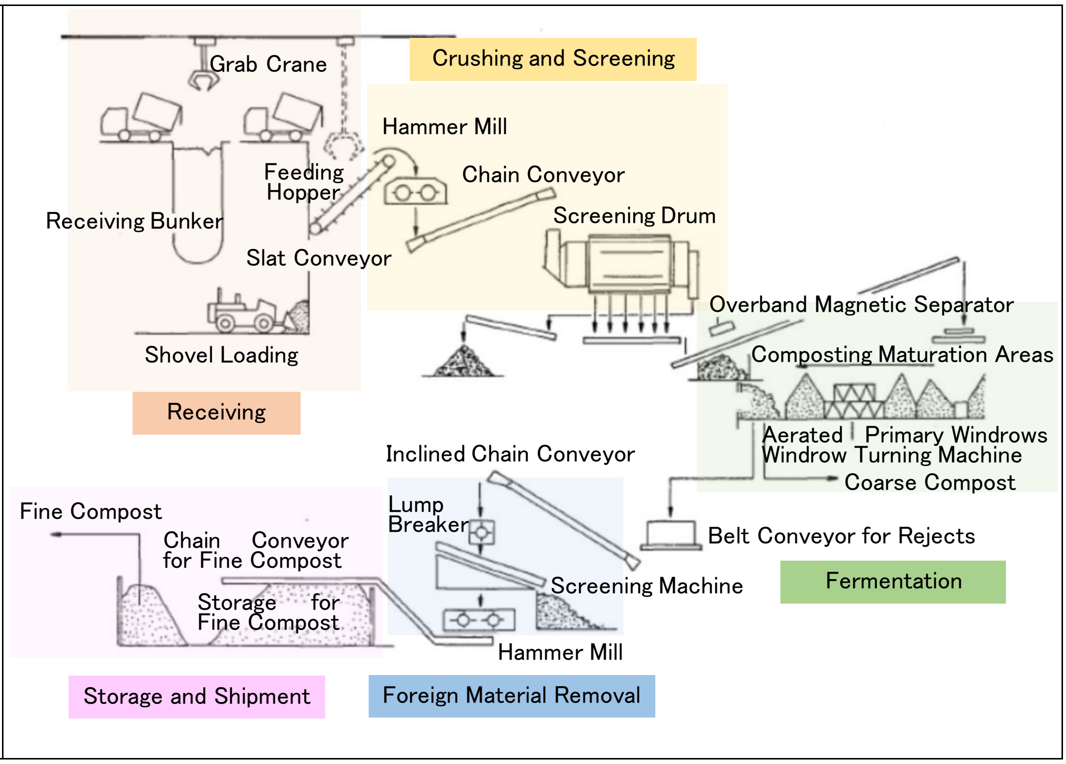
Figure 13 Process of Methane Fermentation

(c) Overview of Composting Technology

In composting, the organic waste in kitchen waste and the like is broken down and made into compost by microbes under aerobic conditions. This technology has been used for recycling kitchen waste in Japan for ages.

Composting

Flow



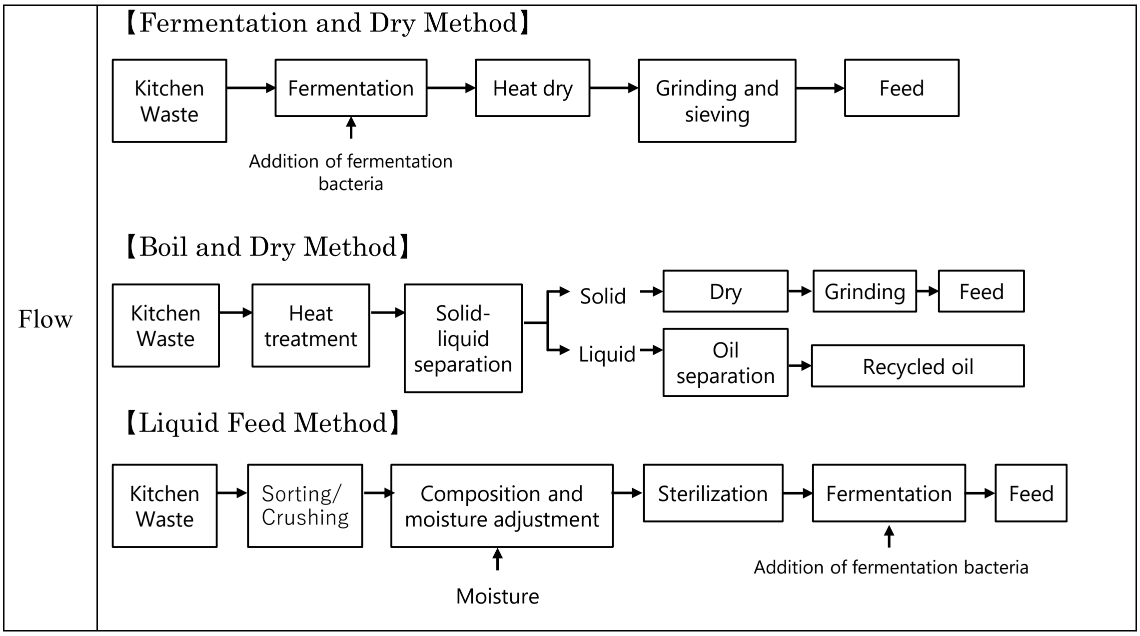
Source: JAPAN ENVIRONMENTAL SANITATION CENTER "Waste management technology in Japan (JICA training text)" (2017)

Figure 14 Flow of Composting

(d) Overview of Technology Related to Turning Waste into Livestock Feed

Under this technology livestock feed is produced from kitchen waste and other organic waste. As is the case with composting, this is a food recycling technology that has been used in Japan for ages. The main technologies involved in turning waste into livestock feed are reducing the water content through thermal treatment and drying, and adjusting the oil and fat content.

Livestock feed



Source: Ministry of the Environment Website "Types and uses of waste biomass"
http://www.env.go.jp/recycle/waste/biomass/biomass.html (accessed January 27, 2022)

Figure 15 Flow Chart of Recycling to Feed

5) Recycling Technology

In order to create a sound material-cycle society, the effective use of resources and recycling is very important. In Japan, various recycling laws have been enacted to promote recycling. It is necessary to economically and safely process waste using methods suitable for source separation and separate collection. The main technologies related to recycling are sorting, shredding, compression, drying, and solidifying.

Recycling technologies such as sorting, shredding, and compressing can also perform the following roles for promoting efficient recycling.

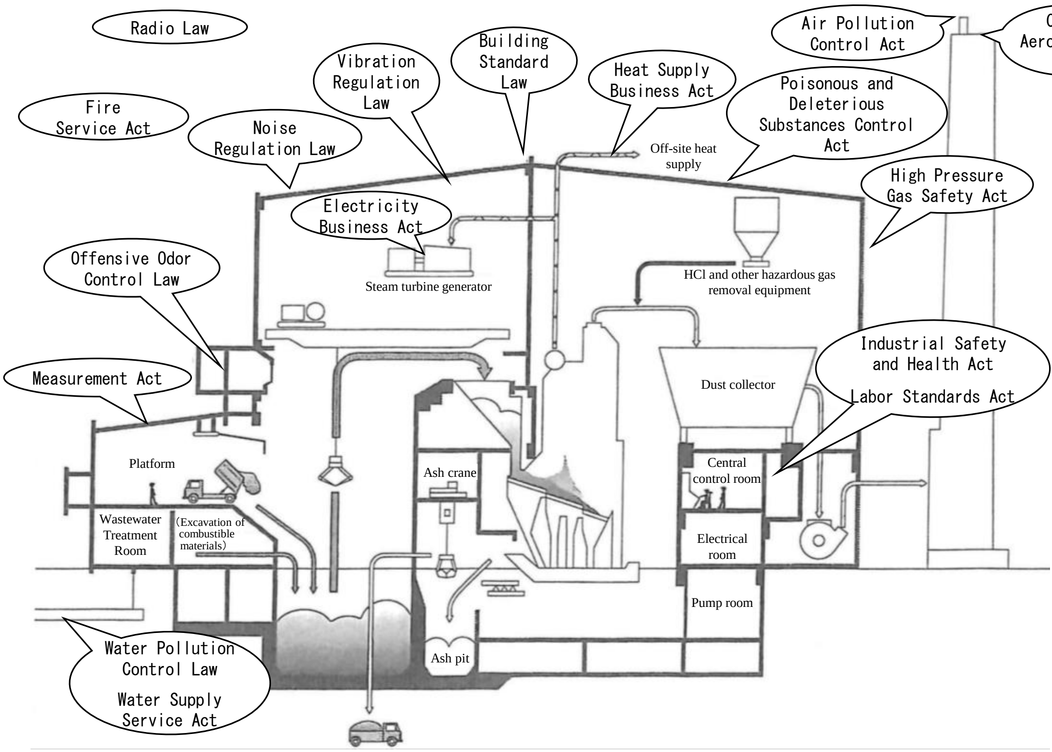
Roles of recycling technology

- Shredding combustible bulky waste into sizes that can be incinerated.
- Shredding organic waste into sizes suitable for intermediate treatment.

- Shredding and sorting incombustible waste and bulky waste to enable recovery of recyclable materials.
- Reducing waste disposal by shredding and compressing waste.
- Reducing final disposal amount by recovering recyclable materials.
- Reducing waste generation amount.
- Resources recovery.

6) Maintenance Related to Intermediate Treatment Facilities

The construction and operation of a waste treatment facility must consider the surrounding environment. The technical standards related to the operation and maintenance management of general waste treatment plants are regulated by the *Waste Management Act*. There are detailed standards that specifically regulate incineration plants which must be met. Waste treatment plants must be operated and maintained under the strictest control to satisfy the related standards.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 16 Relevant Laws and Regulations Pertaining to the Planning of Facilities

(3) Final Disposal

1) History of Disposal Sites

Before the introduction of intermediate treatment, kitchen waste and other types of waste were disposed of at designated locations. However, this caused problems for the surrounding environment such as the generation of odor, pests (mosquitos, flies, etc.), and spontaneous fires caused by gas produced from the disposed waste.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 12 A Landfill Site in Tokyo where Spontaneous Combustion was Occurring Because the Waste was Directly Disposed with no Intermediate Treatment and no Soil Cover Application – circa 1957

During the period of high economic growth in the 1960s, waste increased, the remaining capacity of landfill site was shortened and it became necessary to promote the reduction of waste disposal amount at landfills by incineration.

In the 1970s, the *Waste Management Act* was revised and technical standards for disposal sites covering construction, operation and maintenance, and decommissioning were established. Disposal sites were divided into three categories, namely inert landfill sites, controlled landfill sites, and isolated landfill sites and standards were established for each.

Then, the "Structural Guidelines for Final Waste Disposal Sites" were established in 1979 and the "Performance Guidelines for Final Waste Disposal Sites" were established in 2000. These guidelines dealt with the issues of suitable landfill control, and helped to alleviate the shortage on landfill sites and solved the problems related to the surrounding environment, such as the generation of hexavalent chromium and hydrogen sulfide.

The shortage of landfill sites furthered the need for more sites which was one problem, but on the other hand it was becoming more difficult to gain the understanding of surrounding residents to construct new sites. Therefore, local harmonized landfill sites were proposed, underpinned by the operation and maintenance being strictly controlled and implemented with the understanding of residents. As a result, closed system landfills were adopted as landfill sites for municipal waste. There were 1,620 municipal waste final disposal sites in FY2019, and 83 closed system landfill sites in FY2018.

2) Functions and Features of Landfill Site Facilities and Equipment

The main functions required of landfill sites are as follows: waste storage function to stably store the waste in the landfill; water sealing functions to prevent groundwater from entering the landfill site, and prevent water from the waste in the landfill from being discharged outside the disposal area; and cleaning functions to facilitate the decomposition of organic waste and washing out contaminated matter. The main facilities are storage structures, waterproofing liner system construction, leachate treatment facilities, monitoring facilities, and generated gas treatment facilities.

3) Types of disposal sites

Landfill sites are facilities for disposing of wastes that are difficult to undergo intermediate treatment - such as incineration, recycling, etc., waste items that are difficult to reuse, and the residue from intermediate treatment. They are facilities where waste is appropriately stored without negatively impacting the surrounding environment.

Generally, landfill sites are constructed in mountainous terrain by adopting the topographical features there or by excavation in plains. In Japan due to limitations of finding sites for constructing landfills, the method of constructing a seawall in a coastal area and constructing a landfill at sea, i.e. land reclamation, is also implemented.

In Japan, learning from past experience that construction of landfills was difficult due to opposition from local residents, in recent years closed system landfill sites in which waste is disposed of in enclosed structures have been constructed as regional-friendly facilities that are accepted by the residents. Moreover, operation and maintenance of closed system landfill sites are not affected by the weather and has the advantage of being able to effectively minimize leachate generation as intake of rainwater can be controlled.

Source: Minami-Ashikaga City Website “Landfill” https://www.city.minamiashigara.kanagawa.jp/shisetsu/kankyou/saisyusyobunjyou.html (accessed March 1, 2022)

Photo 13 Landfill of Minami-Ashikaga City

Source: Tokachi Environmental Complex Office Association, "Municipal Waste Final Disposal Facility Ume-ru Center Mikato Pamphlet" (2021)

Photo 14 Outside View of the Landfill “Ume-ru Center Mikato” Landfill of Tokachi Environmental Complex Office Association

Landfill sites are categorized into landfill sites for municipal waste and landfill sites for industrial waste. Landfill sites for industrial waste are categorized into inert, controlled and isolated landfill sites. Landfill sites for municipal waste are almost identical to controlled landfill sites for industrial waste.

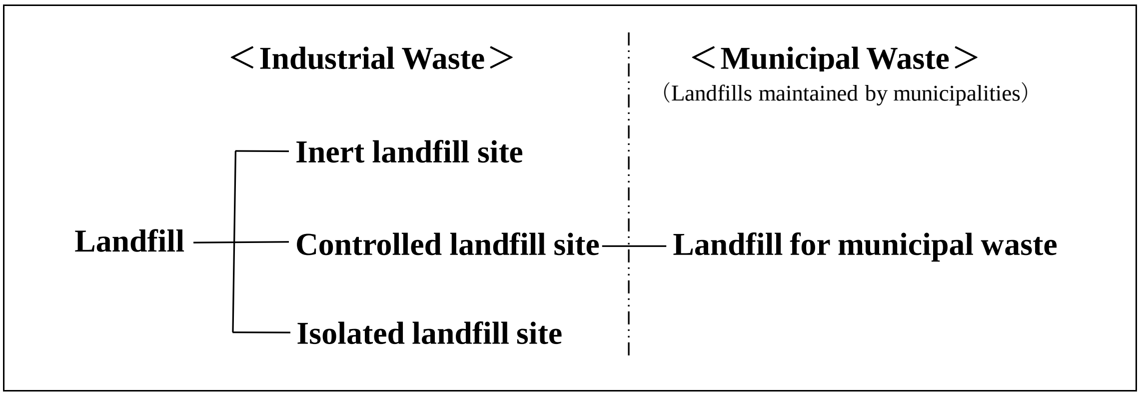
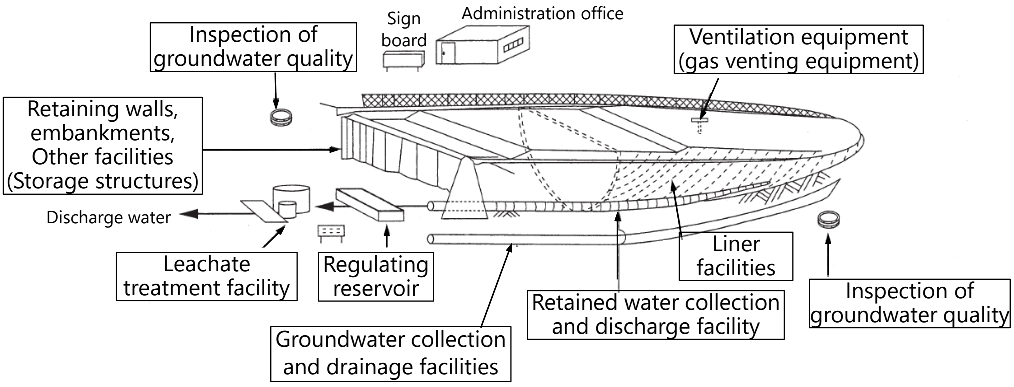


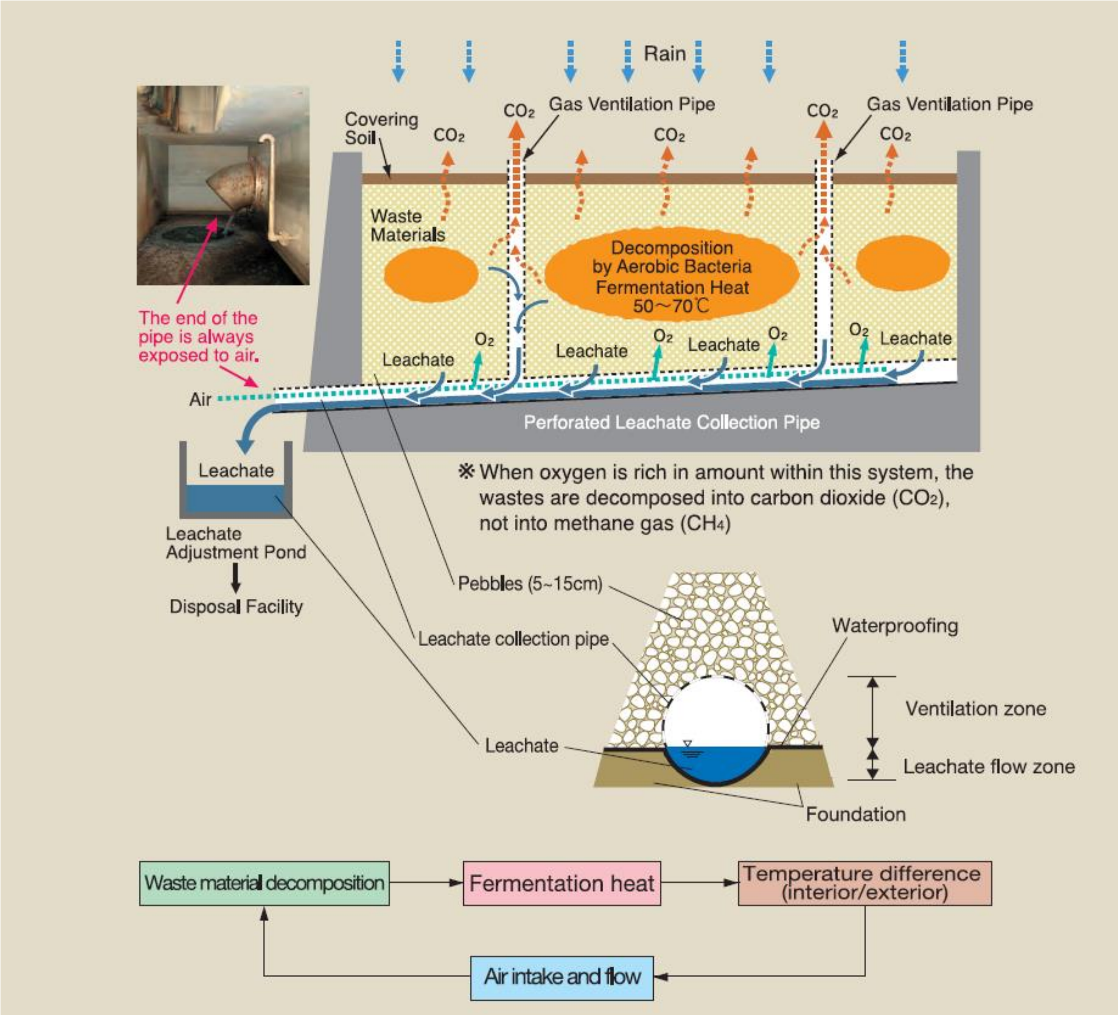
Figure 17 Types of Landfill



Source: Ministry of the Environment "Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007" (2007)

Figure 18 Example of Controlled Landfill Site Structure

The semi-aerobic landfill construction method was researched and developed by professor emeritus Hanashima of Fukuoka University with the cooperation of Fukuoka City. At the time, Fukuoka City was confronted with pollution issues from landfill sites used for kitchen waste that caused water pollution, odor, gas, and pests. Therefore, professor Hanashima and Fukuoka City jointly conducted a study for three years from 1973 to improve the leachate quality and in turn the landfill sites. As a result of these experiments, the basic concept of semi-aerobic landfill construction that uses leachate collection pipes to supply air to the interior of landfill sites was proposed. In 1975, the first semi-aerobic landfill site was constructed at the Shinkamata landfill site. Then, the semi-aerobic landfill construction method was adopted throughout Japan under the name of the Fukuoka Method.



Source: Fukuoka Prefecture "Guide to Introducing The Fukuoka Method" (2020)
English: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086159_misc.pdf
Vietnamese: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086163_misc.pdf
Thai: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086164_misc.pdf

Figure 19 Conceptual Figure of Semi-Aerobic Landfill Construction

4) Operation and Maintenance Management of Landfill Sites

When local governments need to develop landfill sites, they must apply to their prefectural governments. Together with their application, they must submit an operation and maintenance management plan. The understanding and cooperation of local residents are extremely important to facilitate the operation and maintenance of the facility, and the prepared operation and maintenance plan should carefully consider local conditions and aspirations and the plan contents need to be thoroughly discussed with local residents. Once commissioned, the facility should be operated and maintained in accordance with the prepared plan.

Waste Delivery Control

In order to manage and operate a landfill site according to plans, it is important to understand the types, quantities, and characteristics of the waste that will be delivered to the landfill.

Landfill Work Management

Carrying out landfill work as planned is necessary not only for securing disposal capacity at the landfill site, but also for stabilizing landfill waste and managing leachate and landfill gas generated from the landfill. Information on the types and amounts of waste disposed in each landfill disposal cell is also necessary from the perspective of long-term landfill management, including the prevention of environmental pollution during the period after completion of disposal operations and abolition of the landfill and consideration of the land use after abolition.

Facility Operation and Maintenance Management

If the functions of each facility are not fully utilized, the disposal site will become unsanitary, causing problems such as environmental pollution to the surrounding area and negative impacts on the health of workers. In addition, since it takes a long time, in some cases several decades, from the completion of disposal operations to the abolition of the landfill, it is necessary to keep in mind that each facility will be operated for a long period of time.

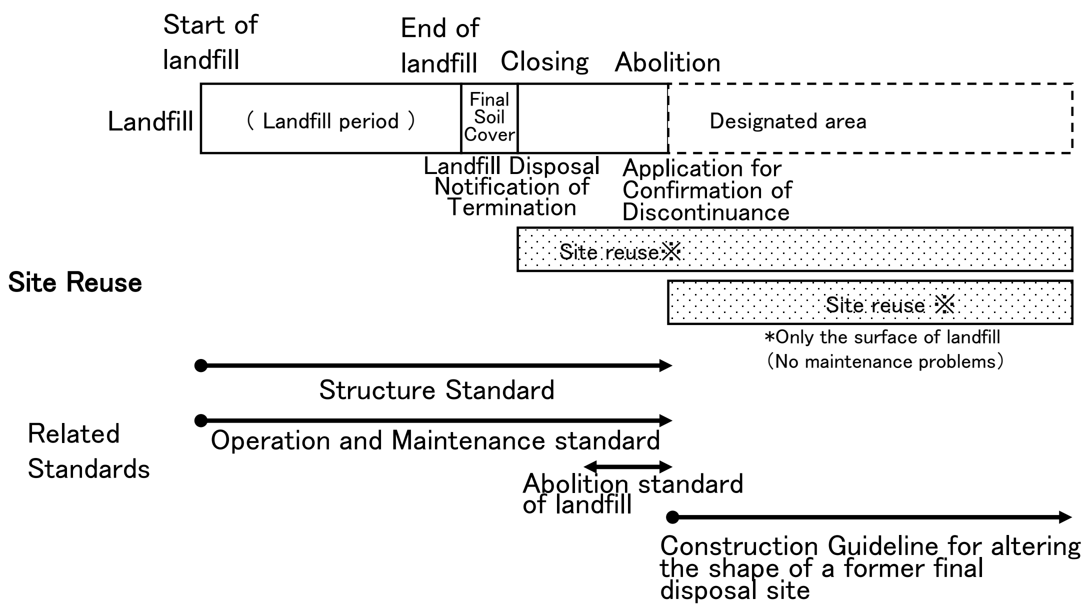
5) Appropriate Closing and Use of the Site

(a) Appropriate Closing

In Japan, when waste is no longer received at a landfill site and landfilling work is terminated, facility services are ended by taking actions, such as the final covering with soil to close it appropriately. When a facility is closed, although there is no new delivery of waste, the disposed waste has not completely decomposed, so the water quality of leachate and gas from the landfill must continue to be controlled according to the facility standards, and operation and maintenance standard. Once a landfill site is closed, entrance to the site is limited and managed so that landfill waste is not agitated.

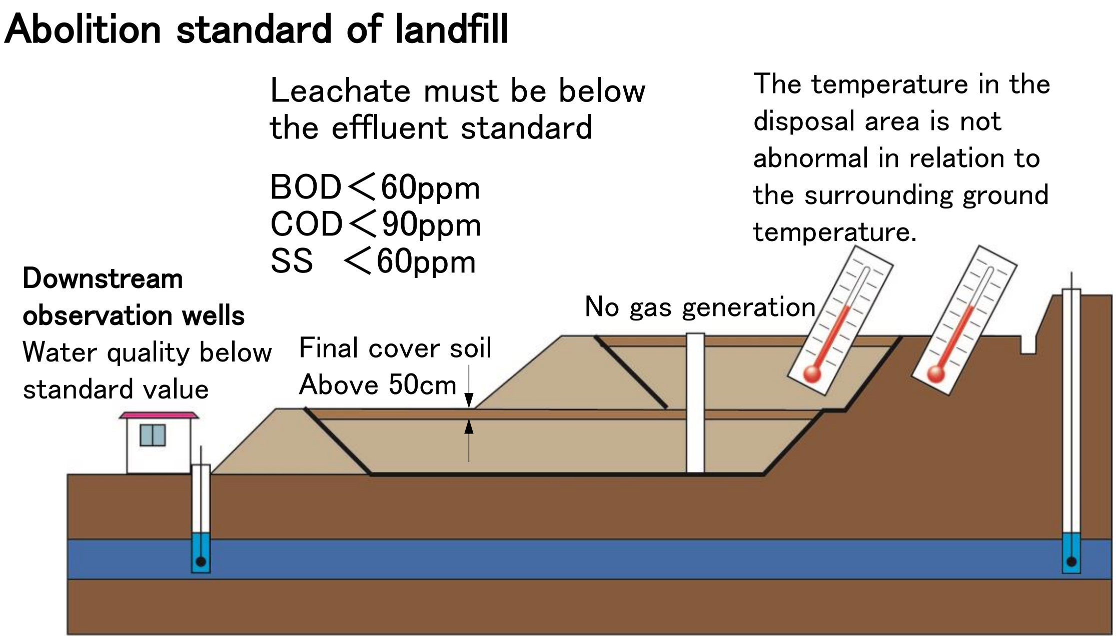
After a monitoring period during which the decomposition of the landfill waste has stabilized, the water quality of leachate, landfill gas emissions, and landfill waste temperature are confirmed to make sure that they comply with the standards. If the abolition standards are met, a new project may be commenced at the site according to the guidelines related to site usage of landfill sites.

Figure 20 shows the flow from the start of a landfill site until the site is reused for another purpose.



Source: Japan Waste Management Association "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition" (2010).

Figure 20 Final Disposal Site Utilization and Related Standards



*: BOD : Biochemical Oxygen Demand
COD : Chemical Oxygen Demand
SS : Suspended Solids

Figure 21 Abolition Standard of Landfill

(b) Site Reuse

After landfilling at landfill sites has been terminated, the site will be relatively large and flat and similar to a vacant lot very much like the condition just before the development of the landfill. It is therefore possible, after a site has been used as a landfill site, to reuse it effectively to help develop or revitalize the area. The site reuse is expected to deepen residents' awareness and understanding of the construction of landfill sites and promote the locating of new landfill sites.

8 Modern Trend of Waste Management (Topic 5)

This Topic introduces Japan’s domestic and international cooperation efforts to manage the issues of illegal dumping, dioxins, hazardous waste, disaster waste, and marine plastics waste as social issues and global trends related to waste management.

In order to deal with these issues, cooperation and consensus building not only within administrative institutions but also with residents, local communities, and industry are indispensable. This Topic covers economic and regulatory measures taken in actual cases in Japan, as well as specific lessons learned and considerations regarding responses and countermeasures that can be used as reference for developing countries.

(1) Illegal Dumping

1) Cases in the Past

In managing waste, illegal dumping is strictly forbidden in Japan and the law prescribes penalties as will be described in this section. However, in the process of industrial development, illegal dumping occurs repeatedly, and it is extremely difficult to discover and control it in a timely manner.

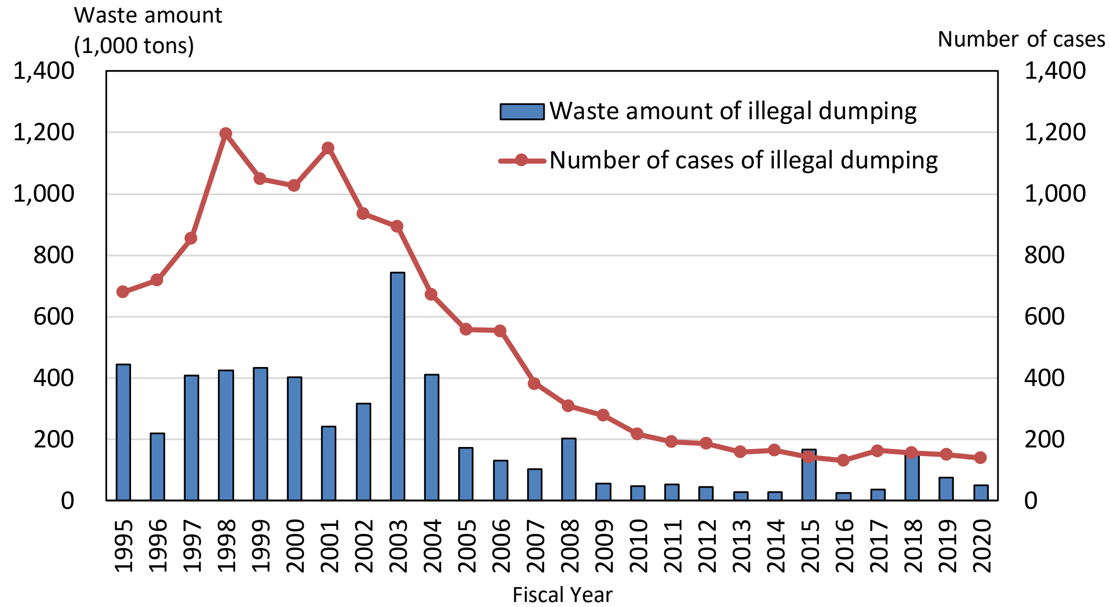
2) Illegal Industrial Waste Dumping Case in Teshima, Kagawa Prefecture

The illegal dumping of industrial waste in Teshima, Kagawa Prefecture in the 1990s is one of the largest cases of illegal dumping that occurred in Japan. Triggered by this case, responses to illegal dumping in Japan became stricter and government officials and citizens have since been cooperating to establish a system to prevent illegal dumping.

Photo 15 Polluted Situation in Teshima **Photo 16 Campaign by the Residents**

Source: Material for Teshima Residents' Council of Countermeasure for Waste Treatment (Photo 15 taken in 1990, Photo 16 taken in 1996)

Various measures have been taken against illegal dumping, such as enactment of necessary laws, strengthening cooperation between the central government and municipalities, strengthening the surveillance system, improving the reporting system, and others and, as a result, the number of newly detected illegal dumping sites has greatly decreased compared with the respective numbers during the peak period of the late 1990s.



Source: Ministry of the Environment “Survey results of illegal dumping, etc. (FY2020)” (2022)

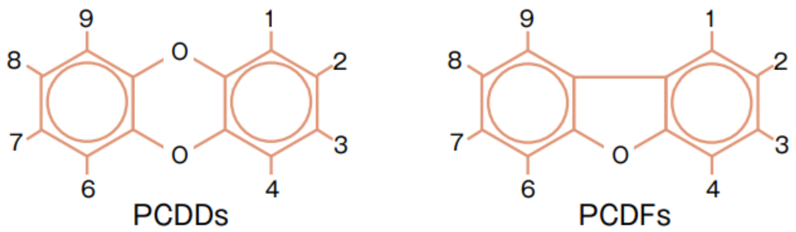
Figure 22 Transition of Number and Amount of Newly Discovered Cases of Illegal Dumping

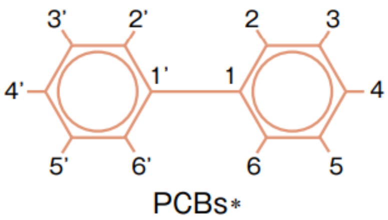
(2) Dioxins Problem

1) What are Dioxins

Dioxins are a generic term for Polychlorinated dibenzo-p-dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs). Although the substances that show toxicity like dioxins such as coplanar-polychlorinated biphenyl (coplanar PCB) are called dioxin-like compounds, dioxins in this document refer not only to PCDDs and PCDFs but also coplanar PCB in accordance with the definition in *Act on Special Measures concerning Countermeasures against Dioxins* enacted in 1999.

Dioxins have basically a structure where two benzene rings are combined with oxygen and chlorine is attached there. There are 75 types of PCDD, 135 types of PCDF, and dozens of types of coplanar PCB since the shape varies depending on the number of attached chlorine and where they are attached, and only 29 types of them are regarded as toxic.





*PCBs, in which benzene rings are on the same plane and have a flat structure, are called “coplanar PCBs”.
Some PCBs have benzene rings on different planes and have similar toxicity as Dioxins. In Japan, they are also called “coplanar PCBs”.

Source: Brochure shared with related ministries “Dioxins” (2012)

Figure 23 Molecular Structure of Dioxins

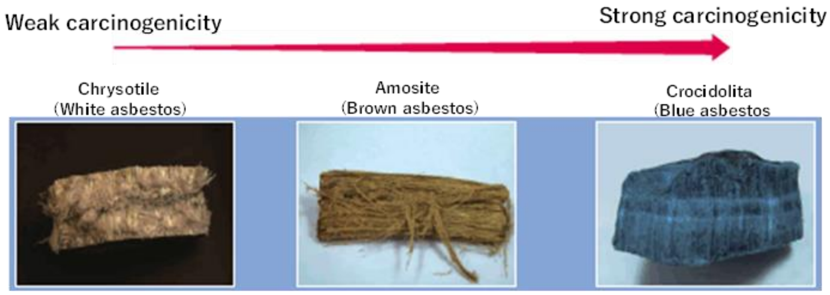
2) Measures Taken Against Dioxins in Japan

Based on the Dioxins Measures Promotion Basic Policy and the *Act on Special Measures concerning Countermeasures against Dioxins* formulated in 1999 with the aim of preventing environmental pollution caused by dioxins, the central government, municipalities, business operators, and citizens worked to implement various pollution prevention measures. As a result, the total amount of emission of dioxins to the environment was reduced by 90% at the end of 2002 compared with 1997.

(3) Hazardous Waste

Waste generated by industries, businesses, and our daily life contains hazardous waste that is difficult to treat. Mercury, PCB, and asbestos have been selected as major hazardous wastes to be discussed; an overview of their properties and toxicity is presented, together with current countermeasures in Japan, and past cases of pollution caused by these wastes. Through the description of actual cases, the necessary measures and the challenges for their implementation are also introduced.

Table 5 Summary of Hazardous Waste

Hazardous Waste	Summary
Mercury	Mercury has an effect on living organisms, which is a disorder due to “corrosive action of inorganic mercury compounds” and “uptake of methyl mercury”. Minamata disease is widely known as the most famous disorder that has occurred in Japan from mercury pollution. Globally, research was conducted by the United Nations in 2000s and the Minamata Convention went into effect in 2017. Japan ratified this convention and is engaged in developing and applying the countermeasures.
PCB	Although PCB was used for various uses in the past, at present orders were issued for discontinuing production, collection, and prohibition of importation. Collected PCB is treated by the Japan Environmental Storage & Safety Corporation (JESCO).
Asbestos	Asbestos that is taken into the human body and remains there causes diseases such as lung fibrosis, lung cancer, and malignant mesothelioma. Its use is regulated in Japan and at present is not imported into the country.  Source: Environmental Restoration and Conservation Agency (ERCA) Website https://www.erca.go.jp/asbestos/what/whats/whatAsbestos.html (accessed February 1, 2022)

(4) Disaster Waste

Due to its location, geography, geology, climate, and other natural conditions, Japan frequently experiences typhoons, severe rainstorms, earthquakes, and other natural disasters. The percentage of global disasters that Japan accounts for is 20.8% of earthquakes with a magnitude over 6, and the percentage of disaster damage costs is 18.3%. As Japan accounts for only 0.25% of the world's land area, these figures are very high. When a disaster occurs, vast quantities of waste are immediately generated and they must be speedily disposed of to help the residents recover.

1) Changes in the System

Based on the lessons learned from the Ise Bay Typhoon of 1959, the *Disaster Countermeasure Basic Act* was enacted in the same year and has been revised several times since then. The purpose of the act is to protect the lives, health, and property of the citizens from disasters and thereby contribute to maintaining social order and assuring public welfare.

In 2011 Japan was struck by the Great East Japan Earthquake, and once more the lessons learned in that disaster led to the establishment of the *Basic Act to Strengthen National Resilience to Contribute to Disaster Prevention and Alleviation to Achieve Strong and Flexible Citizens' Lives* (hereinafter referred to as the *Basic Act to Strengthen National Resilience*) established in 2013, and activities have since been carried out based on the concepts of this act.

Based on these laws, the Basic Plan to Strengthen National Resilience was established in June 2014, and “situations to be avoided” was defined as “situations in which recovery and reconstruction are delayed due to stagnation in the treatment of the vast quantities of waste produced by disasters”. Therefore, countermeasures for disaster waste were included as part of the policies to strengthen national resilience.

2) Current Situation of Disaster Waste Management

The Ministry of the Environment’s Disaster Waste Countermeasure Guidelines (Revised Edition) describes the basic flow of disaster waste management after a disaster has occurred. In principle, disaster waste is managed according to the descriptions in the guidelines.

The Ministry of the Environment is at the center of national level disaster waste countermeasures in Japan. Specifically, the ministry formulates legislation, basic plans, and guidelines as described earlier in this section. The ministry also monitors the efforts by the various local governments, makes suggestions as necessary, and at the same time, it archives information about waste from past disasters and makes it available to the public through its “Disaster Waste Countermeasures Site”.

The Ministry of the Environment also operates the Disaster Waste Treatment Assistance Network (D.Waste-Net) as a secretariat to support disaster waste management implemented by local governments. Numerous research and specialized organizations, as well as municipal waste related organizations, are members of D.Waste-Net.

3) Japan’s International Cooperation

As an example of Japan’s international cooperation related to disaster waste, the debris treatment support provided to Nepal after the major earthquake that struck that country in 2015 and the creation of the “Asia-Pacific Disaster Waste Management Guidelines” are introduced in this section.

From April to May 2015, earthquakes of a maximum magnitude of 7.8 struck the municipality of

Gorkha which is about 77 km northwest of the capital city of Kathmandu. Over 50,000 homes were destroyed and there were over 8,000 casualties. In response, the Japanese government, through the Japan International Cooperation Agency (JICA) dispatched an international emergency relief team and provided about JPY 25 million of emergency relief supplies (tents, blankets, etc.) as humanitarian support for the victims. In addition, based on requests from the government of Nepal and the United Nations Environment Programme (UNEP), the Ministry of the Environment provided technical support for formulating disaster waste treatment plans centered on the recycling of the bricks from the buildings destroyed in Nepal.

At the G7 Toyama Environment Ministers' Summit in May 2016, the "Toyama Material Cycle Framework" was adopted for the field of disaster waste management. The G7 countries agreed to provide support for nations and regions in the Asia-Pacific region that experienced natural disasters.

Based on this agreement, from fiscal 2017, the Ministry of the Environment examined the natural disasters occurring around the world, centering on the Asia-Pacific region, and the treatment of disaster waste, then it organized the issues and lessons learned.

Based on the Japanese know-how on disaster waste countermeasures and the needs of other countries that were identified through the aforementioned study, in October 2018 the Ministry of the Environment created the "Asia-Pacific Disaster Waste Management Guidelines" to describe the points necessary to accurately, smoothly, and quickly process disaster waste.

(5) Marine Plastic Waste Issue

1) Global Situation

Since the introduction of plastic products around the 1950s, their applications have expanded due to the ease of processing and stable non-corrosive characteristics, and the gross production amount so far is said to exceed 8.3 billion tons. Of this, 6.3 billion tons are disposed of as waste, much of which is landfilled or dumped in the ocean. Recently, large amounts of plastics were found from the stomachs of dead seabirds and whales in various regions around the world. A video showing a scene in which a plastic straw was removed from the nose of a turtle was aired in the media and this image galvanized global attention to the marine plastic waste issue. The issue of marine plastic waste is now being addressed as a global scale.

Photo 17 Plastic Waste on the Beach

Photo 18 Sea Turtle and Plastics

Source: DigArt “Plastic bottles and waste washed up on a beach by the incoming tide, covering the entire beach at Umkomaas in KZN, South Africa” (Photo 17), Willyam Bradberry “Water Environmental Pollution Problem Underwater animal Sea turtle eating Plastic” (Photo 18)

2) Current Situation in Japan

Strongly encouraged by this international momentum, Japan is also promoting countermeasures to combat plastic pollution.

At the G20 Osaka Summit that was held in Osaka on June 28, 2019, as the chair country Japan promoted “Osaka Blue Ocean Vision” to each country as a universal global vision. The aim is to completely eliminate extra pollution caused by marine plastic waste by 2050 through the comprehensive approach to life cycle including the reduction of the outflow of plastic waste caused by poor management. This is to be achieved by the improvement of waste management and innovative solutions that are achieved while recognizing the important role of plastics in the society.

In this Summit, Japan also announced the country’s intention to support capacity building and infrastructure development relating to waste management in developing countries. To achieve this objective, the Japanese Government established the “Marine Initiative” to support effective global countermeasures for marine plastic waste, by focusing on (1) waste management, (2) recovery of marine waste, (3) innovation, and (4) capacity enhancement. The Japanese Government supports capacity enhancement of developing countries to promote waste management, recovery of marine waste, and innovation through the following specific policies under this initiative.

3) Japan’s International Cooperation

In terms of countermeasures to prevent marine plastic waste, it is important for the world as a whole, including developing countries, to promote efforts to curb the outflow of plastic waste into the ocean. Accordingly, the Japanese Government is promoting effective support for developing countries through the "MARINE Initiative" and other programs mentioned earlier.

9 Efforts of the Municipalities in Japan (Topic 6)

In discharging their responsibilities for waste management practices, the challenges the municipalities face and the countermeasures they adopt, differ depending on the size of the city, its geography, and economic and social conditions. Based on the history and case studies of waste management in Tokyo (large-scale and capital city), Fujisawa City (medium-scale city), and Shibushi City (small-scale city), this Topic aims to provide experiences and lessons learned that will be useful references for local governments in developing countries to handle similar issues, such as responding to increasing waste amount and waste diversification associated with economic growth, pioneering efforts in intermediate treatment and recycling, and building public consensus for source separation and waste reduction.

Topic 6 introduces the waste management practices of the following three municipalities, selected based on their size and characteristics: the 23 special cities of Tokyo representing a large municipality, Fujisawa City a medium-sized municipality, and Shibushi City a small municipality.

The 23 special cities of Tokyo (hereinafter refer to as Tokyo 23 Cities), the capital of Japan, located at the center of Tokyo, have experienced the challenges of waste management while Tokyo was developing into the large-scale metropolitan capital city of today, and have finally established their current waste management system. Tokyo 23 Cities have also led Japan's waste management program and assisted other municipalities. Local governments in developing countries, especially in capitals and large cities with similar conditions as that of Tokyo, can benefit from the lessons learnt from Tokyo 23 Cities and their experiences.

Fujisawa City is a medium-scale municipality with a population of 430,000. Medium-scale municipalities are suitable for helping to understand the comprehensive system adopted by Japan’s municipalities to manage waste. Fujisawa City has from early on actively engaged the private sector in waste recycling and facilities improvement activities. Thus, Fujisawa City was selected as a representative of medium-scale municipalities. Furthermore, Fujisawa city has maintained records of their waste management efforts for many years, and there are many lessons that can be gleaned from the city’s experiences by municipalities in developing countries aiming to build a comprehensive waste management system including intermediate treatment in the future.

The third municipality selected here, Shibushi City does not have incineration plants and is known for its high recycling rate. Although it has a short history of waste treatment, the city has reduced the amount of waste disposal at landfill by implementing multi-item sorted waste discharge and separate collection to support recycling, and thereby the life of landfill sites has been successfully extended. The case in Shibushi City may be thought-provoking for municipalities of developing countries that are either planning to promote, or are already engaged in recycling. The Shibushi case study demonstrates how the city reached an agreement with its residents and obtained their cooperation during the development process of their multi-item waste recycling system as well as overcoming other issues.

(1) Waste Management Efforts Made by the 23 Special Cities of Tokyo

1) History of Waste Management in Tokyo

From 1900 to the present, the 23 special cities of Tokyo have overcome various waste management problems in changing historical backgrounds. The waste management measures taken in each time period are introduced in this section.

(a) Dawn of the Waste Problem, 1900 - 1955

In the latter half of the 19^{th} century, cholera and plague pandemics were spreading globally and taking measures to protect public health became an issue in Japan as well. The Tokyo Metropolitan Government (TMG) had identified unsanitary conditions as one of the causes of the spread of these infectious diseases, and recognized that prompt and proper disposal of waste and human waste was essential to improve the situation. In 1900 the government of Japan enacted the *Waste Cleaning Ac*t and municipalities assumed responsibility for waste management. In response, Tokyo introduced a waste collection system and started to contract out collection services to business operators. However, in 1908 problems of unreliable waste collection by business operators arose and TMG reversed its decision of contracting out collection and returned to directly-managing waste collection. Furthermore, to cope with the rapidly increasing amount of waste associated with urbanization, Tokyo constructed the first waste incineration plant in Osaki in 1924 and a municipal waste treatment plant in Fukagawa in 1929.

(b) Period of High Economic Growth - Escalation of the Waste Problem, 1955 - 1973

Tokyo's population grew due to the return of evacuees and military personnel, and sanitary conditions worsened, underlining the urgent need to implement drastic waste management countermeasures. In response, Tokyo improved the related ordinances and organization. During this period, the mechanization of waste collection progressed. Furthermore, in 1963, a subsidy system was introduced to support the development of the increasingly required larger waste treatment facilities. The *Waste Management Act* was enacted in 1970, and Tokyo revised the waste ordinances to clearly specify the responsibility of business operators who generate business waste and the importance of obtaining the understanding of residents on the waste management system. Under these circumstances, in 1971, the Governor of Tokyo declared a "war on waste" at the Tokyo Metropolitan Assembly and promoted the development of incineration technology and treatment.

(c) Period of Stable Economic Growth - Addressing the Environmental Problem, 1973 - 1985

Following the enactment of the *Waste Management Act* by the central government in 1970, Tokyo revised the ordinance to clearly specify the responsibility of business operators who generated business waste. As the necessity for reuse and recycling of waste increased, recycling activities and group waste collection were promoted, and thorough discussions were conducted with local residents through explanatory and consultative meetings. In 1985, incineration plants were in operation at only 13 locations and in order to ensure that the combined incineration capacity was sufficient, source separation and separate collection of combustible and incombustible waste were started.

(d) Significant Increase of the Amount of Waste, 1985 - 1990

Rapid economic growth led to redevelopment in Tokyo and a rush to construct new buildings and condominiums. People's lifestyles also changed resulting in generation and disposal of large amounts of waste and increased variation in waste compositions. TMG reacted by calling for waste reduction and recycling.

(e) Introduction of a Sound Material-Cycle Society, 1990 - Present Day

With the revision of the *Waste Management Act* in 1991, promotion of waste reduction and recycling heightened. After the central government enacted the *Act on the Promotion of Effective Utilization of Resources* in 1991, Tokyo started to fully charge for bulky waste collection in the same year and for business waste collection in 1996. Tokyo also established a new ordinance that strictly promoted the reduction of waste generation and reuse of waste in 1992. In 1997, TMG started resource recovery and collection of PET bottles from stores.

More efforts were needed to achieve waste reduction and coming closer to developing a sound material-cycle society, and these included the expansion of waste treatment plants. In the 1990s, dioxins generated from incineration plants by the incomplete combustion of waste became a major social problem in Japan. Tokyo was under pressure to respond to the dioxins problem. Incineration plants were reconstructed, upgraded or altered and new technologies were introduced. During the period from 2002 to 2008 gasification fusion furnaces and ash melting facilities were improved, by 2009 all waste plastics that were not recycled were fully incinerated accompanied by heat recovery, and by 2015 all the ash produced in the incineration plants were reformed into raw material for use in the cement production industry.

Photo 19 Itabashi Incineration Plant (Completed in 1961)

Photo 20 Separate Discharge of Recyclables in Omorideragou Town (1977)

Source: TMG Bureau of Environment

2) Noteworthy Experience: War on Waste

"War on Waste" refers to disputes over the treatment and disposal of waste in the Tokyo 23 Cities, particularly those between Koto City and Suginami City from the late 1950s through the 1970s, which erupted into protests and court battles involving local residents over the construction of an incineration plant. In response to the rapid increase in waste amount, TMG continued to landfill waste in the bay area, and attempted to promote the construction of an incineration plant without the full understanding of local residents. In this background, this was an opportunity to reaffirm the importance of dialogue and cooperation between the local governments and residents regarding the operation of waste management, a common practice today, and the "Principle of waste treatment within the administrative boundary where the waste was generated".

(a) Rapidly Increasing Amount of Waste Generation and Waste Management Dependent on Landfill during the Period of High Economic Growth

The period of high economic growth ushered in changes in the lifestyle of the people towards mass production of products and goods, their increased consumption and early disposal. As a consequence, the waste generated by the citizens of Tokyo increased. In addition, the composition of the generated waste became much more diverse. The increase in waste plastics, bulky waste, and hazardous industrial waste was making the waste management significantly difficult. TMG planned to construct an incineration plant in response to this situation, but the project was promoted without sufficient explanation to the local residents which showed a lack of consideration for their feelings.

(b) Opposition Movement against Construction and Principle of In-City Treatment

The principle of waste treatment within the administrative boundary where the waste was generated was born during the "War on Waste". This principle remains a basic policy of waste management in Tokyo 23 Cities even at present. In some instances a treatment facility in one special city accepts waste from a neighboring special cities. In such instances adjustments are made to distribute the burden of nuisance impartially amongst the 23 cities.

(c) Path toward Reconciliation and the Terms of Settlement

The Suginami incineration plant construction problem was resolved after a long process spanning eight years since the Takaido district was first announced as the planned site in November 1966. The basic determining factors of the settlement were the acknowledgement of the need for reliable pollution control and the importance of residents' participation from the planning phase. Since then, when facilities are to be developed, resident participation is ensured from the planning phase.

(d) Lessons Learned - Changes in Tokyo Residents' Awareness of Waste Treatment

The background of the movements against the construction of incineration plants that took place in various regions during the era of the "War on Waste", was local residents' concerns about pollution and that the importance and seriousness of municipal waste management were not fully shared with the local residents. Since the declaration of the "War on Waste", the awareness of Tokyo residents regarding the waste problem changed dramatically through the blocking of waste coming into Koto City and the problem of constructing Suginami Waste incineration plant. Although waste management is one of the most fundamental urban issues, along with urban planning and water and sewerage systems, the people of Tokyo did not necessarily have such awareness. Rather, they were more conscious of avoiding waste. The declaration of the "War on waste" greatly changed such conception and raised awareness that waste is a very serious problem. It also led to the realization that it is important for project implementers to repeatedly communicate the necessity and safety of the facility and promote the understanding of local residents. Since the "War on waste", the construction of waste treatment facilities has been conducted with the participation of local residents, including careful explanation and incorporation of their requests from the planning stage. In addition, agreements were signed with representatives of residents' groups to operate the facility in compliance with laws and regulations and self-imposed limits, disclose various data on the facility's operations and provide tours of the facilities.

(2) Waste Management Efforts Made by Fujisawa City

1) History of Waste Management in Fujisawa City

Fujisawa City has developed its waste management along with the times, from the improvement of waste collection to the full-scale introduction of 3Rs, and the period from the 1945s to the present is divided into four periods.

(a) Period of Seeking a Better Waste Collection Method, 1945 - 1964

The history of waste management in Fujisawa City began in this period. Waste collection carried out by private sector operators started in 1947 and three years later, the collection operation was changed to direct management by the city. Late in this period, the amount of generated waste significantly increased due to the expansion of the urban district, increase in population, and enhanced standards of living. Accordingly, door-to-door collection was changed to station collection, and use of mechanized collection vehicles was promoted.

(b) Period of Seeking Proper Waste Treatment for Bulky Waste, 1965 - 1974

Accompanied by the high economic growth, consumption styles diversified and discharging of bottles, cans, and home appliances in the waste increased. Both the quantity and quality of waste significantly changed. In addition, the central government thoroughly revised its former *Public Cleansing Act* and enacted the *Waste Management Act* with the aim to secure and preserve appropriate living environment, and regulate waste management from a broad perspective, thereby fundamentally addressing waste management issues throughout the entire municipality.

(c) Dawn of 3Rs and Period for Development of Intermediate Treatment Facilities, 1975 - 1994

The amount of waste continued to increase and the contents of waste were diversified as well. Consequently, it became difficult to conduct proper treatment and disposal of waste collected based on only two categories: municipal waste and bulky waste. To find an effective means for waste reduction, the “Fujisawa City Waste Reduction Promotion Office” was established in April, 1977, and waste reduction and recycling measures were regularly discussed. Fujisawa City invited citizens to participate in the discussions at the early design phase of the waste management system instead of asking citizens for their cooperation after the system had been designed. As a result, a waste separation system was successfully established. It was favorably accepted by the citizens. In October 1990, Fujisawa City established the “Fujisawa City Waste Control Conference” with the participation of four parties: citizens, business operators, academic experts, and municipal administration officials. The Conference proposed measures to reduce the amount of waste by 20% by the year 2000, to the mayor of Fujisawa City in October 1991.

(d) Period of Full-Scale 3Rs Introduction, after 1995

The amount of generated waste nationwide began to increase in the 1980s. Municipalities hastened to improve landfill sites, and started to seriously engage in waste management based on the 3Rs policies, and increased source separation and separate collection activities for some recyclables. In 1999, the collection of PET bottles was initiated citywide, followed by source separation and separate collection of miscellaneous waste paper resources in 2001. In the same year, with the implementation of the *Small Home Appliance Recycling Act*, four home appliance items were excluded from the general collection, and the separate collection of plastic containers and packaging was introduced in 2002.

In 2014, the Recycle Plaza Fujisawa was completed. The Recycle Plaza incorporated a recycling facility and a public educational facility, thereby greatly contributing to public awareness of waste management. This type of recycle plaza has been constructed nationwide since 1990.

2) Noteworthy Experience: Recycling of Recyclables - Fujisawa Method

In the 1970s Japan's major municipalities became involved in separated waste collection. At the time the objective behind separate waste collection was to support the proper treatment of waste, and was not for the promotion of recycling. In those days, incineration was the main method of waste treatment and therefore, incombustible waste and bulky waste that could interfere with the incineration process were separately collected and not taken to incinerators. Many municipalities started to separate recyclables for the purpose of recycling in the 1990s. However, Fujisawa City was engaged in recycling of recyclables earlier, in the 1970s through the joint activities of citizens, municipal administration, and collection operators. This method was referred to as the "Fujisawa method" which attracted countrywide attention.

3) Experience of Construction and Renovation of Incineration Facilities

Construction of waste incineration facilities requires the understanding and agreement of local neighborhood residents through having a dialogue with them. When the new plant, Ishinazaka Environment Center was constructed at the site of the old Ishinazaka incineration plant in Fujisawa City, the neighboring areas were crowded residential areas and strict environmental measures were required. Furthermore, as the service life of incineration facilities is long, ranging from 30 to 35 years, it was necessary to respond to changes both in waste quality, as well as in laws and regulations during the long operation period. Fujisawa City also took countermeasures against high-calorie heat generation and dioxins.

(3) Waste Management Efforts made by Shibushi City

1) History of Waste Management - Waste Recycling Project around the Time Shibushi City was Established

The former towns of Shibushi, Ariake, and Matsuyama did not have any incineration plants and the collected waste was discarded in a landfill located in a depressed area surrounded by mountains. However, with the rising concern for environmental problems, it became impossible to continue discarding waste in this location. Accordingly, in 1990, the South Soo Welfare Association, consisting of the former towns of Shibushi, Ariake, and Osaki, constructed a controlled-type landfill site with a landfill capacity of 720,000 m^3 to directly receive waste generated from those three towns without separating waste items. Since waste was simply dumped in the landfill site, the site became a breeding ground for flies, mosquitos, rats, and crows, causing an offensive odor, and as a consequence a large number of complaints from neighboring residents were lodged with the South Soo Welfare Association. Furthermore, estimates showed that the landfill site would become full in 1998 if direct landfill continued without separating waste items. Thus, waste reduction became an urgent issue. From that time, Shibushi City started to actively work on the recycling.

Table 6 Shibushi City's Efforts in Waste Management from the Inauguration of the City to the Present Date

Start year	Event and project
1990	The former towns of Shibushi, Ariake, and Osaki (South Soo Welfare Association) constructed a controlled-type landfill site with a landfill capacity of 720,000 m^3.
1998	Source separation of cans, bottles, and PET bottles started using designated bags.
1999	Started the sorting process of the above at the Soo Recycle Center, which was completed in 1999.
1999	Collection of 19 items of resources was started at 500 stations in the city.
2003	Started the source separation of 24 items.
2004	The source separation of kitchen waste started three times a week at 600 stations in the former town of Shibushi and Ariake. Composting started in the Soo Recycle Center.
2006	Shibushi City was established through the merger of 3 towns. The source separation of kitchen waste started at the former town of Matsuyama.
2007	The door-to-door collection of bulky waste started.
2011	JICA Partnership program (Grass-roots technical cooperation) project (Fiji)
2013	Collection of small home appliances started. The number of items to be separated became 27.
2018	The source separation of disposable diapers started in model districts.
2019	The model districts for the sorted collection of disposable diapers were expanded.

Source: by interview to Shibushi City

Photo 21 Collected Recyclables at Collection Area

Photo 22 Waste Discharge by Resident

Source: Yachiyo Engineering Co., Ltd.

2) Noteworthy Experience: History of Separation of 27 Waste Items - Shibushi Model

The three former towns of Shibushi, Ariake, and Osaki constructed a full-scale final disposal facility in 1990. However, as the amount of waste brought in increased year by year, it was estimated that the facility would become full by 2004, even with the introduction of separate collection of cans, bottles, and PET bottles. Although construction of full-scale incineration facilities was discussed, there was concern that costs for construction, maintenance, and management of incineration facilities would become a huge burden on the city in the future. As a result, Shibushi City decided to carry out a thoroughgoing recycling for the purpose of waste reduction so as to extend the life of the landfill site.

In contrast to the previous stance of “It is OK to put anything in a black bag”, municipal personnel in charge visited neighborhoods to explain to residents to “Write your name on the waste bag and discharge it responsibly”. The black plastic bags with no names on them were not designed to raise awareness that the person putting out the waste should be responsible for separating it properly, as long as it was impossible to tell who put out what and what was put out.

The city actively promoted public awareness activities. Briefing sessions with residents were frequently held to provide an opportunity for each resident to express an opinion. In briefing sessions, the current conditions of the landfill site and the necessity of recycling were explained in detail. Some residents objected on the grounds that it was troublesome to separate waste, but administrators visited them and respectfully explained the reasons for change. In addition, environmental education programs were implemented 76 times in 2016 and altogether 1,868 people participated in the programs.

The city’s painstaking efforts changed residents’ consciousness about waste management. It seemed that the attitude of sorting waste being “troublesome” changed into an attitude of “gratitude”. This was because residents do not need to store the kitchen waste at home.

The city successfully reduced waste to be disposed of in the landfill by 80% in 2008 and the recycling rate remained very high in comparison with the national average. The landfill site significantly changed because kitchen waste was not being landfilled there anymore. The offensive odor, flies, crows, and rats disappeared. The reduction of the amount of waste being deposited into the landfill made it possible to extend the life of the landfill site.

10 Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects (Topic 7)

This topic introduces examples of JICA projects that were implemented in developing countries to support their waste management systems and tackle specific issues related to improvement of collection and transport, introduction of inter-municipal treatment, appropriate disposal site management, and promotion of 3R activities.

In order to solve these issues, this topic provides Japan's past experience in addressing similar issues and the technologies applied, as well as the lessons learned from the implementation of the project, as a reference, that can be used by developing countries to address similar issues.

An overview of Japanese experiences, technologies, and lessons learned from international cooperation projects in Sudan, Palestine, El Salvador, Bangladesh, Malaysia, and Vietnam are summarized hereafter.

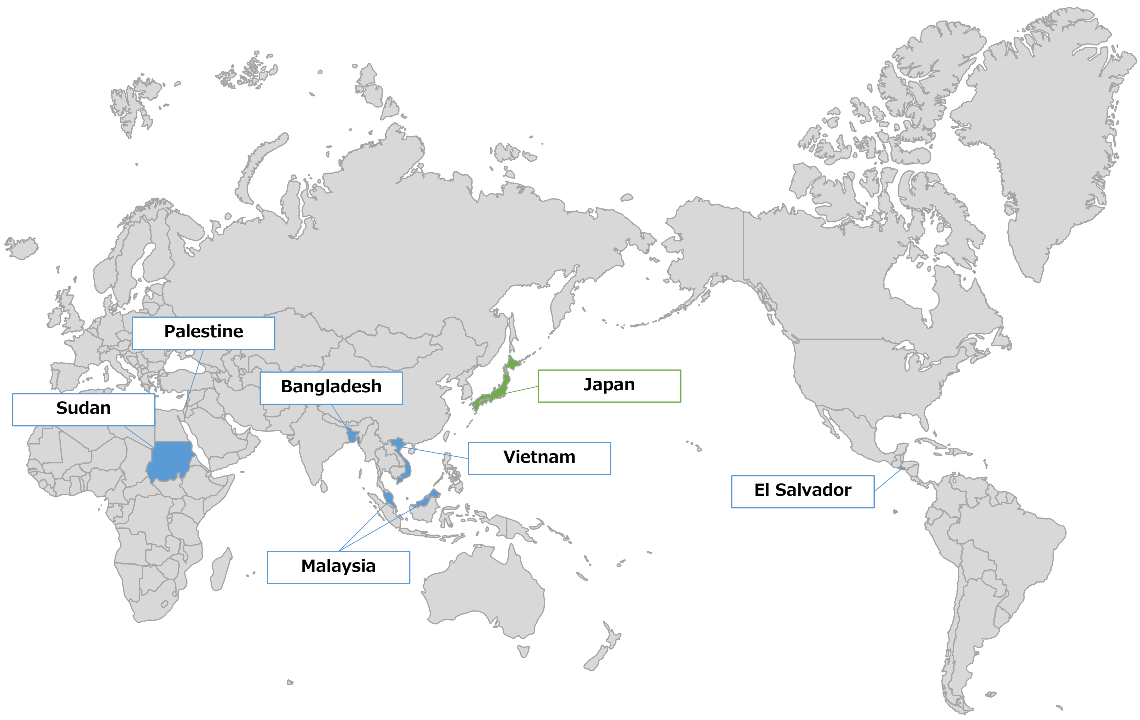


Figure 24 Locations of Countries Covered in Topic 7

(1) Republic of the Sudan ～ Introduction of "Fixed-Time Fixed-Place (FTFP) Collection"～

1) Background

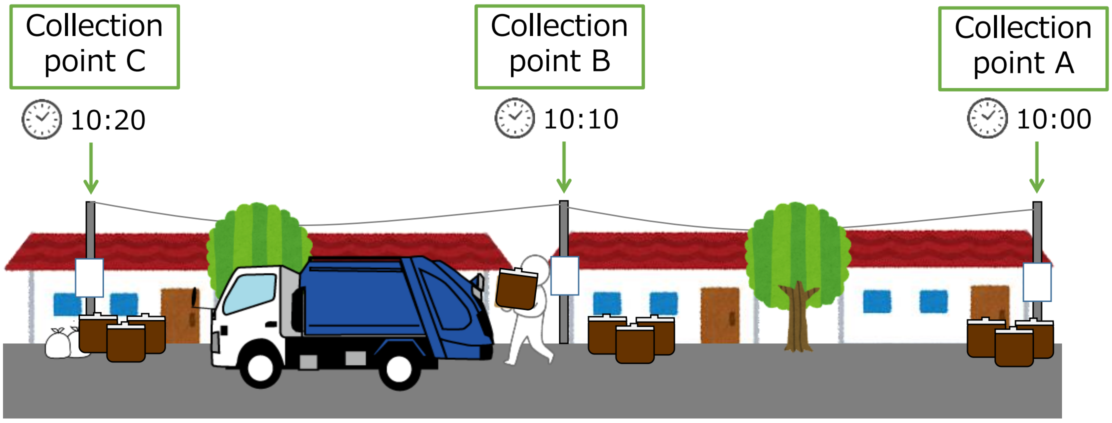
In Khartoum, the capital of the Republic of Sudan (hereinafter referred to as "Sudan"), waste was collected and transported by aging and inadequately maintained collection vehicles due to deterioration of the security situation and financial constraints. As a result, uncollected waste was scattered around the city, degrading the sanitary environment, especially in low-income neighborhoods. Residents were not sure when the waste they discharged would be collected. Residents also had very little interest in waste management because adequate waste collection services were not provided, and waste management were implemented without their cooperation or involvement.

Figure 25 Sudan Location Map

2) Application of Japan's Experiences and Technologies

(a) Introduction of Fixed-Time Fixed-Place (FTFP) Collection

A decision was made to introduce FTFP collection - which has become a mainstream system in Japan - in Khartoum to improve waste collection. FTFP collection is a method of collecting waste discharged at designated collection times and locations. There are a number of advantages in introducing FTFP collection, which include maintaining the cleanliness of communities by prohibiting the discharge of waste outside of designated collection times, reducing time period collection that vehicles spend on routes, and increasing collection efficiency. However, FTFP collection also comes with its own set of challenges: residents may feel burdened because they need to bring waste to specific places at designated times, the sense of individual responsibility may be diminished because it is impossible to identify the generators of the waste discharged, and it can sometimes be difficult to select and coordinate collection sites.



Source: Yachiyo Engineering Co., Ltd.

Figure 26 Image of FTFP Collection

Pilot Project

In Khartoum, pilot projects (PP) were carried out in several areas to examine the possibility of full-scale introduction of FTFP collection. A PP is the process of implementing a system that is being considered for full-scale implementation, together with collecting data to test the system and determine whether it is suitable and achieves the objectives set out. Collecting, analyzing, and verifying data before and after PP implementation makes it possible to measure the effectiveness of PP. The implementation of PP will provide decision-making materials necessary for examining the future direction of the project and knowledge on matters to be considered during the full-scale introduction.

Public Awareness

A public awareness campaign was conducted in Khartoum to promote FTFP collection. FTFP collection places comparatively high burden on residents, which poses a challenge, and the system will not be successful without their cooperation. Therefore, government staff in Khartoum implemented public awareness building activities for the project team (consisting of government officials, community representatives, and other concerned parties) and residents. Through these activities, it was possible to provide residents with opportunities to realize the benefits of FTFP collection and recognize that waste is their own problem.

Photo 23 During PP Implementation **Photo 24 Study Tour**

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Evaluation of Feasibility through PP Implementation, Identification of Ongoing Challenges and Improvements, and Reflection in Collection Plans

By implementing PP for collecting and analyzing data before and after the introduction of FTFP collection, it is possible to quantitatively evaluate FTFP effectiveness. The issues identified in Khartoum at the time of the introduction of the FTFP collection were also found in projects in other countries, and lessons learned can be utilized to other cases. In the planning stage, information necessary for FTFP collection - type and number of collection vehicles, characteristics of the area to be collected (road conditions, etc.), collection routes, number of households to be collected, location of collection sites, etc. - should be shared in advance among the heads of administrative agencies in charge of waste management, officials in charge of collection planning (personnel and vehicle allocation planning), collection staffs, resident representatives, and other relevant parties. It is important to discuss solutions to possible problems through a series of collection and transportation processes. It is equally important to identify issues and points for improvement through periodic monitoring after the introduction of the FTFP collection, and to continuously review the collection plan.

(b) Need for Continuous Awareness Building Activities

While cooperative at the start of a project, residents can become less motivated with the passage of time. In order for the administration and residents to jointly work together continuously while recognizing their respective responsibilities, administration officials must promote understanding by local residents on waste management through regular meetings and awareness building activities, including public awareness programs and environmental education, and reflect the ideas and opinions collected from residents in waste management services. Regarding awareness-raising, it is important to combine various activities, such as holding community meetings and study tours as well as to maintain the continuity of these activities. There also needs to be a mechanism to involve key persons in the community in the activities and to encourage residents to change their behavior and ways of thinking. On the other hand, residents are also expected to be aware of their own responsibilities for the waste they generate and be actively involved in waste management services provided by the government.

(2) Palestinian Interim Self-Government Authority, PA
～ Improving Waste Management through the Introduction of Inter-Municipal Waste Management ～

1) Background

The Palestinian Interim Self-Government Authority (hereinafter referred to as "Palestine") is divided into the West Bank bordering Jordan to the east and the Gaza Strip bordering the Mediterranean Sea to the west and Egypt to the south. The municipalities that make up Palestine are small and each municipality is responsible to collect and dispose of its waste. The waste collection rates were extremely low due to a lack of collection vehicles because of the short supply of financial resources in the municipalities providing the cleaning services. The collected waste was not disposed of properly, and instead was openly burned or dumped, and sanitary conditions were poor. With population growth and transportation barriers, Palestine faced challenges centered around a lack of access to disposal sites, waste management businesses that were not economically viable due to increasing operation and maintenance costs, and improper disposal practices, such as open burning, which created health hazards for residents and environmental pollution problems.[6]

Figure 27 Palestinian Location Map

2) Application of Japan's Experiences and Technologies

(a) Creating a Foundation for the Introduction of Inter-Municipal Waste Management

Waste management in Palestine, which had been carried out by smaller municipalities, is to be implemented by a regional association called the Joint Service Council (hereinafter referred to as "JSC"), under a collaborative initiative by several municipalities. The JSC aims to create an inter-municipal waste management system that will place a small burden on each municipality and provide stable waste management services throughout the entire region. In addition to reducing the budgetary burden on each municipality through the efficient operation and maintenance of collection vehicles and sharing the final disposal site, the inter-municipal system will allow for an increase in the size of the disposal sites and improve the efficiency of construction and operation.

[6] Due to the long-standing conflict with Israel over land, Palestine has become an enclave, and its land area continues to shrink due to repeated Israeli settlement activities. In order to travel between Palestinian areas, one must pass through "checkpoints" set up by Israel on the border. Palestinians are not allowed to enter without an Israeli permit.

(b) Activities to Build Public Awareness on Waste Fee Collection

Costs related to inter-municipal waste disposal in Palestine are covered by waste disposal fees collected from residents. In general, compared to other public services (e.g., electricity and water), waste management is often not a top priority for residents, and it is difficult to enforce fee collection systems without their understanding of the importance of collecting fees. While Palestinian residents tend to be less environmentally conscious, some are not aware of the JSC's activities or may be concerned whether the introduction of inter-municipal waste management will actually improve waste management conditions. Therefore, a variety of activities were implemented to help residents understand the need to collect fees, such as the organization of information sessions for residents, and production of newsletters, leaflets and posters, documentary films, and TV advertisements.

Photo 25 Waste Collection (Ramallah - Al Bireh JSC)

Photo 26 Workshop with Residents

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Improvement of Efficiency of Waste Management through Inter-Municipal Waste Management

Smaller municipalities, where resources are in chronically short, have difficulty continuing to implement quality waste management. One proposed solution is the introduction of a system called "inter-municipal waste management", in which surrounding municipalities come together to jointly implement waste management. When introducing inter-municipal waste management, an inter-municipal association that will function as a secretariat must be established that will be run through the cooperation of participating municipalities.

In order to reduce the burden on each municipality during the organization creation phase, it is important to first investigate the existing equipment, human resources, capabilities, systems, financial resources, mechanisms, and facilities possessed by the municipalities comprising the JSC, and combine them for effective utilization, rather than purchasing new equipment or hiring new personnel at the outset. Reducing the burden in the initial stages will lead to the smooth establishment of the JSC and the continuation of its subsequent operations.

(b) Introduction of Waste Collection Fees

When starting the collection of waste disposal fees, it is important to set an amount that the residents can afford and accept. In the Jericho and Jordan Valley areas, as a result of discussions within JSC, a waste disposal fee was set at an amount that would cover the JSC operating costs and that would not be a burden on the residents. After repeated explanations and discussions with the local residents through explanatory meetings and other means, the residents finally agreed that the waste disposal fee was appropriate.

On the other hand, the actual collection of fees is difficult, and in order to continue the waste management, it is necessary to consider measures such as increasing the fees. In order to improve the rate of fee collection, not only the quality of waste disposal service needs to be improved, but also various measures such as continuous dialogue with residents, suspension and resumption of service, and fee collection together with other public services (electricity, water, etc.) are required.

(3) Republic of El Salvador ～ Path to Proper Management of Sanitary Landfill Sites ～

1) Background

El Salvador did not have a waste management system in place, and waste was usually disposed in open dumps. The resulting increase in disposed waste caused groundwater pollution and contaminated the soil, creating adverse effects on people's health and ecosystems. To improve conditions, El Salvador enacted an *Environmental Law* in 1998 requiring all municipalities to close open dumping sites and build sanitary landfills by September 2007. There was an urgent need for the systematic and phased development of sanitary landfill sites and to reduce the volume of waste, leading the government of El Salvador to decide that it was necessary to bolster the waste management capacities of municipalities.

Figure 28 El Salvador Location Map

2) Application of Japan's Experiences and Technologies

(a) Construction and Proper Maintenance, Management and Expansion of Sanitary Landfill Sites Using the Fukuoka Method

ASINORLU is an inter-municipal association, which was responsible for operation and maintenance of the final disposal site. In 2006 the Santa Rosa de Lima Landfill, managed by ASINORLU was being operated as an open dump site. During the project improvement works were constructed at the site to transform the open dump into a semi-aerobic landfill, applying the Fukuoka method [7] developed in Japan. As a result of the improvement project, waste is no longer scattered around the sanitary landfill site as it was with open dumping, which indicates a dramatic improvement in environmental conditions as well. The reasons behind the site's proper maintenance as a sanitary landfill is the application of daily soil cover over the freshly disposed waste, thorough cleaning of storm water drains and site roads, and preventive maintenance of heavy equipment.

(b) Introduction and Expansion of Regional Waste Treatment through Inter-Municipal Cooperation

ASINORLU is composed of nine cities. It is necessary to reach agreements with each of the nine cities on setting disposal (tipping) fees to be paid to ASINORLU in order for waste to be accepted at

[7] In the semi-aerobic landfill system, gas venting pipes and leachate collection and drainage pipes are installed to allow air to flow naturally into the interior waste layers. The supply of oxygen to the interior of the disposed waste layers increases the speed of waste decomposition, decreases the concentration of pollutants in the leachate, and suppresses odors and methane gas emissions. As a result, the stabilization period of the landfill site is shortened. The Fukuoka method is becoming popular in developing countries because inexpensive local materials such as waste tires, drums, bamboo, and rubble can be substituted as materials for pipes and paving stones.

the landfill site. Since waste management is not always a high priority for mayors, ASINORLU provided detailed explanations to each mayor and obtained their consent to increase the cost for disposal. In addition to that, the citizens' understanding of waste management was promoted through environmental education and 3R activities at schools and government offices, and tours of disposal sites.

Source: Yachiyo Engineering Co., Ltd.

Photo 27 Newly Constructed Sanitary Landfill (Phase 2)

Photo 28 Briefing to the Mayor

Photo 29 Site Visit at the Regional and National Seminar

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Political - Examining the Impacts of Changes in Government Administration

In El Salvador, the term of office for the President is five years, while the term of office for mayors is three years. A change in government, including political party, can result in significant changes in policy. In some cases, waste management falls in priority, budgets are reduced and, the introduction of inter-municipal waste management by associations has been postponed for reasons such as these. Every time the mayor of a city in the association changes, it is important for staff from the association to visit the city and provide a detailed explanation of the situation to the new mayor and city council.

(b) Financial - Securing Funding

It is important for the central government to establish a budgetary framework for the development of inter-municipal waste management facilities. Only with this framework can inter-municipal cooperation be promoted in detail, and it will be easier to obtain the commitment of each municipality. The role of the central government should be to raise funds from donors and promote the allocation of the country's budget.

(c) Public Participation - Importance of Disclosing Information

An important factor in promoting inter-municipal waste management is the fair disclosure of information about project plans and outlines, and impacts on areas around facilities from the early stages of the planning process. As a first step, it is important to provide examples of proper development and operation and maintenance of landfill sites to avoid NIMBY-related problems.

Participation by residents and communities is an essential part of the waste management process, and incorporating their opinions, including opposing views, into project plans from an early stage and solving problems that arise will put the project on a fast track to implementation. There have been several cases where projects did not make it to the implementation phase due to failures to disclose information. Encouraging residents to actually visit sites through field trips to landfill sites and treatment facilities will also help them see waste issues as something that concerns them and will dispel causes for concern.

(d) Organizational - Securing Human Resources

As counterparts of projects move on, the experience and knowledge from the project and results of training in Japan may leave with them. However, in ASINORLU, counterparts are still directly involved in waste management, and significant developments have been observed even after the project ended. When staff are replaced within an organization, it is necessary to devise ways to retain the skills and methods developed through the project within the organization.

(e) Organizational - Improvement of Staff Motivation

In order to continuously maintain and manage a facility, it is important to motivate and maintain the staff involved in operation and maintenance management. In addition to a good working environment and a stable salary, visualization of work results, appropriate evaluation of work, and attention from others can also effectively motivate employees.

(f) Country Differences - Challenges in Expanding Systems to Other Countries

El Salvador is working on expanding lessons learned to other countries in Latin America based on ASINORLU's experience. However, it is not always possible to be applied successfully due to differences in laws and political systems in target countries. Conditions in other countries must be taken into account, and cooperation is needed to develop countermeasures to address this.

(4) People's Republic of Bangladesh ～ Community Participation in Waste Management～

1) Background

The population of Dhaka, the capital of Bangladesh[8], is estimated to be over 20 million. With rapid urbanization, the city is facing growing urban environmental problems, such as waste, air and water pollution. In Dhaka, waste management was being collectively implemented by the city government, but in such a large city it was difficult for an individual organization to be consistent in managing the discharge, collection and transport, intermediate treatment, and final disposal of waste. In addition, waste management in Dhaka City had been stagnating due to weak organizational structures, lack of equipment, and low sanitary awareness among the population.

Figure 29 Bangladesh Location Map

2) Application of Japan's Experiences and Technologies

(a) Ward Based Approach (WBA)

The Ward Based Approach (WBA), a management method for stable and continuous implementation of field-led waste management in wards[9], which are the smallest administrative units in Dhaka City, was introduced. Through WBA, for each ward, various activities such as staff training and awareness raising, improvement of organizational functions, improvement of equipment, and improvement of collection systems are combined in a synergistic manner to improve waste management. WBA consists of four activities: (1) Construction of ward cleaning offices and strengthening field management, (2) Improvement of working environment for cleaner, (3) Promotion of public participation, and (4) Improvement of collection and transportation.

WBA1 - Construction of Ward Cleaning Offices and Strengthening Field Management

In order to create a base in each ward to help wards improve waste management on their own, ward cleaning offices were constructed, and their functions strengthened. The offices were built to serve a

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[8] The term "Dhaka City" refers to the former Dhaka City before the partition of the city into North and South Dhaka in 2011, which is now the combined area of Dhaka North City and Dhaka South City. In this material, "Dhaka City" is used for the sake of convenience.

[9] The smallest administrative unit of a city area. Multiple wards make up a single zone. As of 2022, there are approximately 130 wards in Dhaka City (Dhaka North City: 54 wards in 10 zones; Dhaka South City: 75 wards in 10 zones). The population per ward consists of tens to hundreds of thousands of people.

number of functions, including; as a point of contact for residents to reach out with complaints, a base for labor management and guidance for cleaner, a place for cleaner to take breaks, and a storage space for cleaning tools.

WBA2 - Improvement of the Working Environment for Cleaner

In Dhaka City, a safety and health committee was established to raise safety and health awareness and improve work efficiency, thereby providing a foundation for ensuring the occupational safety of the cleaner. A manual with diagrams was prepared for cleaner so that even those who couldn't read were able to understand the contents, and points to be kept in mind relating their work were made known to them. In addition, safety gear such as masks and gloves were distributed to cleaner to protect their health and safety, and information on how to use first aid kits and nearby hospitals were provided. Furthermore, a workshop was held to share with the cleaner the aims of waste management in Dhaka and to encourage their awareness that they, as city employees, are involved in the waste management.

WBA3：Promotion of Public Participation

In order to implement community-based participatory waste management, it was necessary to attract the attention of many residents and encourage them to change their behavior, and the participation of influential figures in the community was essential. Therefore, a survey was conducted to identify representatives and influential figures of local residents' organizations in each ward and new residents' organizations for waste management were established, with the identified individuals as key persons. Activities were mainly carried out through these community organizations to encourage the participation and cooperation of local residents in waste management. Activities included a march by local residents calling for city beautification projects, campaigns to raise awareness of the environment through plays and musical events, and clean-up campaigns organized together with cleaner.

WBA4：Improvement of Collection and Transportation

In order to remove large dustbins and containers causing unsanitary conditions in the city and traffic congestion, Dhaka City introduced compactor trucks for secondary collection. In parallel, the city introduced fixed-point collection, in which waste is discharged at a designated time and place. Unlike dustbins and containers, the time that waste was kept in the city was reduced, contributing to improved sanitation.

Photo 30 Meeting with Cleaners in Ward Cleaning Office

Photos 31 Part of the Cleaner Work Manual

Photo 32 Residents Cleanup Activities

Photo 33 Waste Collection by Compactor (Fixed-Place Collection at Regular Intervals)

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) To Improve Integrated Waste Management

WBA is an effective method for developing site-driven participatory waste management in the community. The construction of the ward cleaning 0ffice provides administrative work space for the cleaning supervisors and a place for the cleaner to rest and store their safety gear. It also serves as a point of contact for residents to casually discuss waste management issues, helping to build a relationship between the government and residents.

Protecting the occupational safety of cleaner is also important to avoid the sudden absence of cleaner due to injury or illness, especially if weakness in occupational safety interferes with collection work. Collection services can be improved by selecting appropriate collection methods, allowing services to be provided that not only consider the sanitation of local residents and the surrounding environment, but also the health and safety of the cleaner who perform collection work.

In order to encourage the participation of residents, who play an essential role in promoting proper waste management, it is important to identify local representatives and influential people in the community and establish a resident's organization led by these individuals. The existence of such an organization will establish a foundation for local residents to work together and contribute to the implementation of activities to improve the sanitation environment in the community.

(5) Malaysia ～ Data Management Systems, Dissemination of 3R Activities and Environmental Education ～

1) Background

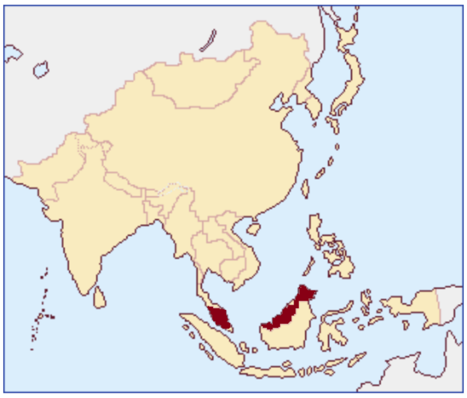


Figure 30 Malaysia Location Map

In Malaysia, prior to the transfer of waste management and recycling administration to the central government (National Solid Waste Management Department) in 2011, waste management was a local government task and the Ministry of Housing and Local Government (MHLG) was in charge of waste administration. Since the mid-1980s, Malaysia has experienced an increase in the amount of waste generated due to urbanization and diversification of lifestyles in line with economic development, as well as problems with disposal costs and securing landfill sites. Therefore, the National Development Policy has emphasized the concepts of reduce, reuse, recovery, and recycling, and made recommendations on the use of environmentally friendly products. In addition, the Ministry of Housing and Local Governments (MHLG) has been promoting recycling and raising awareness with citizens on the 3Rs at the national level, while local governments have promoted recycling activities. However, these efforts were limited to only a few local governments that had an advanced level of environmental awareness, and recycling rate was only 2% to 5%.

2) Application of Japan's Experiences and Technologies

(a) Development of a Data and Information Management System

One of the Japanese technologies that has been applied under the project in Malaysia is for creating databases on waste. A database was created in an information management system using data on the collection of recyclable materials digitally submitted by local governments and key information related to recycling shown below.

- General information about the local government: address, contact information of officer(s) in charge, website URL, etc.
- Collection centers, collection container locations, administrators
- Types of recyclable materials collected
- List of related organizations submitted by the local government

This database has made it possible to access and search key data, as well as create tables and graphs for purposes of research, analysis, and publication.

(b) Source Separation

Five target groups were selected in this project to verify source separation under different conditions: (1) general households (single-family houses), (2) general households (apartment complexes), (3) office buildings, (4) mega-marts, and (5) hotels. After targets were selected, waste was separated at source through the establishment of separation methods and collection routes for resources, and the organization of workshops and briefings to obtain stakeholders' understanding and cooperation. Finally, source separation guidelines were developed to promote separation at source. For each business operator, it took time to coordinate with the pilot project for introduction of source separation, because they were required to bear the costs of labor for sorting the waste, costs to purchase containers for the sorted recyclables, as well as to allocate personnel and consider a location for placing the containers.

(c) 3R Activities and Environmental Education

Prior to the start of activities, guidelines were developed for promoting the 3Rs in schools in collaboration with the ministries in charge of waste management, Ministry of Education, local governments, and school teachers. Based on these guidelines the schools were classified into levels according to the extent existing waste reduction programs were already being implemented. The guidelines also indicated the need to incorporate PDCA (Plan, Do, Check, Act) cycles to review and improve 3R activities that have been planned and implemented. It was important to initially provide appropriate guidance to school teachers so that guidelines could be properly implemented in educational settings, and therefore 3R workshops were also organized for teaching staff. Based on these activities, 3R programs were implemented in schools in Miri City, Johor State and other areas.

Photo 34 Briefing on Source Separation Activities to Residents

Photos 35 Awareness Survey on 3Rs in Schools

Source: JICA, Yachiyo Engineering Co., Ltd., EX Research Institute Ltd. "The Study on National Waste Minimization in Malaysia Final Report" (2006)

3) Lessons

(a) Training and Securing Competent and Appropriate Human Resources

Data management, updates to networks, and monitoring are essential aspects of waste management operations. Therefore, in order to maintain data management systems, it is necessary to educate not only the central ministries and agencies that manage the databases, but also the local government administrators who collect and submit data, and to appoint competent, appropriate, and trained personnel to maintain the systems.

(b) Coordination between Stakeholders on Source Separation

It took time to coordinate with the parties concerned, as they were required to bear the costs of labor and sorting containers for the introduction of source separation, as well as to allocate personnel and secure an installation site. Source separation programs for commercial facilities, such as supermarkets and hotels, faced various problems such as informing customers and gaining their understanding of cost burdens, etc. in terms of coordinating and negotiating with stakeholders. These problems lay beyond the control of local governments and the project team, and caused significant delays in the implementation of the program. For separation at source, it is necessary to coordinate with households and commercial facilities separately, and pay particular attention to the interests of stakeholders of commercial facilities.

(c) Strategic Implementation of Educational and Dissemination Programs through Inter-Agency Collaboration

In order to introduce sustainable waste reduction practices, it is necessary to teach the philosophy of the 3Rs to the younger generation through practical school education and extracurricular activities. Collaborative activities between ministries responsible for waste management (in this case, the Ministry of Housing and Local Government) and the Ministry of Education are essential for the introduction of sustainable and strategic educational and awareness programs suitable to students. The Ministry of Education and teachers were involved from the initial stage in developing guidelines to promote 3R activities in schools, which made the guidelines even more applicable in educational settings. It is important for multiple ministries and agencies to collaborate in order to efficiently implement educational and awareness programs.

(6) Socialist Republic of Vietnam ～ 3R Activities Involving Multiple Stakeholders～

1) Background

Figure 31 Vietnam Location Map

Environmental pollution in Hanoi, the capital of Vietnam, was worsening due to un-collected solid waste scattered on public roads and illegal waste dumping in lakes. Under the nation's environmental strategy to recycle 30% of waste by 2020, the government had been trying to promote a recycling movement for solid waste, but the collection of recyclables remained mainly limited to informal waste collectors.

The 3R Initiative, which combines the Reduce, Reuse and Recycle of waste, was positioned as a key component in the country's environmental strategy. The Ministry of Natural Resources and Environment was established in 2002 to work with local governments on environmental measures related to water and air quality and solid waste management.

2) Application of Japan's Experiences and Technologies

(a) Public Participation Initiatives Involving Various Stakeholders

This was an attempt to apply Japan's experience and knowledge of public participation as a key factor in the sustainable implementation of waste management and the 3Rs. Hanoi's 3R project involved a diverse range of stakeholders, including residents, local communities, government, media, students, experts, the private sector, and NGOs, attempted to position local residents at the center of the project and turn the focus on them. Many groups as described below, were formed to engage in 3R activities, and a wide variety of activities were implemented.

<u>3R Stars</u>; 85 organizations and individuals, including representatives from government agencies, universities, the media, private companies, and model districts, came together to form it.

<u>3R Volunteers Club</u>; These activities included instruction on sorting waste on the streets and in parks, participation in environmental events and other 3R publicity activities, and extracurricular 3R classes at elementary schools.

<u>3R Supporters</u>; The groups focused on 3R awareness-raising activities, such as providing guidance on sorting in the community and preparing and distributing leaflets on sorting methods.

(b) Separate Collection and Composting

As a result of the model project implemented in the four districts (total of four districts: about 18,300 households, population of 72,820) there have been improvements in the separate collection of the recyclables, collection of the food waste, as well as composting. The introduction of fixed time fixed place collection (FTFP) using containers and collection vehicles (trucks and hand-pushed waste carts) for use on narrow roads has made it possible to collect separated waste regularly even in densely populated residential areas. This has improved the rate of separate collection of food waste. The quality of compost improved with upgrades to the composting process. A better understanding of the demand for compost was formed and then market expansion was attempted.

Photo 36 Publicity Activities on the Street by 3R Volunteers

Photo 37 Containers for Designated Wastes in the Park

Source: JICA "Project for Implementation Support for 3R INITIATIVE in Hanoi City to Contribute to the Development of a Sound Material-Cycle Society Final Report" (2009)

3) Lessons

(a) Mobilize and Promote Public Participation of a Wide Range of Stakeholders to Effectively Implement the 3Rs Initiative

The creation of the 3R volunteer program was an opportunity for young people to become interested in the 3Rs and environmental issues and led to independent activities involving residents. In addition, a wide range of stakeholders were invited to take part in discussions at the 3Rs Stars Meeting and to propose their ideas to policy-making organizations.

These activities encouraged public participation and increased the effectiveness and impacts of the project. The greater the interest and louder the voices of the residents, the harder it is for policymakers to ignore them. In today's world, it is necessary to find ways to engage the public that are appropriate to local conditions, such as the use of social networks.

(b) Need for Innovation when Introducing Source Separation

Public participation and behavioral changes are essential when introducing source separation. Even if rules for source separation are established, they will generally not be followed or sustained. Furthermore, consistency between source separation and collection systems and securing a place to pick up separated waste are also essential conditions. In order to introduce source separation and establish relating rules, the introduction of incentives for residents and pick-up locations is considered a challenge, but with the city's budget constraints, no solution has been found.

As with Hanoi's 3R initiatives, one solution may be to motivate residents by involving all stakeholders and guide the momentum of society as a whole in the same direction. However, since it is difficult to ensure sustainability only with the participation of local residents, synergistic effects from multifaceted efforts, such as technological and operational improvements at recycling facilities and the widespread use of reusable containers, are desired. In addition, in a large city such as Hanoi, the challenges of rapid urban expansion continue, and in the waste agenda as well, there is a need to review collection methods along with the development of transfer stations and incineration facilities, and to position source separation and 3Rs in consideration of this background.

Topic 1. Waste Management Facts and Plans

Contents

1 Present Status of Waste Management in Japan

In Japan, various data pertaining to waste management are continuously collected in accordance with the law in an effort to develop an understanding of the circumstances of waste management throughout the country. This continuous accumulation and analysis of data enables a quantitative understanding of trends over time, and is used as basic data for formulating strategies and plans for waste management.

This section uses numerical data to introduce the state of waste management in Japan and presents information obtained from the basic data that can be verified using numerical values. The information presented demonstrates the importance of understanding the circumstances of waste management relying upon basic data and setting numerical targets in waste management plans.

1.1 Definition and Categorization of Waste

Waste is generated from many different sources; therefore, it is essential to have a clear definition of waste when considering anything related to waste management. In Japan the waste is classified into two broad categories by the law: municipal waste and industrial waste.

*This text discusses the municipal solid waste component of municipal waste.

The *Waste Management and Public Cleansing Law* (*Waste Management Act*) of Japan defines waste as follows.

Chapter I General Provisions
(Definitions)
Article 2

1 In this Law, "waste" refers to refuse, bulky refuse, ashes, sludge, excreta, waste oil, waste acid and alkali, carcasses and other filthy and unnecessary matter, which are in solid or liquid state (excluding radioactive waste and waste polluted by radioactivity).

2 In this Law, "municipal solid waste" refers to waste other than industrial waste.

3 In this Law, "specially controlled municipal solid waste" refers to those municipal solid waste specified by a Cabinet Order as wastes which are explosive, toxic, infectious or of a nature otherwise harmful to human health or the living environment.

4 In this Law, "industrial waste" refer to the waste categories defined below:

1) Ashes, sludge, waste oil, waste acid, waste alkali, waste plastics and others specified by a Cabinet Order among all the wastes remaining as a result of business activity.
2) Imported waste (excluding the kinds of waste defined in the preceding Item, those wastes attributable to navigation of a ship or aircraft (confined to the items specified by a Cabinet Order), which are defined as "navigational waste" in Paragraph1 of Article 15-4-2, and waste personally carried into Japan by persons entering the country (confined to the items specified by a Cabinet Order), which are defined as "carried-in waste" also in Paragraph 1 of Article 15-4-2).

5 In this Law, "specially controlled industrial waste" refer to those industrial wastes specified by a Cabinet Order as wastes which are explosive, toxic, infectious or of a nature otherwise harmful to human health and the living environment.

Source: "Waste Management and Public Cleansing Law" (Law No. 137 of 1970)

Accordingly, waste is unwanted matter in a solid or liquid state (excluding gases), and earth and sand are outside the scope of the *Waste Management Act*.

Figure 1-1 shows how waste is categorized in Japan, as well as the characteristics of the waste categorization.

- Wood scraps, metal scraps, and 20 other types of waste from among the waste generated in connection with business activities are defined as industrial waste (Table 1-1 shows categories and examples of waste items).
- Industrial waste that is potentially explosive, toxic, or infectious is defined as specially controlled industrial waste (Table 1-2 provides summaries of the categories).
- Waste, other than industrial waste is classified as municipal waste, which is further categorized into municipal waste, sewage, and specially controlled municipal waste (Table 1-3 provides summaries of the categories). Additionally, municipal waste is categorized into household waste and business waste generated by offices and the like.

(FY[1] 2019 figures: Municipal waste amount generated: 42.74 million tons/year, Industrial waste amount generated: 379.75 million tons/year)

It should be noted that in many countries, construction waste is categorized as municipal waste; however, in Japan, construction waste - generated during the demolition of private dwelling houses - is categorized as industrial waste.

Note that this text generally deals with municipal waste. Additionally, the term “waste” is used to mean municipal waste unless otherwise specified. However, the term may include industrial waste when policies, laws, hazardous waste, dioxin-related problems, and the like are discussed in the relevant text.

[1] In Japan, Fiscal Year (FY) starts from April and ends in March. For example, FY 2019 means from April 2019 to March 2020.

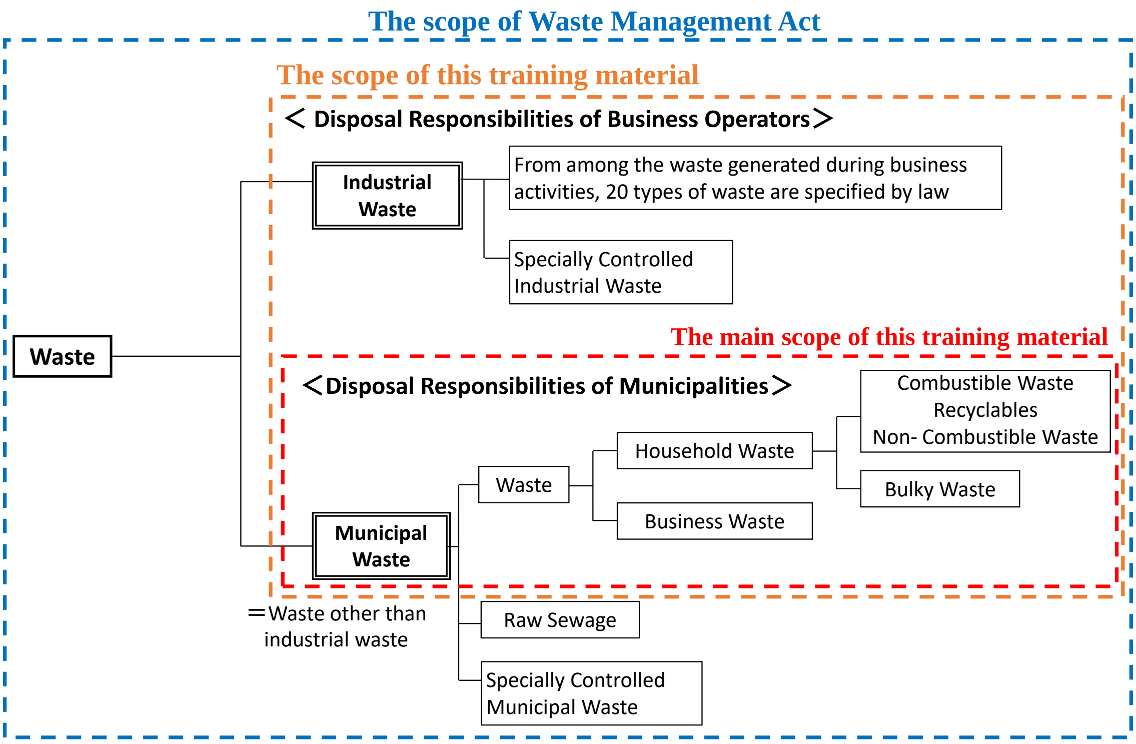


Figure 1-1 Categories of Waste in Japan

Table 1-1 Types of Industrial Waste and Examples of Waste Items

Category	Examples of Waste items
1. Cinders, Ashes	Coal dust, incinerator ash, particles from furnace cleaning, and other incineration residues
2. Sludge	Organic sludge: Paper sludge, sewage sludge, activated sludge, glue dregs, *urushi* lacquer dregs, etc. Inorganic sludge: Coagulated sedimentation sludge, plating sludge, bentonite mud, crushed stone sludge, etc.
3. Waste oil	Waste oils (e.g., lubricating oil, insulating oil, cleaning oil, cutting oil), waste solvents, tar pitch, and all other waste oil from mineral oils and animal and vegetable fats and oils
4. Waste acid	Waste sulfuric acid, waste hydrochloric acid, waste photo developing solution, and all other acidic waste liquids
5. Waste alkali	Waste metallic cleaning liquid, waste photo developing solution, and all other alkaline waste liquids
6. Waste plastics	All waste plastics from solid and liquid synthetic polymeric compounds (e.g., synthetic resin waste, synthetic fiber waste, synthetic rubber scraps)
7. Waste paper	Waste paper from the construction industry (generated by the construction, remodeling, or demolition of structures) and the paper manufacturing, pulp/paper products manufacturing, newspaper, publishing, bookbinding, and printed material processing industries
8. Wood scraps	Wood scraps from the construction industry (generated by the construction, remodeling, or demolition of structures), the lumber industry, wood products manufacturing, pulp, imported lumber wholesaling, and goods

Category	Examples of Waste items
	leasing industries, and wood scraps from pallets used for distributing goods
9. Waste fibers	Items containing waste natural fibers from the construction industry (generated by the construction, remodeling, or demolition of structures) and the textile industry (excluding the clothing/other textile product manufacturing industry)
10. Animal and vegetable residues	Animal and vegetable residues used as raw materials in the food products manufacturing, medicinal product manufacturing, and fragrance manufacturing industries
11. Solid animal waste	Solid unwanted materials generated in the process of slaughtering animals at slaughterhouses and poultry processing plants
12. Rubber scraps	Natural rubber scraps (synthetic rubber scraps are categorized as waste plastics)
13. Metal scraps	Scraps generated by grinding or cutting steel and nonferrous metals
14. Glass shards, concrete rubble (excluding that generated by the construction, remodeling, or demolition of structures), and ceramic waste	Glass, concrete rubble generated in the product manufacturing process, ceramic waste, waste plasterboard, etc.
15. Slag	Residue (slag) from blast furnaces, open-hearth furnaces, and the like, cupola slag, slag, bad ore, bad coal, coal dust, waste sand from castings, etc.
16. Rubble	Concrete fragments and similar unwanted materials generated by the construction, remodeling, or demolition of structures
17. Animal manure	Manure from cattle, horses, pigs, sheep, goats, and other livestock generated by livestock farming
18. Animal carcasses	Carcasses of cattle, horses, pigs, sheep, goats, and other livestock generated by livestock farming
19. Soot	Soot generated by, and collected in the dust collection systems of facilities that generate soot and smoke
20. Items treated for the disposal of the types of waste listed above	Items treated for the disposal of the types of industrial waste listed in 1-19, that do not fall under any of categories 1-19 (e.g., concrete-solidified sludge)

Source: Waste Disposal and Public Cleansing Act (Act No. 137 of 1970)
Enforcement Order of the Waste Disposal and Public Cleansing Act (Cabinet Order No. 300 of 1971)

Table 1-2 Summary of the Categories of Specially Controlled Industrial Waste

<table>
<tr><th>Classification</th><th colspan="2">Main category</th><th>Summary</th></tr>
<tr><td rowspan="17">Specially controlled industrial waste</td><td colspan="2">Waste oil</td><td>Gasoline, kerosene, diesel oil (excluding flame-resistant pitch and the like)</td></tr>
<tr><td colspan="2">Waste acid</td><td>Extremely corrosive waste acid of pH 2.0 or lower</td></tr>
<tr><td colspan="2">Waste alkali</td><td>Extremely corrosive waste alkali of pH 12.5 or higher</td></tr>
<tr><td colspan="2">Infectious industrial waste*1</td><td>Industrial waste generated by medical facilities and the like that may contain infectious pathogens or have infectious pathogens attached to them</td></tr>
<tr><td rowspan="13">Specified hazardous industrial waste</td><td>Waste PCBs</td><td>Waste PCBs and waste oil containing PCBs</td></tr>
<tr><td>PCB-contaminated materials</td><td>PCB-soaked sludge, PCB-coated or -soaked waste paper, PCB-soaked wood scraps or waste fibers, plastics or metal scraps that encapsulate PCBs or have PCBs attached, ceramic waste or rubble with PCBs attached</td></tr>
<tr><td>PCB treatment materials</td><td>Items treated for the disposal of waste PCBs or PCB-contaminated materials, that contain PCBs*2</td></tr>
<tr><td>Waste mercury and mercury compounds</td><td>(1) Waste mercury and mercury compounds generated at specified facilities*1
(2) Industrial waste containing mercury or mercury compounds, or waste mercury recovered from mercury-containing products that have become industrial waste</td></tr>
<tr><td>Designated sewage sludge</td><td>Sludge designated under Article 13-4 of the Enforcement Order of the Sewerage Act*2</td></tr>
<tr><td>Slag</td><td>Items containing heavy metals in excess of certain concentrations*2</td></tr>
<tr><td>Waste asbestos</td><td>Items associated with asbestos material removal work or items generated by workplaces with dust-generating facilities specified under the Air Pollution Control Act, susceptible to scattering</td></tr>
<tr><td>Cinders</td><td>Items containing heavy metals or dioxins in excess of certain concentrations*2</td></tr>
<tr><td>Soot</td><td>Items containing heavy metals, 1,4-Dioxane, or dioxins in excess of certain concentrations*2</td></tr>
<tr><td>Waste oil</td><td>Items containing organochlorine compounds or 1,4-Dioxane*2</td></tr>
<tr><td>Sludge, waste acid, or waste alkali</td><td>Items containing heavy metals, PCBs, organochlorine compounds, pesticides, 1,4-Dioxane, or dioxins in excess of certain concentrations*2</td></tr>
</table>

*1: Applies only to facilities from which they are discharged
*2: See the criteria set out in Enforcement Regulations of the Waste Management Act and the Ministerial Order for Criteria for Determining Industrial Waste Containing Metals (Ministerial Order for Determination Criteria)
*3: PCBs: Polychlorinated biphenyls
Source: Overview of Regulations for Specially Controlled Waste, Ministry of the Environment Website
http://www.env.go.jp/recycle/waste/sp_contr/ (accessed December 11, 2021)

Table 1-3 Summary of the Categories of Specially Controlled Municipal Waste

Classification	Main category	Summary
Specially controlled municipal waste	Parts containing PCB	Parts containing PCB in waste air conditioners, waste TVs, and waste microwave ovens
	Waste Mercury	Waste mercury recovered from products containing mercury that have become municipal waste
	Soot	Soot generated in the dust collection systems of waste treatment plants
	Soot, cinders, sludge	Items from waste incinerators - specified facilities under the *Act on Special Measures against Dioxins* - with dioxins content in excess of 3 ng/g
	Infectious municipal waste*	Municipal waste generated by medical facilities and the like that may contain infectious pathogens or have infectious pathogens attached to them

*: Applies only to facilities from which they are discharged

Source: Overview of Regulations for Specially Controlled Waste, Ministry of the Environment Website
http://www.env.go.jp/recycle/waste/sp_contr/ （accessed December 11, 2021）

Column: Background of Waste Classification in Japan

As explained previously, the *Waste Management Act* - Japan's basic law on waste management - sets out two classifications of waste: municipal waste and industrial waste. The classification is based on waste generated in connection with business activities and who is responsible for treatment, which is rather uncommon when compared with other countries. The following is the background behind this classification.

Photo 1-1 Waste Vehicles Traffic at Landfill (Tokyo in the 1970s)
Source: Tokyo Metropolitan Government Bureau of Environment

Photo 1-2 Landfill (Tokyo in the 1970s)
Source: Tokyo Metropolitan Government Bureau of Environment

As people's lives became more affluent during Japan's period of high economic growth (1960s and 1970s), pollution became a serious problem due to factors such as increasing urban population density and the expansion of the heavy and chemical industries. At the time, the *Public Cleansing Act* (1954 - 1970) clearly stipulated that the government was responsible for waste management services, however the actual services provided mainly focused on the collection and disposal of waste discharged from households in urban areas. It was not clear who was responsible for waste associated with industrial activities; and therefore, a lot of waste was not properly collected or disposed of. Consequently, waste associated with industrial activity became an important factor caused various types of pollution of the environment.

Under these circumstances, a committee comprising central government ministries, municipalities, and academics was established in 1967 to engage in discussions with the aim of modernizing waste management. The committee recognized that the increasing amount of waste and changes in the composition of waste associated with economic growth were major problems. The committee further identified the increase in plastics, bulky waste, and waste associated with industrial activities in the waste stream as major concerns for the future. In particular, waste associated with industrial activities was completely unregulated, despite clear indications that this waste category would continue to increase as the economy grew. The committee's reports highlighted the extreme importance of establishing systems and methods for treating and disposing of waste associated with industrial activities in pursuit of pollution prevention.

Based on reports from the committee and others, the Ministry of Health and Welfare (Ministry of Health, Labour and Welfare) made the following proposal: “Given the present state of waste, and based on the ‘polluter pays’ principle, we should establish standards for the treatment of waste associated with industrial activities as the responsibility of business operators, and consider waste generated in daily life as the responsibility of municipalities, expanding areas in which municipalities should treat the waste beyond urban areas.”

As a result, the *Waste Management Act* enacted in 1970 set out two categories of waste: municipal waste, which is waste generated by household and businesses activities, and industrial waste, which is waste generated by industrial activities.

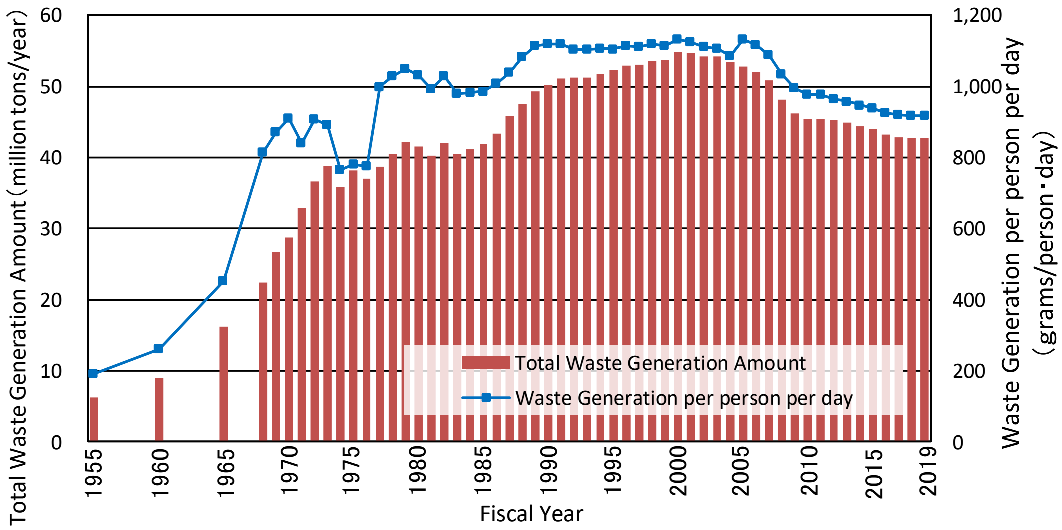
1.2 Waste Management Conditions

(1) Waste Generation Amount

Although the waste generation amount in Japan increased as the economy grew, it has begun to decline since the formation and promotion of a sound material-cycle society based on the 3Rs. The amount of waste generated is greatly affected by demographic changes, however social and economic factors also have an impact.

During Japan's period of high economic growth (1960s and 1970s), factors such as rising incomes and changes in consumer behavior drove the development of an economic structure based on mass production and mass consumption, causing both municipal and industrial waste to rapidly increase and diversify. Later, during the bubble era[2] (late 1980s and early 1990s), the amount of waste increased swiftly as consumption and production activities expanded further. However, the total amount of waste generated and the unit generation rate per person per day have trended downward since 2000, in part due to the efforts to develop a sound material-cycle society. Accordingly, the total amount of waste generated is also changing in response to social and economic changes. Figure 1-2 shows trends in the total amount of waste (municipal waste) generated in Japan and the amount generated per person per day.

[2]The bubble era refers to the economic boom in Japan, especially in the late 1980s and very early 1990s, when asset prices soared. The name is derived from the way asset prices expanded like a bubble and burst under certain circumstances.



*1: Disaster waste amounts generated by natural disasters such as earthquakes and floods are not included.
*2: Total Waste Generation Amount = Planned Collection Amount + Group Collection Amount + Direct Transported Waste Amount to Treatment Facilities (refer to the following Figure 1-3). However, from 1971 to 1984, Group Collection Amount was recorded as Domestic Self Disposal Amount, and there is no data for Domestic Self Disposal Amount before 1970.
*3: Waste Generation per person per day = Total Annual Waste Generation Amount / (Total Population x Number of days in one year)
Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1972-2019)
Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

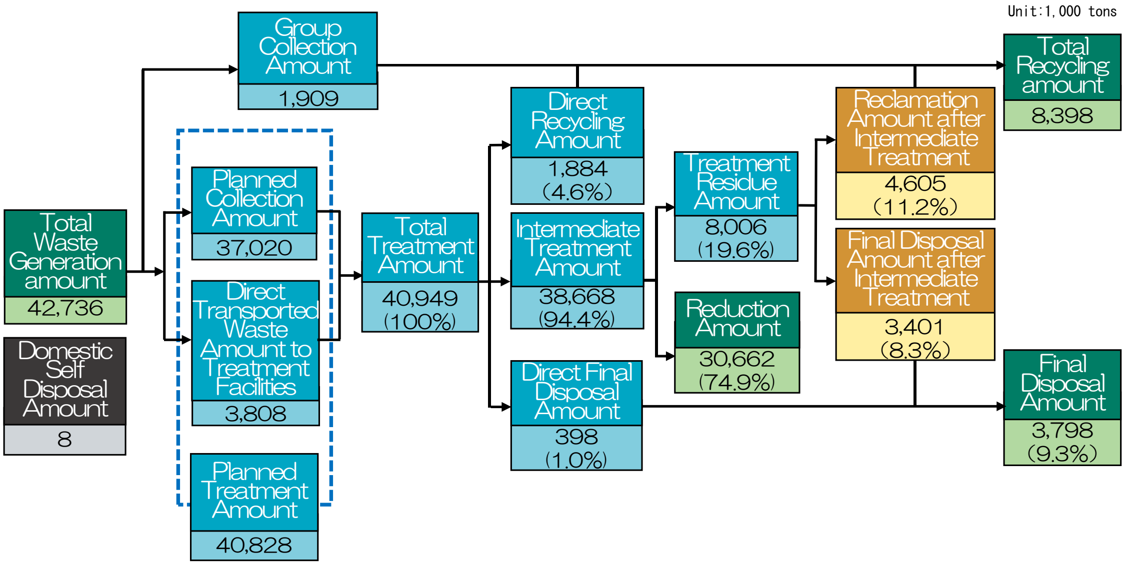
Figure 1-2 Waste Generation Amount and Waste Generation per Person per Day

(2) Waste Management Flow

The waste management flow clarifies how the waste is transferred from collection to the discharge to final disposal sites. Additionally, using numerical values to visualize the relationships between amounts of waste at the different flow stages of generation, treatment, recycling, and disposal can make it easier to identify issues, verify the effectiveness of measures and develop waste management plans.

The Ministry of the Environment and municipalities regularly prepare waste management flows that visualize the path waste travels from discharge to recycling and final disposal. This waste management flow makes it possible to develop an appropriate understanding of the relationships between amounts of waste at the different stages of treatment, recycling, and disposal, which is useful for understanding the status of waste and formulating plans.

Figure 1-3 shows the waste management flow in Japan in FY2019. According to the flow chart, all discharged waste is treated, except for the waste collected through Group Collection (recyclables collection activities organized by residents groups) which is recycled. Of all discharged waste that does not undergo intermediate treatment, 4.6% is directly recycled and 1.0% is sent directly to final disposal without intermediate treatment; 94.4% of discharged waste undergoes intermediate treatment. Overall, assuming the total processed waste amount is 100%, then the amount of waste reduced is 74.9%, the amount of waste recycled is 15.8%, and the amount of waste for final disposal is 9.3%.



*: Because of Planning errors, "Planned Treatment Amount" and "Total Treatment Amount" (Total Treatment Amount ＝Intermediate Treatment Amount + Direct Final Disposal Amount + Direct Recycling Amount) are not equal.

Source : Ministry of the Environment "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 1-3 Waste Management Flow in Japan (FY 2019)

Table 1-4 Definitions of the Main Terms Used in the Waste Management Flow

Term	Definition
Total waste generation amount	The sum of the amount of waste collected by municipalities for proper treatment and recycling (planned collection amount), the amount of waste directly received from waste generators at municipality treatment plants (direct receiving amount), and the amount of waste collected by local communities for recycling purposes (group collection amount).
Planned treatment amount	The amount of waste to be treated, calculated for future plans and set after listing present circumstances and setting reduction targets and forecast populations, and estimating future generation amounts of waste.
Total processed waste amount	The sum of the amount of waste that undergoes intermediate treatment such as incineration, shredding, sorting, etc. (intermediate treatment amount), the amount of waste sent directly to final disposal without intermediate treatment (direct final disposal amount), and the amount directly received by recycling operators (direct recycling amount).
Direct recycling amount	The amount of waste collected by municipalities (or contractors) as recyclables and delivered directly to recycling operators. This item was newly established in Japan in 1998.
Group collection amount	The amount of waste collected through recycling activities in which local residents' groups (e.g., town assemblies, neighborhood associations, children's associations, parent-teacher associations (PTAs), condominium associations) collect used paper, aluminum cans, and other recyclables from private residences for recycling, and deliver them to contracted collection operators.

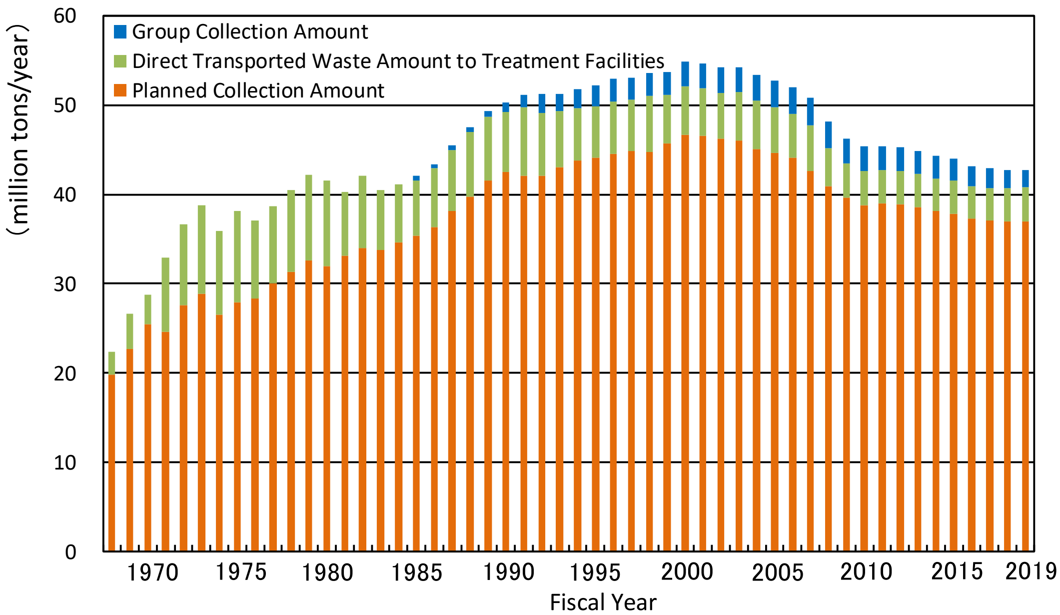
Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

(3) Waste Collection and Transport

To deal with the increasing volume of waste, efforts are being made to streamline waste collection and transport in Japan by transitioning away from the model in which municipalities directly manage collection and transport, and toward a model in which the work is outsourced and licensed to private operators.

1) Planned collection amount

The planned collection amount is the amount of waste collected by municipalities for proper treatment and recycling. Direct transported waste amount refers to the amount of waste brought directly to waste treatment facilities by waste generators. Group collection is an activity of local residents' groups to collect used paper, aluminum cans, and other recyclables from each household for recycling, and deliver them to contracted collection operators. In Figure 1-4, the planned collection amount, direct transported waste amount to treatment facilities and group collection amount in Japan are shown. The planned collection amount can be calculated properly because surveys pertaining to amounts of waste have been conducted every year, and annual figures for amounts of waste are known.



*: Group collection amounts prior to 1984 are unknown; the sum of planned collection amount, direct transported waste amount to treatment facilities, and group collection amount after 1984 is consistent with the definition of total waste generation amount.

Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1972-2019)

Figure 1-4 Planned Collection Amount

2) Status of Machinery and Equipment for Waste Collection and Transport

Discharged waste is collected using collection vehicles, which transport the waste to treatment plants or transfer facilities. Collection vehicles are commonly referred to as “packers” in Japan. The waste collected by the collection vehicles is transferred to transport vehicles, often referred to as secondary transport for onward transport to treatment plants; and the majority of the transport vehicles are trucks (for more details on waste collection and transport machinery and equipment, refer to Topic 4-1.3: Features of Vehicles and Equipment for Waste Collection and Transport).

Table 1-5 provides descriptions of the three operation forms of waste collection and transport: directly managed, outsourced, and licensed.

Table 1-5 Forms of Waste Collection and Transport

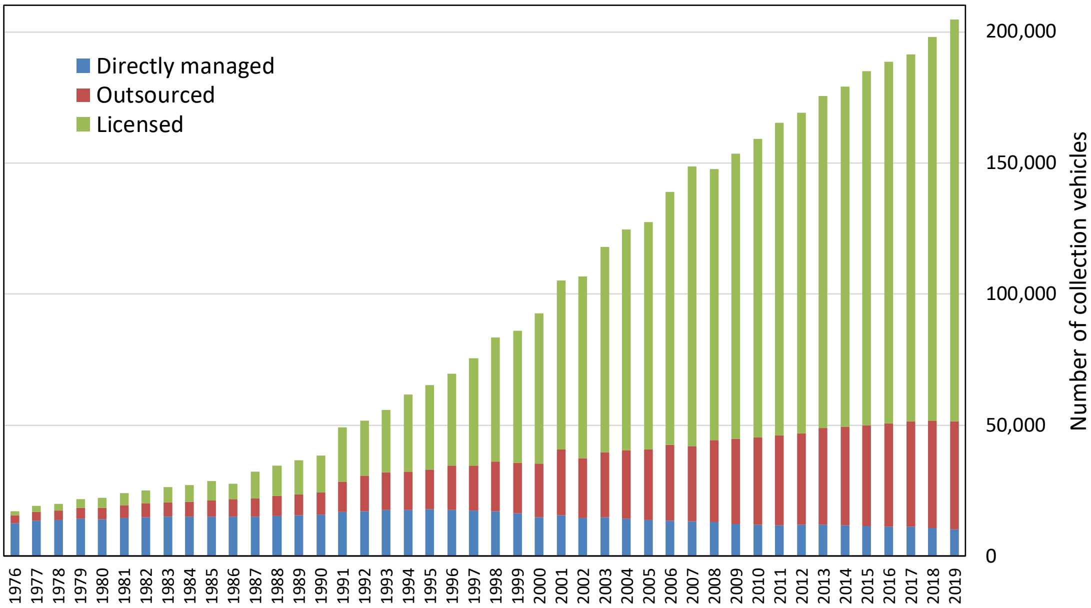
Form	Description
Directly managed	When a local government (e.g., municipality) or association*1 implements waste collection and transport.
Outsourced	When a private operator implements waste collection and transport, outsourced as part of municipal public services.
Licensed	When a private operator in business for profit implements waste collection and transport.*2 These operators collect and transport business waste.

*1: Association refers to a group established under an agreement for multiple parties to fund and jointly operate a business; in the area of waste management, an association is an organization that is jointly engaged in the construction, operation, and maintenance of facilities, as well as waste collection and transport and other aspects of the business.

*2: Operators licensed to handle the municipal waste components included in business waste (e.g., kitchen waste, waste paper, wood scraps, waste fibers, vegetable scraps, sorted sludge).

Japan is in the process of transitioning away from waste collection and transport directly managed by municipalities in order to deal with increasing amounts of waste, through outsourcing and licensing of increasing shares of waste collection. Accordingly, the number of waste collection and transport vehicles under the directly managed form of waste collection and transport is decreasing. In particular, small and medium-sized municipalities have more difficulty in securing funds and human resources compared to large municipalities, and thus are using contractors and licensed operators in an attempt to streamline waste collection and transport operations. Figure 1-5 shows trends in the number of vehicles for waste collection and transport under the three operation forms.

Notably, the trends are the same when comparing vehicle capacity for the three forms rather than number of vehicles.



*1: Prior to 1990, some vehicles owned by associations were included, and from 1991, only vehicles owned by municipalities were included, excluding vehicles owned by some associations.

*2: Vehicles before 1990 were classified as special vehicles and transport trucks, and although the definition of vehicles is different, special vehicles are counted as collection vehicles.

Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) “Waste Management in Japan ” (1972-2019)

Figure 1-5 Number of Collection Vehicles

(4) Intermediate Treatment of Waste

1) Waste Treatment Amounts

Measures of waste treatment have been promoted in Japan in line with the basic policy to incinerate waste as a method of intermediate treatment in pursuit of sanitary treatment. As a result, incineration treatment now accounts for roughly 80% of overall intermediate treatment, while the amount of waste disposed directly into landfills has decreased. In the meantime, recycling-related legislation has been established in an effort to promote material recycling. Consequently, the amount of directly recycled waste increased and the amount of waste disposed directly into landfills decreased, although both trends have since leveled out.

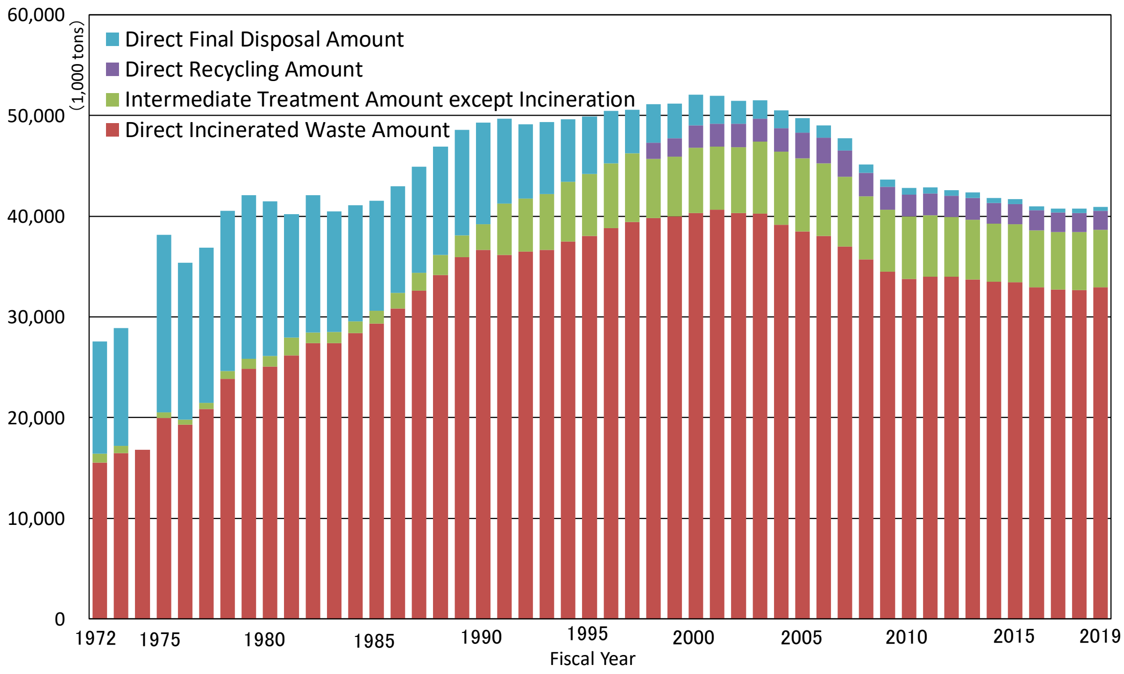
Collected waste is transported to intermediate treatment plants for treatment. In Japan, intermediate treatment has long been used to mitigate the difficulty of securing landfill sites and in pursuit of the sanitary treatment of waste, and various intermediate treatment technologies are being used to promote recycling and further reduce the waste amount for final disposal. There are many types of intermediate treatment plants for different wastes; examples include incineration plants, bulky waste treatment plants, and composting plants (for more details on intermediate treatment, refer to Topic 4-2: Intermediate Treatment).

In FY 2019, the total treated waste amount[3] was 40.95 million tons, of which 32.94 million tons, or roughly 80%, underwent incineration treatment (direct incineration amount). A total of 5.72 million tons of waste underwent intermediate treatment other than incineration (intermediate treatment amount excluding incineration), and 1.88 million tons was directly received by recycling operators (direct recycling amount).

The direct incineration amount increased until around 2000 amid the ongoing upgrade of intermediate treatment plants at the time to process growing amounts of waste. Additionally, the direct final disposal amount has trended downward since the 1980s and decreased to 400,000 tons in 2019 as a result of the increase in the direct incineration amount.

The intermediate treatment amount from recycling and the like started to increase in the 1990s with the launch of efforts to establish a sound material-cycle society and the enactment of laws on recycling, but leveled off in 2007 and has remained flat since.

[3] Total treatment amount = Intermediate treatment amount + Direct final disposal amount + Direct recycling amount



*1: Excluding disaster waste generated by natural disasters such as earthquakes and floods.
*2: Intermediate treatment facilities other than incineration include bulky waste treatment facilities, facilities for recycling, waste composting facilities, methanization facilities, waste fuel conversion facilities, etc.
*3: "Direct Recycling Amount" is a new item used since 1998. Until 1997, the "Direct Recycling Amount" was probably recorded in the "Intermediate Treatment Amount excluding Incineration".
Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1972-2019)

Figure 1-6 Waste Treatment Conditions in Japan

2) Recycling Amount

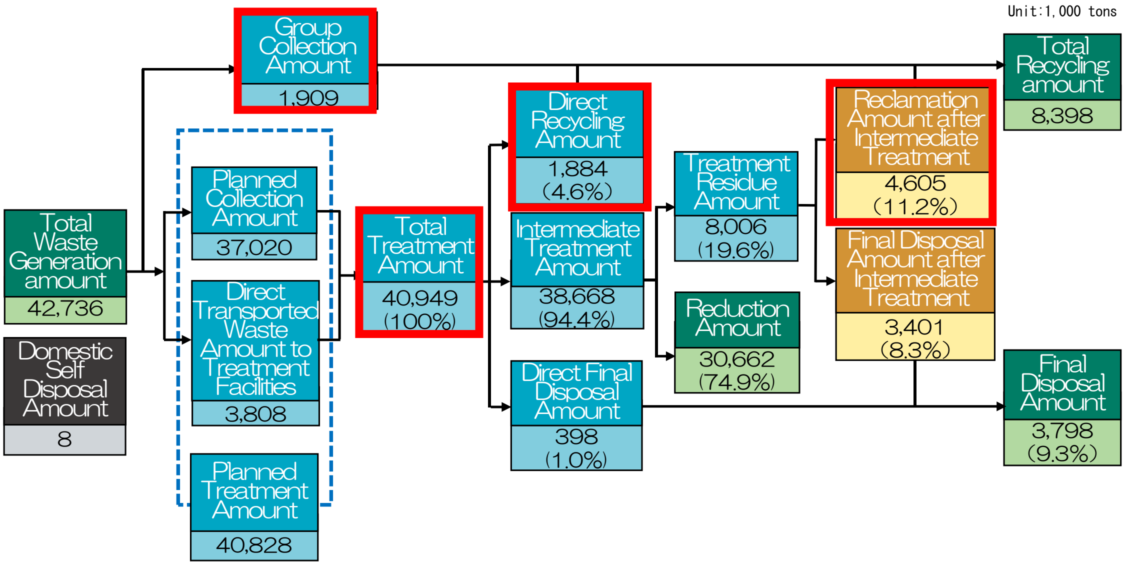
In Japan, the recycling rate can be used as an indicator to examine the results of efforts to improve recycling, including thorough sorting and separate collection (direct recycling amount), efficient intermediate treatment (recycling amount after intermediate treatment), and the promotion of recycling activities by residents (group collection amount).

Recycling is the recapture and reuse of resources that have been discarded (here, recycling means material recycling, in which materials are reused as raw materials, and does not include thermal recycling[4], in which thermal energy is recovered and utilized). In Japan, the recycling rate is defined as the percentage the total recycled waste amount (Direct recycling amount + Group collection amount[5] + Recovery amount after intermediate treatment) of the total treated waste amount (Total treatment amount + Group collection amount).

[4] In the EU, the concept of energy recovery is used to distinguish it from thermal recycling, and recovery of thermal energy is not included in recycling.

[5] All the Group collection waste is considered to be thoroughly sorted at source and composed only of recyclables.

$$\text{Recycling Rate (\%)} = \frac{\text{Direct Recycling Amount} + \text{Group Collection Amount} + \text{Recovery Amount after Intermediate Treatment}}{\text{Total Treatment Amount} + \text{Group Collection Amount}} \times 100$$

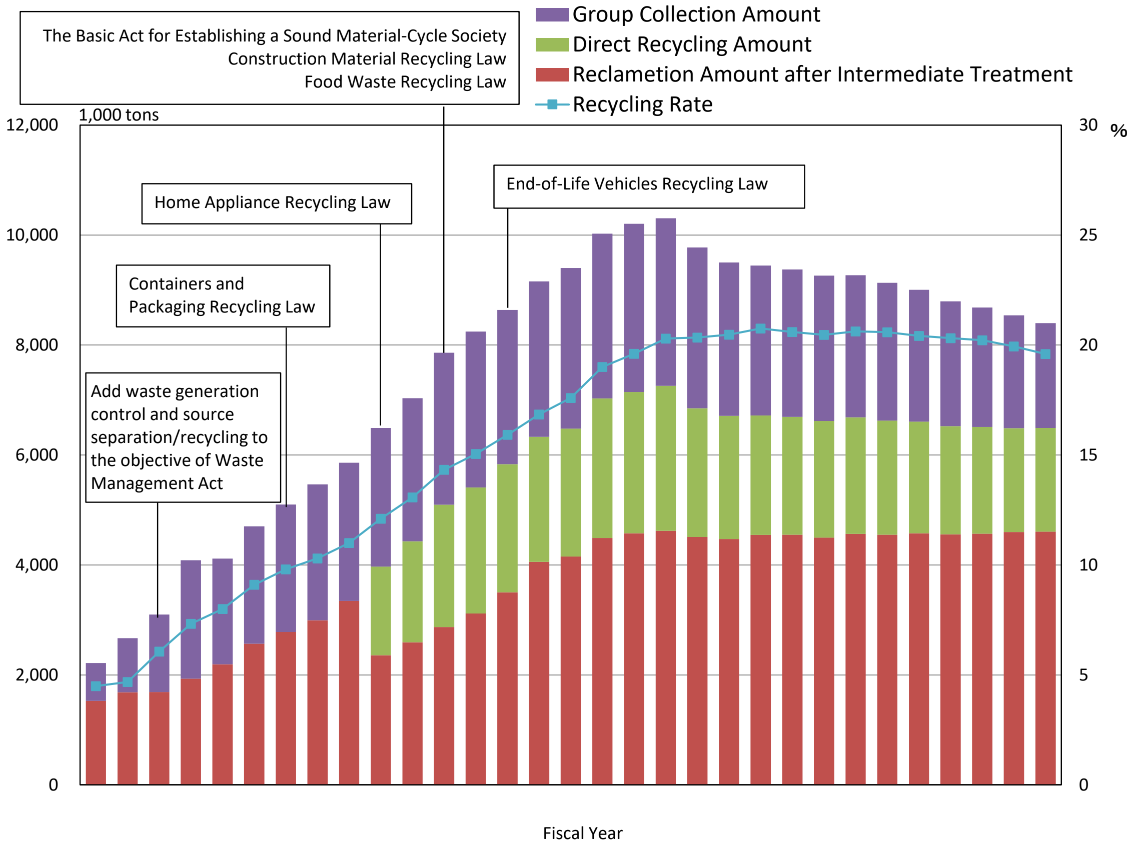


*1：Because of planning errors, "Planned Treatment Amount" and "Total Treatment Amount"
(＝Intermediate Treatment Amount + Direct Final Disposal Amount + Direct Recycling Amount) are not equal.
*2: "Direct recycling" is defined as the direct delivery to a recycler without passing through a recycling facility.
*3: Red boxes are items related to the calculation of the recycling rate.
Source : Ministry of Environment "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 1-7 Waste Management Flow in Japan (FY 2019) (Reproduced)

Since the 1990s, Japan has promoted the recycling of waste and strived to increase the direct recycling amount by amending the *Waste Management Act* and establishing the *Act on Establishing a Sound Material-Cycle Society* and other laws on recycling. Additionally, the increase in awareness on recyclables among residents and business operators and the technological innovations in intermediate treatment have improved recycling (for more details on laws and regulations, refer to Topic 2-2.2: Legal Structure Pertaining to Waste Management).

As shown in Figure 1-8, the enactment of recycling laws have significantly contributed to the increase in recycling amount (the sum of the direct recycling amount, the recovery amount after intermediate treatment, and the group collection amount) and the trend in recycling rate increased through 2007 due to the promotion of sorting and recycling of containers and packaging, home appliances, and more under these laws.



*1: Excluding disaster waste generated by natural disasters such as earthquakes and floods.

*2: "Direct Recycling Amount" is a new item since 1998. Until 1997, the "Direct Recycling Amount" was probably recorded in the "Intermediate Treatment Amount except Incineration".

Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1972-2019)

Figure 1-8 Recycling Amount and Recycling Rate

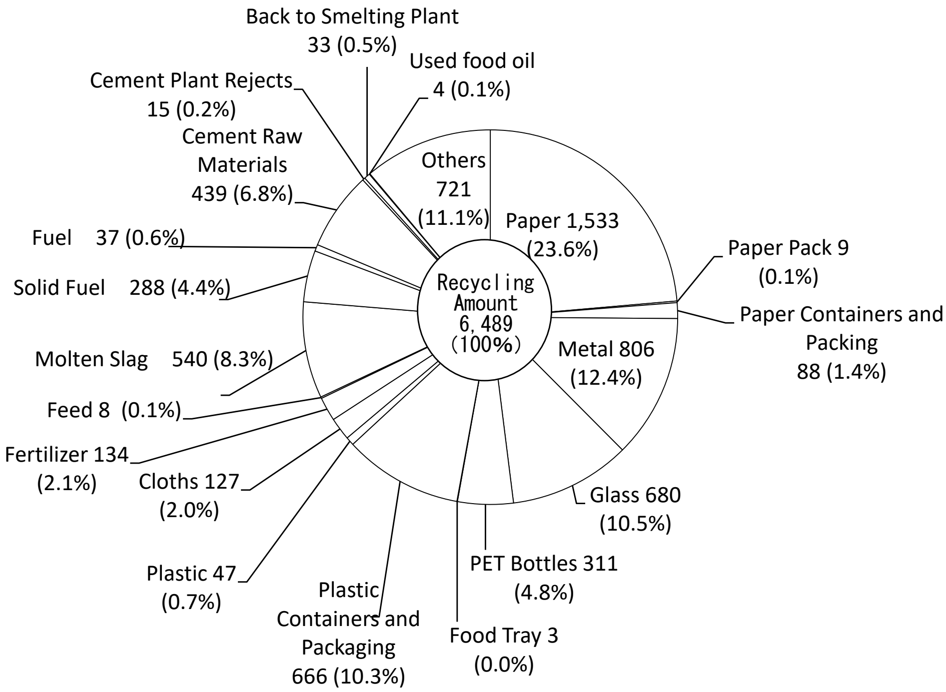
An item's suitability for recycling depends on how easy it is to recycle it (how willing residents and business operators are to cooperate) as well as local characteristics and customs. Paper has been recycled in Japan for a long time; it was the most recycled resource in FY2019. Paper comprises more than 20% of separate waste collected by municipalities, and more than 90% of recyclables collected through resident-driven group collection.

Figure 1-9 provides a breakdown of the amount of resources recycled and group collection amounts by item in FY2019. The total amount of resources recycled through separate collection by municipalities (direct recycling amount) and resources recycled after intermediate treatment (recovery amount after intermediate treatment) was 6.49 million tons (amount of resources recycled), and the amount of resources recycled through group collection by residents' groups (the group collection amount) was 1.91 million tons.

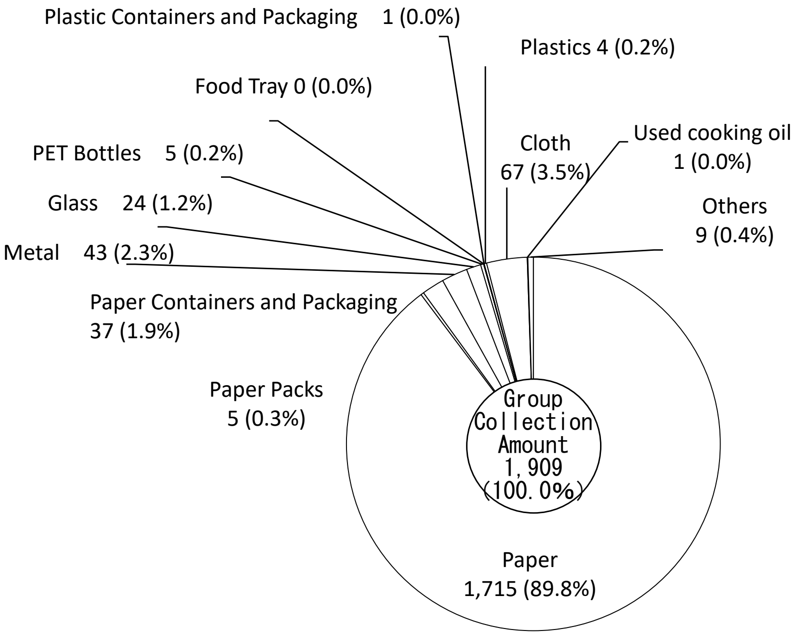
The most commonly recycled item was paper (23.6%), followed by metals (12.4%), glass (10.5%), plastic containers and packaging (10.3%), and molten slag (8.3%). Additionally, the most common item in group collection was paper (89.8%), followed by textiles (3.5%), metals (2.3%), paper containers and packaging (1.9%), and glass (1.2%). Newspapers, magazines, cardboard, and other paper comprised nearly 90% of group collection (for more details on recycling technologies, refer to Topic 4-2.5: Recycling Technology).

Unit: 1,000 tons

Recycling Amount



Group Collection Amount



Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" (2021) https://www.env.go.jp/press/files/jp/115966.pdf（accessed January 24, 2022）

Figure 1-9 Breakdown of Recycling Amount and Group Collection Amount (FY2019)

3) Present State of Intermediate Treatment Plants

In Japan, various intermediate treatment technologies, such as incineration plants, are being implemented based on the characteristics of the municipalities. In densely populated urban areas, incineration technology is favored for its effectiveness in reducing the high amounts of waste generated in those areas. In sparsely populated rural areas - specifically in areas with close-knit local communities - recycling technologies and treatment methods other than incineration tend to be used because it is easier to get residents there to cooperate with waste sorting. Regarding incineration plants, technological innovations are being made not only to properly treat waste but also to facilitate effective measures, including inter-municipal waste treatment, dealing with dioxin-related problems, and promoting residual thermal utilization.

Examples of intermediate treatment plants include waste incineration plants, bulky waste treatment plants, organic waste recycling plants (e.g., composting plants, livestock feed processing plants, methane gasification plants), recycling plants, and fuel processing plants (for statistical data in Japan, waste incineration plants are classified into incineration, gasification melting/reforming, carbonization, and others).

Table 1-6 shows the number and treatment capacity of waste incineration plants by type in FY2019. As of 2019, there are a total of 1,067 incineration plants in Japan with a total treatment capacity of roughly 177,000 tons per day.

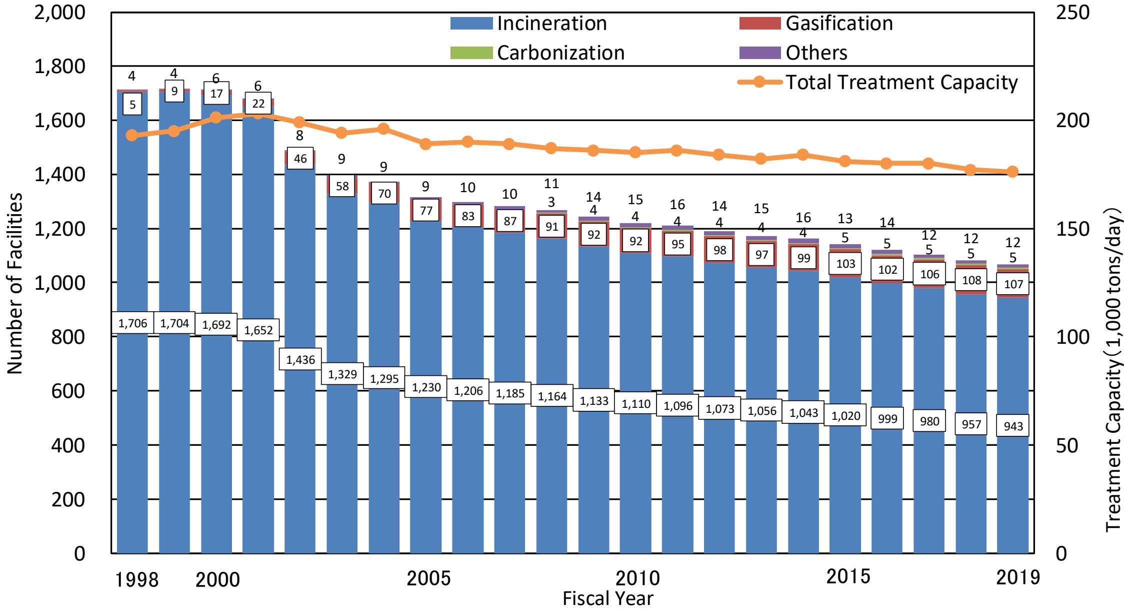
Figure 1-10 shows trends in the number and treatment capacity of waste incineration plants by type. Although both the number and treatment capacity of these plants are trending downward, the latter is only decreasing slightly. The treatment capacity is decreasing less than the number of plants because of expansion of inter-municipal waste treatment and measures to promote the consolidation of waste incineration plants into those with treatment capacity of at least 100 tons per day, even though the amount of waste generated is decreasing due to factors such as the promotion of the 3Rs. Consequently, efforts are being made to maintain proper waste treatment capacity while promoting dioxins countermeasures (for more details on waste incineration plants, refer to Topic 4-2.2: Incineration Technology, and for more details on dioxins countermeasures, refer to Topic 5-3: Dioxins Problem).

Table 1-6 Number of Facilities and treatment Capacity by Type of Incineration (FY2019)

Type of Facilities	Incineration	Gasification	Carbonization	Others	Total
Number of Facilities	943	107	5	12	1,067
Treatment Capacity (ton/day)	153,978	21,196	206	1,328	176,707

*: Facilities established by municipalities and clean associations, including those for which construction began in the year in question and those for which construction was suspended, excluding disused facilities and those owned by private companies.

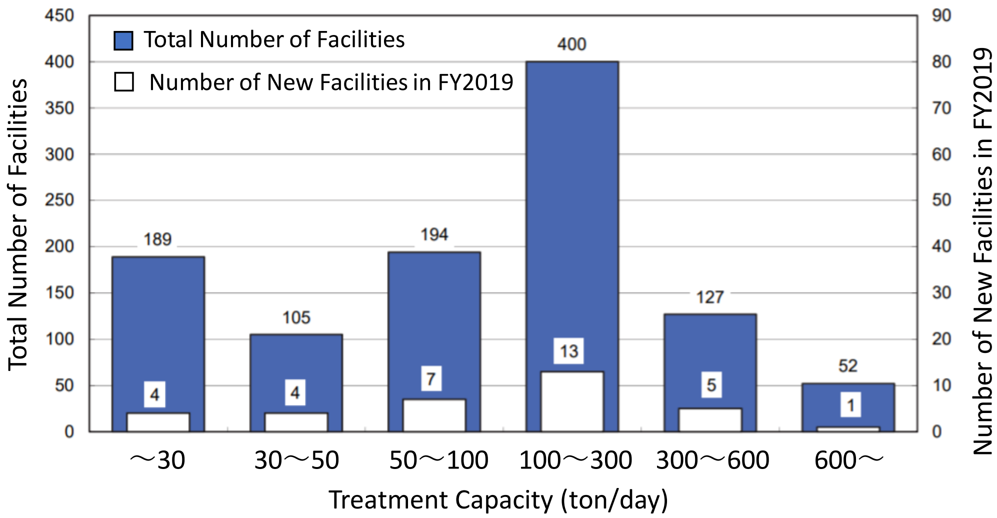
Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)



*1: Facilities established by municipalities and clean association, including those for which construction began in the year in question and those for which construction was suspended, excluding disused facilities and those owned by private companies.
*2: Until 2004, carbonization was included in incineration.
Source: Ministry of the Environment "Waste Management in Japan" (2000-2021)

Figure 1-10 Number of Waste Incineration Facilities by Type of Incineration

Figure 1-11 shows the number of waste incineration plants by capacity in FY2019. As a result of the promotion of inter-municipal waste treatment and waste incineration power generation, there are more waste incineration plants with treatment capacity of 100 to 300 tons per day (400 plants) than any other capacity range. The plants being developed in Japan are smaller than those in major cities in foreign countries, which are capable of treating at least 1,000 tons per day.



Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 1-11 Number of Waste Incineration Facilities by Treatment Capacity (FY2019)

4) Residual Thermal Utilization at Waste Incineration Plants

Innovations in incineration power generation technology and measures and legislation to promote the use of renewable energy have driven the introduction of thermal power generation at incineration plants. The residual heat generated by incineration treatment is used not only inside plants but also at facilities outside plants for giving back to residents.

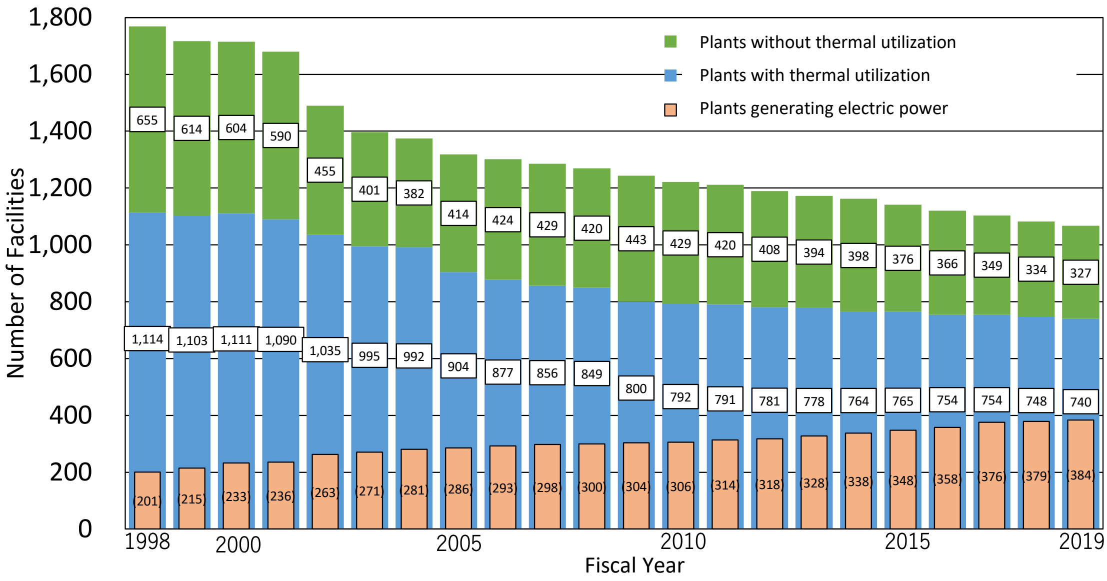
Table 1-7 shows the state of residual thermal utilization at waste incineration plants in FY2019. Residual heat is utilized at 740 plants, or 69.4% of the total plants. Methods of residual thermal utilization include hot water, steam, and power generation; for purposes such as supplying electricity and heating air and water within plants, as well as for heating swimming pools and at other local facilities outside plants.

Table 1-7 Residual Thermal Utilization at Waste Incineration Plants (FY2019)

Thermal Utilization	With Thermal Utilization								Without Thermal Utilization
		Hot Water		Steam		Power Generation		Others	
		Inside Plant	Outside Plant	Inside Plant	Outside Plant	Inside Plant	Outside Plant		
Number of Facilities	740	618	206	236	90	381	267	40	327

*1: Due to duplicated responses, the total number of facilities does not match the total number of respondents.
Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

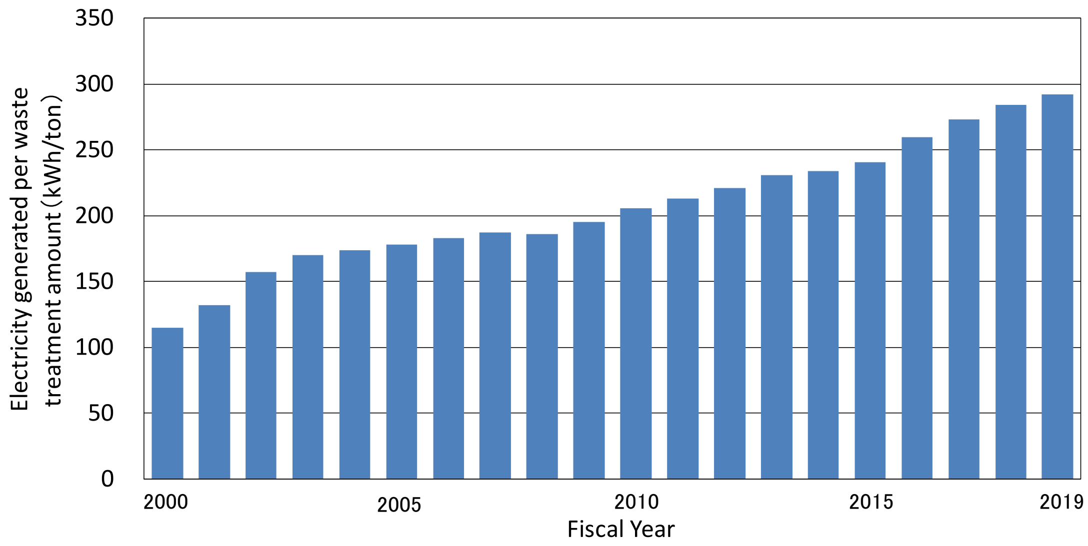
Figure 1-12 shows trends in the number of waste incineration plants where residual thermal utilization is implemented. Although the number of waste incineration plants has been decreasing, the number of plants where residual thermal utilization is not implemented is also decreasing, falling to 327 in 2019. Conversely, the number of plants where waste incineration power generation is implemented has been increasing, rising to 384 in 2019. In Japan, waste power generation is being proactively introduced in an effort to establish a sound material-cycle society. Legislation for the introduction of waste power generation has been developed; for example, the *Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities*, which requires electricity utilities to use new energy sources, was enacted in 2003, and the feed-in tariff (FIT) system for renewable energy was put into operation in 2012.



Source: Ministry of the Environment "Waste Management in Japan" (2000-2021)

Figure 1-12 Number of Waste Incineration Plants with Residual Thermal Utilization

Figure 1-13 shows the annual increasing trend in electricity generated per ton of treated waste. Although the low efficiency of waste incineration power generation was an issue when it was first introduced at waste treatment plants, efficiency has improved thanks in part to increasing heating (calorific) values of the waste incinerated partly due to the increase in waste plastics, and technological innovations in power generation facilities, thereby helping to promote the introduction of waste incineration power generation. Of all waste incineration plants with power generation facilities, 285 (74% of the total) had power generation efficiency of at least 10% in FY2019. Additionally, 45 plants had a power generation efficiency of at least 20% (for more details on the systems, refer to Topic 2-3.2: Thermal Recovery).

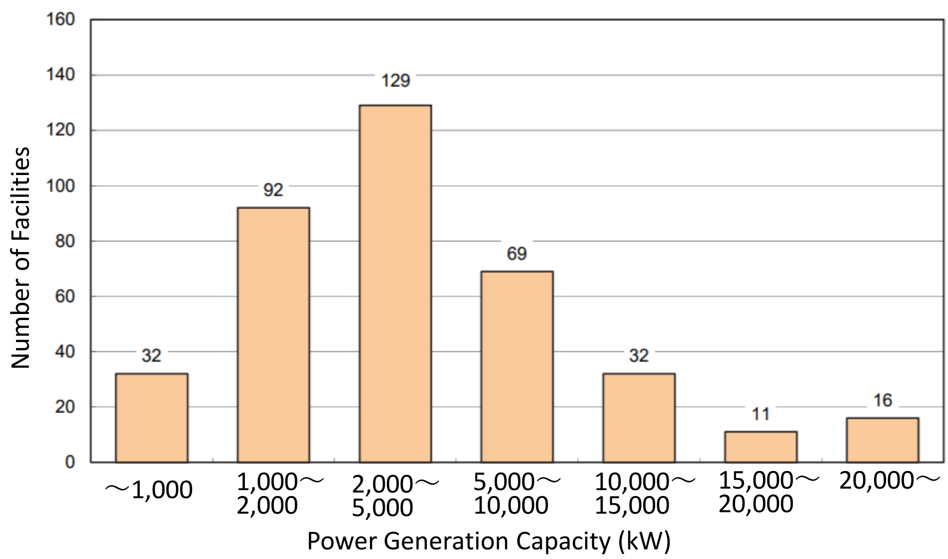


*: Available electric energy per ton of waste treated (kWh/ton) = $\frac{\text{Total annual electricity generated in facilities (kWh)}}{\text{Annual waste treatment amount in facilities (tons)}}$

Source: Ministry of the Environment "Waste Management in Japan" (2000-2021)

Figure 1-13 Electricity Generated per Ton of Waste Treated

Figure 1-14 shows the number of waste incineration plants by electric power generation capacity in FY2019. There are more plants with power generation capacity of 2,000 kW to 5,000 kW (129 plants, 34% of the total) than any other capacity range. A total of 59 plants - 15% of the total - have a power generation capacity of more than 10 MW.



*: Of the 384 facilities with power generation equipment, 381 facilities with valid responses were included in the survey.
Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 1-14 Number of Waste Incineration Plants by Electric Power Generation Capacity (FY2019)

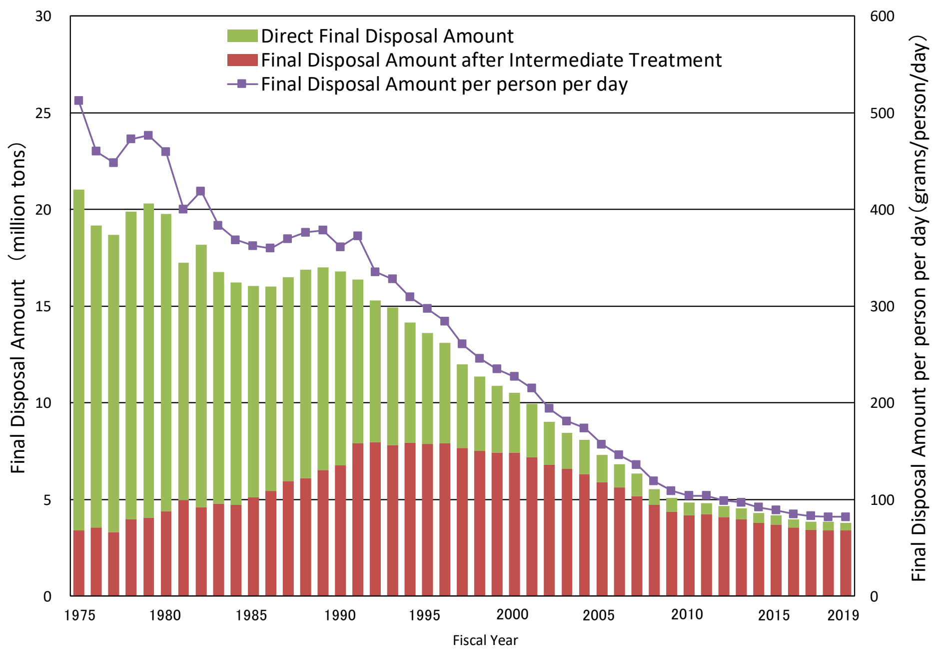
(5) Final Disposal of Waste

1) Final Disposal Amount

The final disposal amount in Japan has decreased as a result of the proactive introduction of intermediate treatment technologies, i.e. the usage of incineration plants and the promotion of recycling.

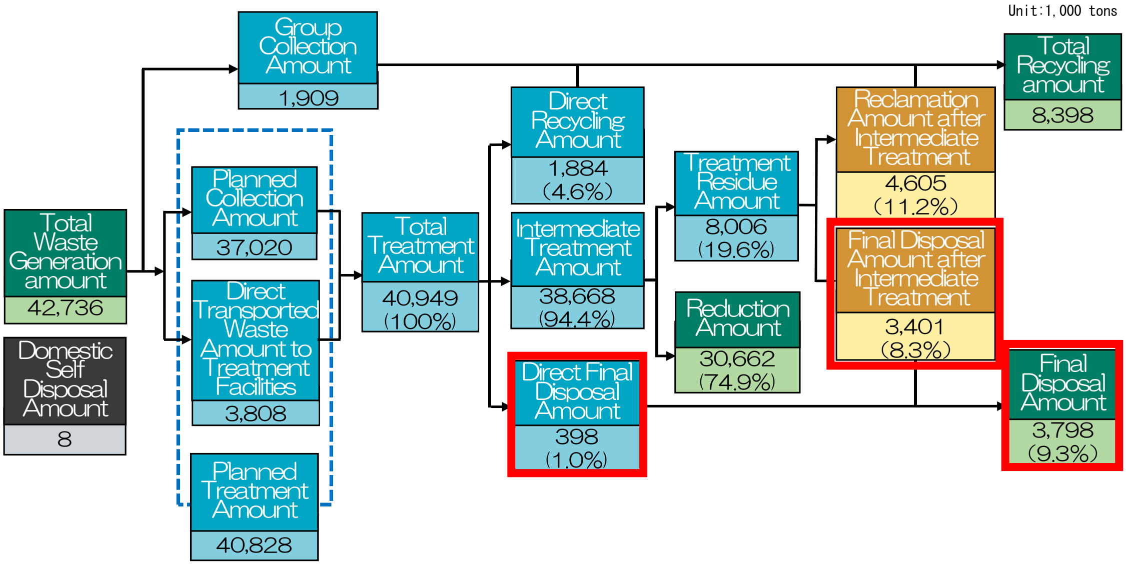
"Final disposal" means that waste is ultimately disposed into landfill sites at the last stage of the waste management flow. The final disposal amount is the sum of the amount of waste sent directly to final disposal without intermediate treatment (direct final disposal amount) and the amount of waste sent to final disposal after intermediate treatment (final disposal amount after intermediate treatment).

Figure 1-15 shows the annual trends in the final disposal amount. The direct final disposal amount has decreased substantially due to incineration and other forms of intermediate treatment and promotion of the 3Rs; the figure fell to 400,000 tons in FY2019. The final disposal amount after intermediate treatment has also remained low (3.4 million tons in FY2019) due in part to advances in incineration technology that have improved the rate of reduction through incineration. The total final disposal amount has generally continued trending downward due to the effects of measures for waste minimization and recycling, among other things; in FY2019, the total final disposal amount was 3.8 million tons, or 9.4% of the total treatment waste amount (for more details on final disposal, refer to Topic 4-3: Final Disposal).



Source: Ministry of Health and Welfare (1975-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1975-2019)

Figure 1-15 Final Disposal Amount in Japan



*1: Because of Planning errors、"Planned Treatment Amount" and "Total Treatment Amount" (＝Intermediate Treatment Amount + Direct Final Disposal Amount + Direct Recycling Amount) are not equal.
*2: "Direct recycling" is defined as the direct delivery to a recycler without passing through a recycling facility.
*3: Red boxes are items related to the final disposal.
Source : Ministry of the Environment "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 1-16 Waste Management Flow in Japan (FY 2019) (Reproduced)

2) Remaining Life and Capacity at Landfill Sites

All though the service life of landfill sites in Japan is increasing due to the reduction of final disposal amount, the capacity of the landfill continues to decrease over time. Therefore it is crucial to reduce the final disposal amount as well as to develop new landfills. Since the shortage of landfill sites is an important issue, and because it takes time to develop landfill sites, statistical data over a period of time is used to calculate and verify the number of years sites can remain in service, which are then used in plans for future landfill site development.

When looking into constructing new landfill sites, it is essential to have a firm understanding of the remaining life and capacity of existing landfill sites. Table 1-8 shows the number and remaining life of landfill sites for municipal waste in FY2019, and Figure 1-17 shows how those figures have trended. As of the end of FY2019, there are 1,620 municipal waste landfill sites in Japan, with a remaining capacity of about 100 million m^3 and a remaining life of approximately 21 years.

The downward trend of remaining landfill capacity has slowed due to the establishment of legislation to minimize waste, promote recycling, and reduce the final disposal amount in response to the priority issue - the shortage of landfill sites – and because of measures including the promotion of reduction through intermediate treatment and recycling technologies. Although the remaining life of landfill sites has held steady at above 20 years in the last 10 years, necessary measures continue to be implemented in light of the severity of the situation.

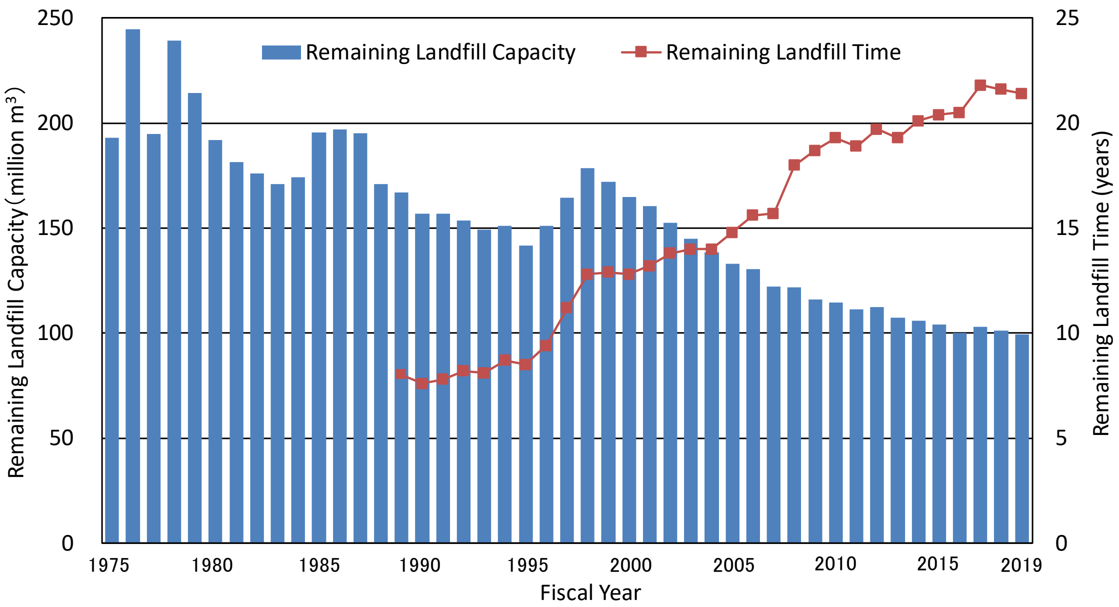
Notably, the remaining life of landfill sites is the period (number of years) during which disposal at existing landfill sites is possible if the final disposal amount in a given fiscal year is maintained without developing new landfill sites. Remaining life is calculated using the following formula.

$$\text{Remaining Time (Year)} = \frac{\text{Remaining capacity at the end of the year}}{\text{Final Disposal Amount of year / volume-to-mass ratio of the waste (bulk density of the waste can be 0.8163)}^{6}}$$

Table 1-8 Number and Capacity of Municipal Waste Landfill Site（FY 2019）

Number of Landfill Sites by terrain					Total Area	Total Capacity	Remaining Capacity	Remaining Time
Mountains	Sea	Water surface	Flat Land	Total	(1,000m²)	(1,000m³)	(1,000m³)	(Year)
1,165	25	10	420	1,620	42,762	470,762	99,507	21.4

Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)



Source: Ministry of Health and Welfare (1972-1997) and Ministry of the Environment (1998-2019) "Waste Management in Japan" (1972-2019)

Figure 1-17 Number and Capacity of Municipal Waste Landfill Sites

[6] The relative bulk density of landfill waste is the volume-to-mass ratio of the waste at the time it was dumped. In Japan, it is generally considered to be roughly 0.3 when waste is discharged and 0.8 when it is dumped into landfills.

(6) Composition of Waste

In order to understand the types, characteristics, and other attributes of waste generated in each area, it is essential to survey the composition of waste and its three components of moisture content, combustibles content, and ash content. Ongoing surveys are required because the quality of waste changes in response to factors such as changes in social circumstances and the diversification of lifestyles. Survey results can be used as basic data not only for design conditions when developing facilities such as incineration plants and landfill sites, but also for considering suitable measures to reduce waste and promote recycling based on the waste quality.

Paper, textiles, and plastics comprise roughly 70% of waste in Japan, and data from surveys shows that this waste contains high-calorie combustibles and relatively little moisture content; this data is the basis for efforts to utilize incineration technologies and promote the recycling of plastics.

Waste composition is the categorization of waste into items and material classifications; waste composition surveys categorize waste into paper, textiles, kitchen waste, and the like, and show the relative weights of each as percentages. The three components of waste – moisture content, combustibles content, and ash content - are indicators of the properties of waste. In Japan, municipalities conduct surveys at incineration plants and other facilities four times a year in accordance with the *Waste Management Act* in order to develop an understanding of the types, characteristics, and other attributes of waste generated in each area.

The results of waste composition surveys can be used to verify the composition of the waste being generated, which is useful for examining the state of the generation of plastics and other recyclable items and measures suitable for those items as well as considering the possibility of introducing waste incineration plants and plant specifications. The results of surveys of the three components are important indicators for verifying the properties and combustibility of waste, and are essential data for planning the development of waste incineration plants. Additionally, because most ash content is incombustible waste, the three-component data is important for considering landfill capacity and other matters when formulating plans for developing landfill sites.

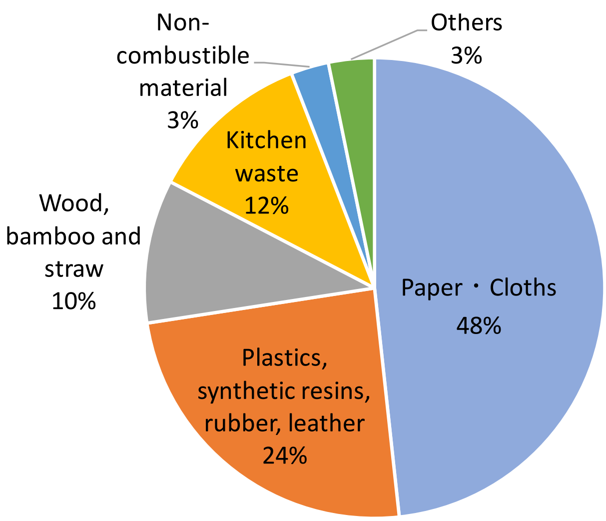
The results of waste composition and three-component surveys are compiled by municipalities and reported to the Ministry of the Environment, where the data is accumulated and used to identify nationwide trends. Table 1-9 and Figure 1-18 show the results of waste composition analysis (dry weight base) at waste incineration plants throughout Japan in FY2019; although lifestyle changes prompted an increase in plastics, kitchen waste decreased as a result of advancements in recycling and minimization of organic waste.

Table 1-9 Result of Composition of Waste (Dry Weight base)

Survey year	Paper, Cloth	Plastic synthetic resins, rubber, leather	Wood, bamboo and straw	Kitchen waste	Non-combustible waste	Others	Total
2019	48%	24%	10%	12%	3%	3%	100%

*1: The composition of municipal waste delivered mainly to incineration facilities is surveyed, so recyclables sorted before collection are not included.
*2: The composition ratio is by dry-base weight excluding water.
*3: The values are obtained by dividing the survey results for each treatment facility in Japan proportionally by the amount of waste treatment at each facility.
Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 25, 2022)

FY 2019



*: The values are obtained by dividing the survey results for each treatment facility in Japan proportionally by the amount of waste treatment at each facility.
Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 25, 2022)

Figure 1-18 Result of Composition of Waste (Dry Weight Base)

Waste composition surveys also measure bulk density (weight of waste per m^3 of waste). The unit volume weight is important data for designing the remaining life of landfill sites, waste pits at waste incineration plants, and storage facilities at other plants. Lower calorific values represent available rather than measurable thermal energy, and are extremely important data for designing waste incineration plants.

Table 1-9 shows the composition of waste (dry weight base) in FY2019. Paper and cloth account for about half of the total weight, and plastics, rubber, and leather for a quarter. Table 1-10 shows the bulk density, the three components, and the lower calorific values (measured values) in FY2019. It should be noted that these values are based on dry weight base, which does not take moisture content into account, and thus differ in composition from wet weight base, which take moisture content into account.

The highest and lowest values for the three components and lower calorific values indicate the extreme variations in the waste data. Reasons for these large variations may be attributed to differences in types of waste and the lack of uniformity in waste samples used in the surveys. Accordingly, the coning and quartering technique is used to ensure the uniformity of samples to the extent possible in waste composition surveys (for more details on the coning and quartering technique, refer to Column: Surveys on Municipal Waste Composition in Developing Countries).

Table 1-10　Weight per Volume, Three Components and Lower Calorific Value of Waste

Survey year	Value	Weight per Volume (kg/m³)	Three Components (%)			Lower Calorific Value* (Measured value kJ/kg)
			Moisture content	Combustible content	Ash content	
2019	Weighted average	153	43	45	12	9,796
	Maximum	596	72	91	74	22,241
	Minimum	15	4	2	2	1,393

*: Lower Calorific Value＝Higher Calorific Value－Latent heat of condensation of water vapor×Amount of water vapor

Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 25, 2022)

Column: Surveys on Municipal Waste Composition in Developing Countries

Knowing the composition of waste is essential for formulating plans for recycling and the stable operation of intermediate treatment plants. In developing countries in particular, there are conspicuous seasonal variations in waste composition, especially during the rainy season, when the moisture of the waste is higher and heating values are lower, making incineration more difficult. Additionally, waste often contains large amounts of concrete rubble, earth, and sand, increasing the burden on the machinery and equipment at intermediate treatment plants (for details on the significance of surveys, refer to Topic 1-2.1: Management of Waste-Related Data). It is also necessary to distinguish between surveys of waste composition at the generation sources and at landfill sites and other receiving facilities, depending on the intended use of the composition data. The following points are worthy of particular attention when conducting waste composition surveys in developing countries.

Important Points to Remember

(1) Timing of Surveys

In areas with clearly defined rainy and dry seasons, conduct surveys in both seasons. The amount of moisture content and bulk density of waste differs widely between the seasons because the waste contains a lot of moisture during the rainy season.

Additionally, avoid conducting surveys during Christmas, New Year's, and other holidays specific to the country because the quantity and quality of waste generated differ from normal times.

(2) Safety of Work

Organize and prepare the gear needed to work safely (e.g., gloves, boots, safety clothing, and masks).

Also, pay sufficient attention to countermeasures against mosquito-borne infections and hazardous waste such as injection needles, and sort the waste in covered areas.

Table 1-11 Examples of Equipment Needed for Waste Composition Surveys

Equipment to wear	Equipment
Vest	Hanging scale
Helmet	Container box (large ~ small）, Bucket
Boots	Plastic sheeting
Medical Mask	Zip Lock, Plastic bag
Gloves	Tongs, Shovels, Scoops
Goggles	Measure tape, Duct tape

(3) Accuracy of Sorting and Measurement

Clarify among the survey team in advance the standards for sorting, the methods of measurement, and the minimum unit of measurement weight (conduct practical exercises in the field in advance). Pay particular attention to what kind of waste is categorized as “other.” Additionally, check whether the waste to be surveyed is missing any recyclables that were collected from the generation sources (private residences or business operators), transfer stations, or the like prior to taking the survey samples.

In the waste composition surveys, the coning and quartering technique is usually used to obtain representative samples and minimize the effects of waste non-uniformity and imbalance. The following figure illustrates the coning and quartering technique.

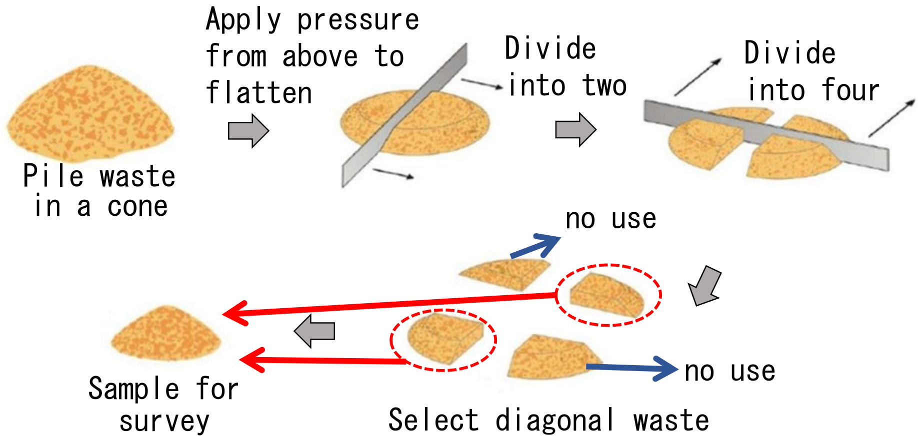


Figure 1-19 Overview of Conical Quartering Technique

Photo 1-3 Piling up

Photo 1-4 Dividing into four

Photo 1-5 Separating

Photo 1-6 Plastics

Photo 1-7 Glass

Photo 1-8 Cloth

Source: Yachiyo Engineering Co., Ltd.

Surveys on Municipal Waste Composition in Indonesia

Photo 1-9 Separating

Photo 1-10 Separating

Source: Yachiyo Engineering Co., Ltd.

Surveys on Municipal Waste Composition in Senegal

Column: The Three Components of Waste

The values of the three components are important for understanding the combustibility of waste and the amount of incinerator ash generated when developing the specifications of incineration plants. The composition of moist waste can be broadly classified into three categories: moisture, ash, the inorganic matter that remains after combustion, and combustibles which are burned off. Moisture content, ash content, and combustibles content are known as the three components of waste. Table 1-12 shows the characteristics of each.

Table 1-12 Main Elements in the Three Components

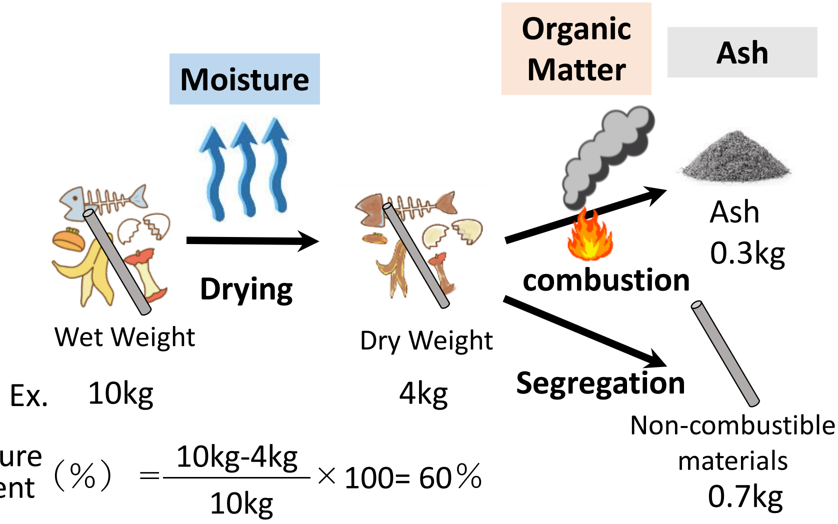
Three Components	Properties and constituent elements
Moisture content	Water（H_2O）
Ash content	The inorganic substance that remains after the complete combustion of a substance. Main elements are potassium (K), calcium（Ca）and magnesium (Mg) .And include small amounts of metallic elements such as iron (Fe), aluminum (Al), zinc (Zn), sodium (Na), copper (Cu), etc.
Combustible content	Organic matter that turns to gas when burned and disappears. It is composed of elements such as carbon (C), oxygen (O), hydrogen (H), nitrogen (N) and phosphorus (P). When heated at high temperatures and with sufficient oxygen supply, it becomes a gas such as carbon dioxide.

Processes such as drying and burning are necessary for determining the actual proportions of the three components of waste. The table below shows the methods of calculating the proportions.

Table 1-13 Calculation Method of the Three Components

Three Components	Calculation method
Moisture content	$\text{Moisture (\%)} = \dfrac{\text{Wet Weight} - \text{Dry Weight}}{\text{Wet Weight}} \times 100$ Calculated by the difference in weight before drying and after drying at 105°C.
Ash content	$\text{Ash (\%)} = \dfrac{\text{Weight of "combustible" residue after drying} + \text{Weight of "non-combustibles"}}{\text{Wet Weight}} \times 100$ Calculated as the sum of the weight of incombustibles and ash remaining after combustion *: All incombustible materials (e.g., iron, stone, etc.) are considered to be non-combustible
Combustible content	$\text{Combustible (\%)} = \dfrac{\text{Wet Weight} - \text{Moisture Weight} - \text{Ash Weight}}{\text{Wet Weight}} \times 100$ Calculated from the difference between the wet weight and the weight of the moisture and ash content

For example, suppose the wet weight of waste is 10 kg, the dry weight is 4 kg, and the ash and non-combustibles after combustion weigh 0.3 kg and 0.7 kg, respectively. In this case, the ratio of the three components to the wet weight can be calculated as shown on the next page. Also, using the Turner triangle shown on the next page it is possible to use the values of the three components to approximate what can be burned without auxiliary fuel when the heating value cannot be measured.

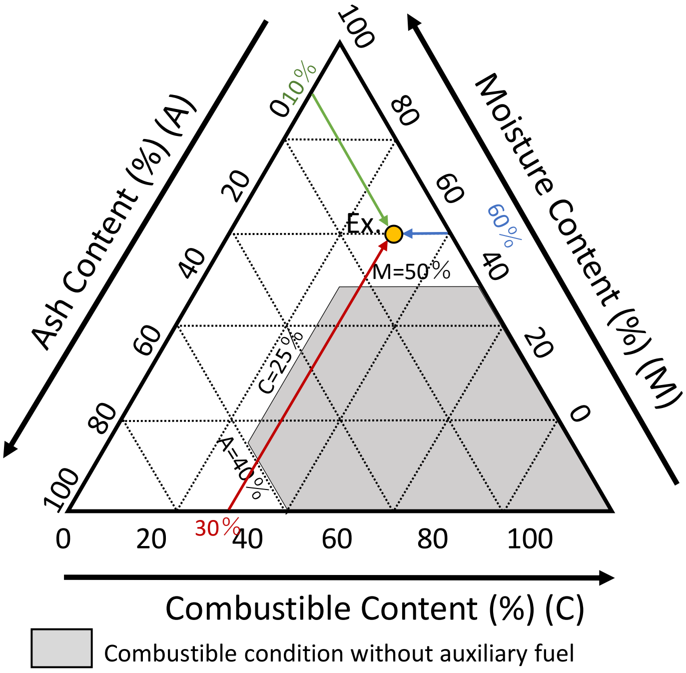


$$\text{Moisture Content}\ (\%) = \frac{10\text{kg}-4\text{kg}}{10\text{kg}} \times 100 = 60\%$$

$$\text{Ash Content}\ (\%) = \frac{0.3\text{kg}+0.7\text{kg}}{10\text{kg}} \times 100 = 10\%$$

$$\text{Combustible Content}\ (\%) = \frac{4\text{kg}-(0.3\text{kg}+0.7\text{kg})}{10\text{kg}} \times 100 = 30\%$$

Figure 1-20 Example of the Calculation of Three Components



Source: World Bank Technical Paper No.462 “Municipal Solid Waste Incineration” (T. Rand, J. Haukohl, U. Marxen 2000)

Figure 1-21 Triangle for Assessment of Combustibility of Waste

2 Waste Management Plans

The Ministry of the Environment uses quantitative figures as basic information when considering the formulation of policies and plans related to waste management, which makes it possible to set numerical targets for policies and the like and to indicate specific plans for developing facilities.

Municipalities use data collected and analyzed in the course of carrying out municipal waste management in areas under their jurisdiction to formulate and implement plans for collection, sorting, facility maintenance, and more. Each of these plans contains basic policies and specific measures for efficient and effective waste generation reduction, waste collection and transport, intermediate treatment, and final disposal, and serves as the basis for carrying out waste management administration.

This section introduces the frameworks and approaches for formulating various plans for waste management at national and local levels, which are based on quantitative data.

2.1 Management of Waste-Related Data

(1) Data Management for the Entire Country

In Japan, the central government collects data from municipalities to create a shared database. The database enables the Ministry of the Environment to understand the circumstances of waste management across the country and municipalities to share information with each other. This allows the Ministry of the Environment to formulate measures and strategies that are in line with the actual circumstance and to promote cooperation between the Ministry and municipalities.

In Japan, the Ministry of the Environment publishes the results of an annual survey on the state of municipal waste management. Since the 1970s the Ministry of the Environment has been conducting a survey in the form of a questionnaire to municipalities and associations for the purpose of obtaining basic data on municipal waste administration. The central government then collects and accumulates the data from municipalities to build a nationwide database, which is characteristic of data management in Japan.

Table 1-14 shows the survey items, which are broadly divided between the conditions of facility operation and the conditions of treatment. The data obtained is aggregated by municipalities in each prefecture, and the statistical tables are available to the public. This data fulfills an important role in examining and setting specific priority targets, achievement indicators, and other criteria when formulating plans for waste management.

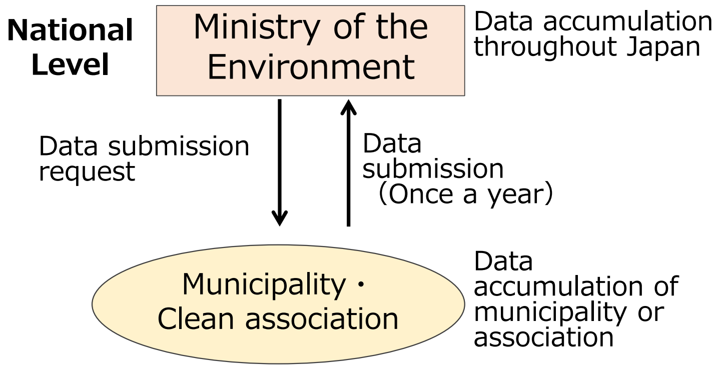


Figure 1-22 Waste Data Collecting System in Japan

Table 1-14 Survey iItems Covered in the Ministry of the Environment Survey on Municipal Waste

Items		Main survey contents
Facility	Incineration plant	Annual treatment amount, Type of waste, Type of facilities and plants, Waste composition, etc.
	Bulky waste treatment facility	Annual treatment amount, Collected resources amount, Type of waste, Type of treatment
	Recycling facility	Annual treatment amount Collected resources amount, Output amount, Type of facilities, etc.
	Fuel conversion facility	Annual treatment amount, Type of waste, Type of facilities, Capacity of facilities, etc.
	Other facilities	Annual treatment amount, Type of waste, Treatment method, Capacity of facilities, etc.
	Storage facility	Annual storage amount, Type of waste, Type of facilities, number of categories, etc.
	Landfill	Capacity, Disposal amount, Remaining landfill capacity, Type of waste, etc.
	Sewage treatment facility	Annual treatment amount, Recycling amount, Type of treatment, Capacity of facilities, etc.
	Small-scale sewage treatment equipment	Sewage treatment amount, Type of treatment, Planned maximum sewage amount, etc.
	Reuse and repair facilities	Annual treatment amount, Area, Targeted items, etc.
Treatment	Waste management status	Total population, Waste generation amount, Waste treatment amount, Disposal amount, etc.
	Waste management system	Collection and transport (Household and Business waste), Number of sorted items, Service fee, etc.
	Treatment of raw sewage	Total population, Service fee, etc.
	Expense	Specific revenue sources (central government disbursements, local government disbursements, etc.), general revenue sources, etc.
	Personnel, machinery, etc.	Number of staff, Number of collection vehicles, Number of outsourced contracts, Number of treatment companies, etc.
	Disaster waste treatment	Treatment amount, Reduction processing rate, Recovered Amount after Intermediate Treatment, etc.
	Expense for disaster waste treatment	Specific revenue sources (central government disbursements, prefectural government disbursements, etc.), general revenue sources, etc.
	Personnel, machinery, etc. for disaster waste treatment	Number of staff (General and technical staff)

Source: Ministry of the Environment Website "Results of the survey on municipal waste management"
https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 26, 2022)

(2) Formulation of Various Plans Based on Data

Data collected through surveys on waste can be used not only to set basic policies on waste management, but also as the basis for various plans and policies, including waste collection and transport plans, development plans and life extension plans for facilities, and policies for promoting waste minimization and recycling.

In the course of carrying out waste management, municipalities continuously collect a variety of data and use it to formulate policies and plans for the future.

Waste incineration plants and other intermediate treatment plants and landfill sites in Japan are equipped with scales that automatically weigh and collect data of incoming waste, recyclables (e.g., cans, glass bottles, paper), and disposal waste such as incinerator ash. The amount of waste generated can be ascertained from the amount of incoming waste weighed at waste incineration plants and other intermediate treatment plants or at landfill sites when said treatment plants are not available. Ascertaining the amount of waste generated makes it possible to verify that plants are operating according to plans and staying within their treatment capacities. Additionally, combining the amount of waste generated with other data such as demographic trends makes it possible to project amounts of waste generated in the future. This ability to project amounts of waste generated makes it possible to examine the number of collection vehicles, the treatment capacity of incineration and other forms of intermediate treatment, and the remaining disposal capacity (remaining service life) of landfill sites, which enables the review of waste collection and transport plans and the formulation of plans for developing intermediate treatment plants and landfill sites.

The results of waste composition surveys can be used to develop an understanding of the types and amount of waste, making it possible to verify whether the quality of the waste meets the design conditions for intermediate treatment plants or whether it causes problems with the plants’ functions. Additionally, identifying recyclable items makes it possible to formulate policies and plans for recycling and resource circulation.

Regarding surveys of the three components and heating values of waste, the results for combustibles demonstrate the combustibility of the waste, while the results for ash content make it possible to estimate incineration residue; therefore, survey results make it possible to estimate waste combustion efficiency and final disposal amounts.

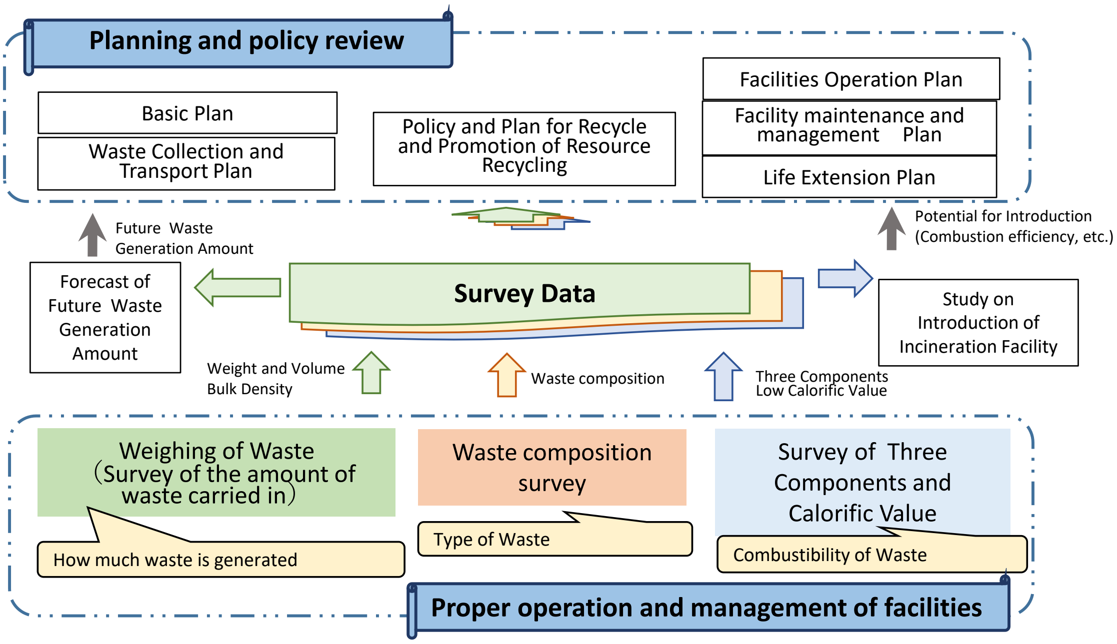


Figure 1-23 Examples of Utilization of Waste Survey Data

2.2 National-Level Waste Management Plans

Plans formulated by the central government clearly set out specific numerical targets and implementation items for the target fiscal year. The data collected by the central government from municipalities is used in the plans, which set out policy for waste management at the national level.

(1) Fundamental Plan for Establishing a Sound Material-Cycle Society

The Fundamental Plan for Establishing a Sound Material-Cycle Society goes beyond the framework of waste to outline the sound material-cycle society Japan should aim to become, and includes matters such as ensuring material circulation in society, curtailing natural resource consumption, and reducing environmental impact. Because the plan presents the basic policy of the central government, municipalities have a clear idea of the vision for each area and how they should go about achieving it.

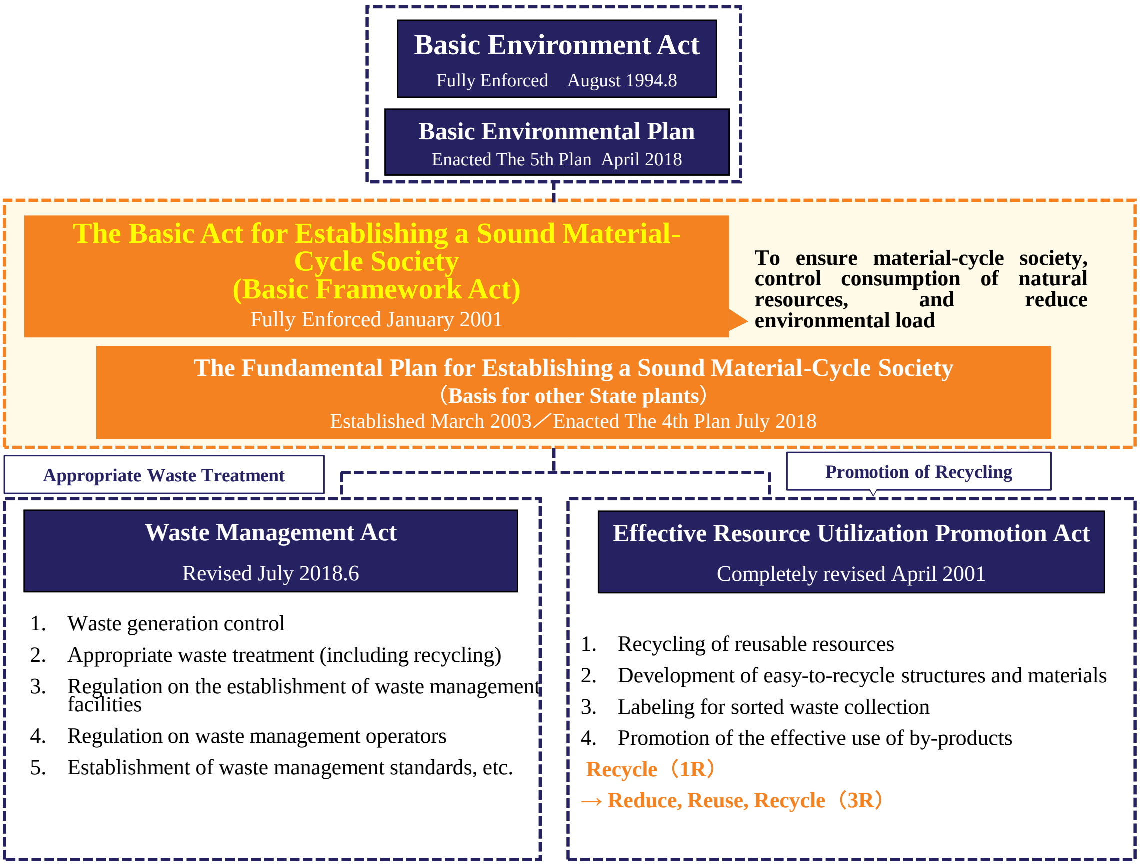
The plan lists priority targets for resource productivity, that include among others the ratio of recycled resources to natural resources used, the final disposal amount, and sets out specific future targets in the form of numerical values.

Figure 1-24 shows the positioning of the Fundamental Plan for Establishing a Sound Material-Cycle Society, which was developed to comprehensively and systematically promote measures for forming a sound material-cycle society founded on the *Basic Act on Establishing a Sound Material-Cycle Society* (for more details on the *Basic Act on Establishing a Sound Material-Cycle Society*, refer to Topic 2-2 (2): Basic Act for Establishing a Sound Material-Cycle Society).

The Fundamental Plan for Establishing a Sound Material-Cycle Society is updated every five years, and the Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society was formulated in 2018. This fourth iteration of the plan sets out visions, initiatives, and indicators for each of seven pillars (e.g., integrated efforts to create a sustainable society, regional revitalization through the formation of a Regional Circular and Ecological Sphere) with the aim of resolving the issues in the area of recycling listed below. Table 1-15 is an overview of the Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society.

Issues in the Area of Recycling in Japan

- Restoration and recovery from environmental contamination caused by radioactive materials released from nuclear power plant accident
- Frequent occurrence of major disasters, and delayed countermeasures
- Changes in people's focus (from material wealth to spiritual wealth)
- Securing the leaders of resource circulation and proper treatment



Source: Ministry of the Environment “Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society” (2018)

Figure 1-24　Position of the Fundamental Plan for Establishing a Sound Material-Cycle Society

Table 1-15 Overview of the Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society

Item	Description
Overview	The plan was established to comprehensively and systematically promote measures for forming a sound material-cycle society based on the *Basic Act on Establishing a Sound Material-Cycle Society*.
Formulation date	June 2018 (updated every five years (previously updated in 2003, 2008, and 2013))
Plan duration	Five years from FY2018 to FY2022
Implementation items	1. Integrated efforts to create a sustainable society 2. Regional revitalization through the formation of a Regional Circular and Ecological Sphere 3. Thorough resource circulation throughout product lifecycle 4. Promotion of proper treatment, and environmental restoration 5. Establishment of a disaster waste treatment system 6. Establishment of a proper international resource circulation system, and overseas expansion of the recycling industry 7. Infrastructure development in the area of recycling
Priority targets (FY2015 to FY2025)	・Resource productivity*1: From JPY 380,000/ton to JPY 490,000/ton ・Inflow ratio of recycled resources to natural resources used*2: 16% to 18% ・Outflow ratio of recycled resources to natural resources used**3: 44% to 47% ・Final disposal amount: 14 million tons to 13 million tons (3 million tons of municipal waste, 10 million tons of industrial waste) ・Expansion of sound material-cycle society business markets: Roughly double the FY2000 level (JPY 40 trillion) by FY2025 ・Reduction of household food loss: Half of the FY2000 level (4.33 million tons) by FY2025 ・Amount of waste generated per person per day: From 925 g/person/day (FY2016) to 850 g/person/day ・Amount of household waste generated per person per day: From 507 g/person/day (FY2016) to 440 g/person/day ・Remaining life of landfill sites: Municipal waste: Maintain above 20 years in FY2022 Industrial waste: Roughly 10 years by FY2020 ・Rate of formulation of disaster waste treatment plans: Prefectures: From 43% to 100% Municipalities: From 21% to 60% ・Electronic manifest diffusion rate: From 53% (2017) to 70% (2022) ・Rate of implementation of specific 3R actions: Increase 20% by FY2025 from the level in the FY2012 public opinion survey

*1: Resource productivity = GDP / Natural resource input

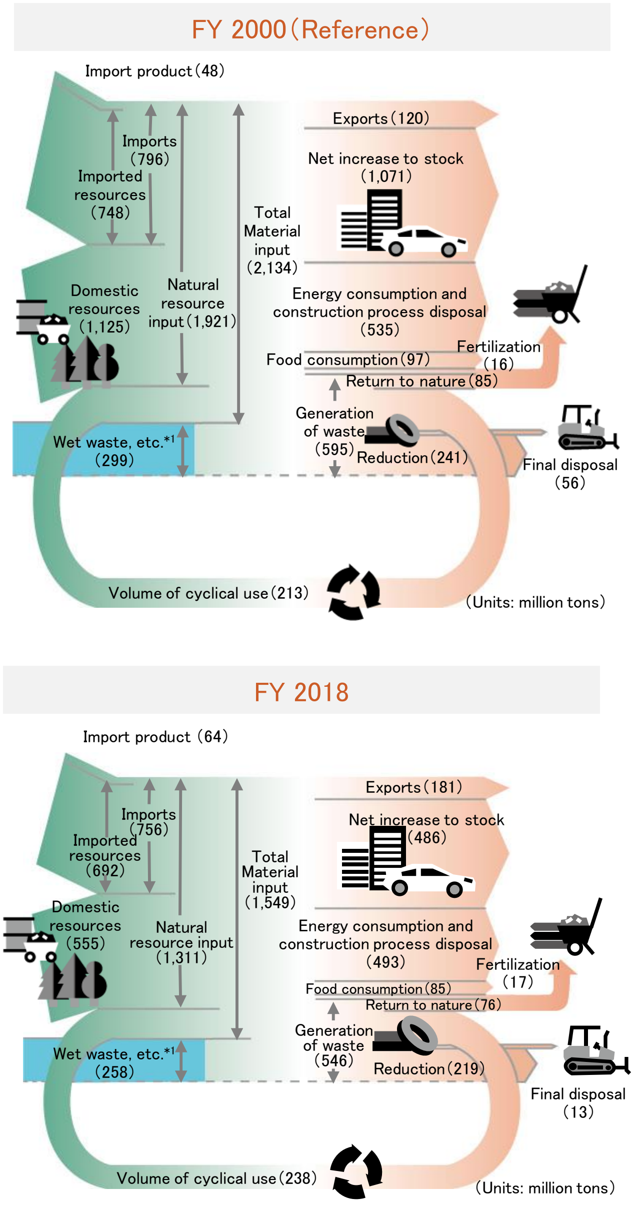
*2: Inflow ratio of recycled resources to natural resources = Amount of recycled resources used / (Input of natural resources + Amount of recycled resources used)

*3: Outflow ratio of recycled resources to natural resources = Amount of recycled resources used / Amount of waste generated

Source: Ministry of the Environment "Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society" (2018)

Column: Material Flow in Japan

The first step in establishing a sound material-cycle society is knowing the amount of resources being extracted, consumed, and disposed of. Material Flow Analysis (MFA) is the basis for the overall vision of material flow in Japan's economy and society (FY2000 and FY2018) and the target values for material flow indicators set in the Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society.



*Wet waste, etc.: Input of water included in waste and the like (sludge, livestock waste, night soil, waste acid, waste alkali) and sediments dumped in the process of economic activities (sludge in mining, construction and in waterworks as well as slag)

Source : Ministry of the Environment Website "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 1-25 Material Flow Analysis in Japan

Resource Productivity

Resource productivity is indicated by GDP (the total value added of goods and services produced within a defined period of time) in terms of the amount of natural resource input. The aim is to provide more goods and services with less resource input.

Inflow Ratio of Recycled Resources to Natural Resources Used

While materials become waste on the outflow side, they are material input on the inflow side. In other words, the inflow ratio of recycled resources to natural resources used is the ratio of the amount of recycled resources in terms of the total amount of material input.

Outflow Ratio of Recycled Resources to Natural Resources Used

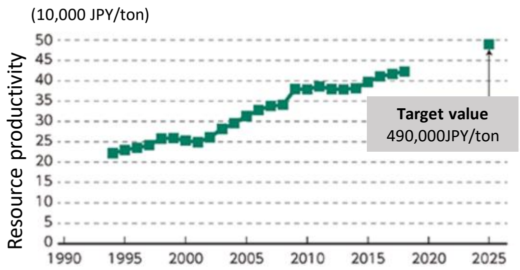
This is the ratio of the amount of recycled resources in terms of the total amount of waste generated.

Final Disposal Amount

This is the amount of waste disposed of in landfill sites or otherwise dumped.

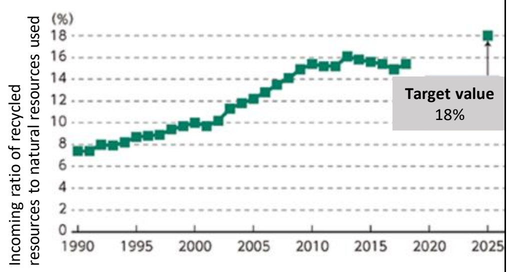
Resource Productivity

(= GDP*1/ Natural resources ,etc. input)



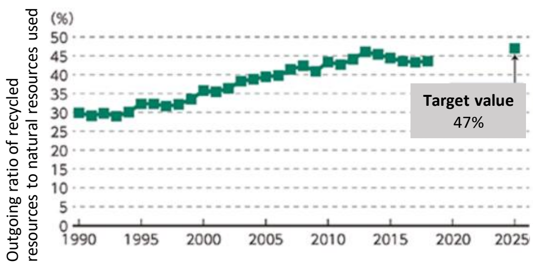
Inflow Ratio of Recycled Resources to Natural Resources Used

(= Cyclical amount used/(Natural resources, etc. input + cyclical amount used))



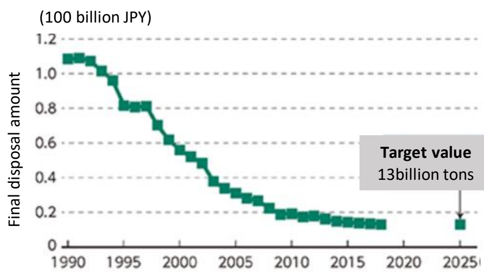
Outflow Ratio of Recycled Resources to Natural Resources Used

(= Cyclical amount used/ Waste generation Amount)



Final Disposal Amount

(= Waste disposal amount)



*1: GDP: Gross Domestic Product

*2: Due to a revision of the method for estimating inflow and outflow ratios of recycled resources, the figures for FY2016 and later were estimated differently than those for and before FY2015.

Source : Ministry of the Environment Website “Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021” (2021)

Figure 1-26 Resource Productivity, Inflow and Outflow Ratios and Final Disposal Amount

(2) Waste Management Facility Development Plan

The Waste Management Facility Development Plan is a plan for the development of facilities for the treatment and disposal of waste. However, recently various functions have been demanded of these facilities in addition to proper waste treatment. The plans includes interaction with the local community, response to social structural changes, and disaster countermeasures. For this reason, the plan provides specific figures for the recycling rate, remaining life of the disposal facility, average incineration power generation efficiency, and the percentage of waste derived energy supplied externally as priority targets.

The Waste Management Facility Development Plan defines the targets and outline of the waste management facility development project for the planning period, based on the *Waste Management Act*. The Waste Management Facility Development Plan is updated every five years, and the plan formulated in 2018 emphasizes the development of waste management facilities that create new value for the region, in addition to the promotion of the 3Rs and proper treatment, climate change countermeasures, and strengthening of disaster countermeasures, which have been addressed in the past. Furthermore, in light of changes in the social structure surrounding waste treatment, such as a declining population, the plan also describes the soft measures necessary for the proper operation of waste treatment facilities. The outline of the waste treatment facility development plan (formulated in 2018) is shown in Table 1-16.

Table 1-16 Outline of the Waste Management Facility Development Plan (Formulated in 2018)

Item	Contents
Outline	The plan defines the targets and outline of the waste management facility development project for the planning period, based on the *Waste Management Act*.
Date of formulation	June 2018 (formulated every five years – introduced in 2003, and revised in 2008, and 2013)
Plan period	Five-year period from FY 2018 to FY 2022
Basic philosophy	1. Promote the 3Rs based on basic principles 2. Ensure a municipal waste treatment system that is resilient and safe against climate change and disasters 3. Develop municipal waste treatment facilities that take advantage of local autonomy and ingenuity
Implementation items	1. Promotion of 3Rs through municipal waste treatment systems for municipalities 2. Stable and efficient development and operation of facilities to ensure sustainable and appropriate treatment 3. Promotion of climate change measures in waste treatment systems 4. Promotion of the utilization of waste biomass 5. Strengthening disaster countermeasures 6. Development of waste treatment facilities that create new value for the region 7. Securing the understanding and cooperation of local residents, etc. 8. Ensuring proper bidding and contracting for construction work related to waste treatment facility development
Priority targets (FY2018↓ FY2022)	Waste recycling rate: 21%→27% ・Remaining life of landfill sites for municipal waste: Maintain the level of FY2017 (20 years) ・Average power generation efficiency of waste incineration facilities constructed during the period: 19% → 21% ・Percentage of facilities supplying energy from waste to external sources: 40% → 46% ・Population penetration rate of septic tanks in septic tank improvement areas: 53% → 70%. ・Percentage of combined treatment septic tanks: 62% → 76% ・Greenhouse gas reduction due to the introduction of energy-saving septic tanks: 50,000 t-CO_2 → 120,000 t-CO_2

Source: Ministry of the Environment "Waste Management Facility Development Plan" (2018)

2.3 Plan for Waste Management at the Municipality Level

Municipalities, which are responsible for the practical management of waste, formulate their own plans according to the plans and policies formulated by the central government. Because each municipality is responsible for the realization of the plan (for example, implementation of collection work, construction of facilities, etc.), it is necessary to formulate a plan that is feasible according to the actual situation. Accumulated data and data from other municipalities are being utilized for this purpose.

Based on the numerical data, measures to be taken and their effectiveness (emission control, reduction, and public awareness) will be considered, and necessary facilities will be planned.

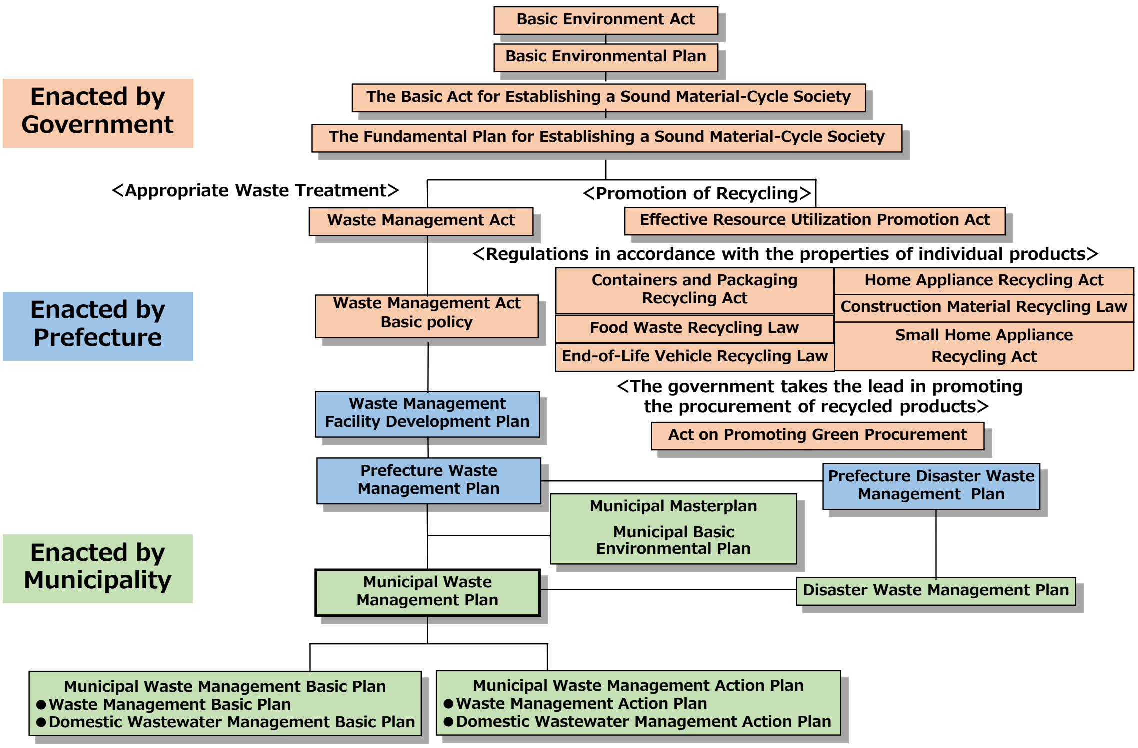
Based on the various laws and plans at the national level, plans for waste management at the municipality level are formulated (as of 2020, 1,741 municipalities: 23 special wards, 792 cities, 743 towns, and 183 villages). The central government prepares guidelines and manuals for each municipality to formulate their plans. Each plan has a set period of time, and a new plan is developed for every set period of time (5 years, 10 years, etc.).

Municipalities develop not only plans required by law, but also action plans such as implementation plans, which are designed to promote activities through cooperation between the administration and local residents. Municipalities that formulate a variety of plans disclose information on draft plans on their websites, and collect public comments on the plans in order to enhance the practicability of the plans. Medium and long-term plans are periodically reviewed to maintain highly feasible plans in line with social conditions, and that the plans are being reliably implemented.

Main items to be analyzed and calculated in the plan based on basic data related to waste (waste amount and composition) are shown below.

- Projected future waste amount
- Amount of waste to be collected, treated, and disposed of in the future
- Number of collection vehicles required for collection in the target area
- Amount of waste that can be recycled in the target area
- Treatment capacity of intermediate treatment (incineration facilities, etc.)
- Landfill disposal capacity of landfill sites

The relationship between the various laws and the plans is shown below in Figure 1-27.



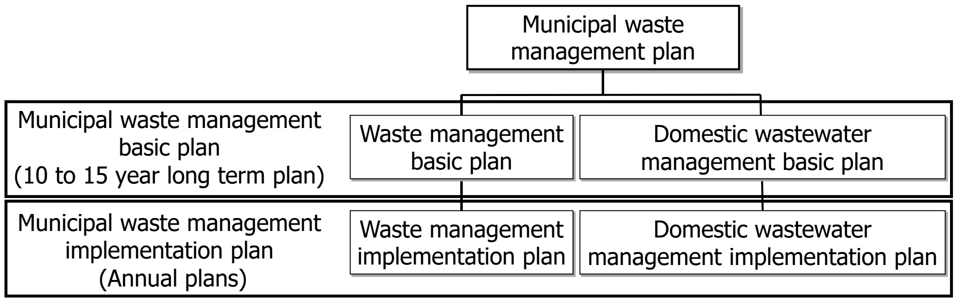
Source: Ministry of the Environment “Waste Management Basic Plan Formulation Guidelines” (2016)

Figure 1-27 Relationship between Various Laws and Plans

(1) Municipal Waste Management Plan

The municipal waste management plan shown in Figure 1-27 is based on the *Waste Management Act*, and is set by the municipality regarding the municipal waste management plan in the area of the municipality. The outline of the municipal waste management plan is shown in Table 1-17. There is a basic long-term plan for 10 to 15 years and an implementation plan that is set for each fiscal year. The long-term plan will be reviewed every five years based on the status of achievement of the plan.

Table 1-17 Outline of the Municipal Waste Management plan

Item	Contents
Outline	Based on the *Waste Management Act*, the municipality establishes a plan for municipal waste disposal in the area of the municipality in order to properly dispose of general waste while preserving the living environment and improving public health, which are the objectives of the Act.
Scope of application	All areas within the municipality
Target	All municipal waste generated in the municipality (including municipal waste to be disposed of under the instructions of the municipality, by large waste generators and by parties other than the municipality)
Plan structure	
Contents of each plan	**[Municipal waste management basic plan]** Clarifies the basic policy from a long-term perspective, the future social and economic conditions surrounding waste treatment, the expected generation of municipal waste, local development plans, and the demands of local residents. In addition to the above, the development of municipal waste treatment facilities and systems, and the securing of financial resources are fully considered. Then, realistic and concrete measures to realize them are comprehensively examined. [Items specified in the waste management basic plan] 1. Estimated amount of waste generated and treated → Refer to column on next page 2. Matters related to measures to reduce waste discharge 3. Types and categories of waste collected separately 4. Basic matters concerning the proper treatment of waste and the persons who carry out such treatment 5. Matters concerning the development of waste treatment facilities 6. Other necessary matters concerning waste treatment **[Municipal waste management implementation plan]** The plan must be formulated annually based on the municipal waste management basic plan, and clarify the status of general waste discharge, treatment entities, collection plan, intermediate treatment plan, and final disposal plan. Municipalities must conduct collection, transportation, and disposal based on this plan.

Source: Ministry of the Environment “Waste Management Basic Plan Formulation Guidelines” (2016)

Column: Projecting the Future Amounts of Waste Generated and Treated

According to the Ministry of the Environment's Waste Management Basic Plan Formulation Guidelines (2016), the methods for future projections of waste generation and treatment are as follows.

(1) Future Projections of Population and Business Activities, etc.

A. Future Projections of Population

It is appropriate to use the trend method*[1] or the cohort factor method*[2] to project the future population. It is also possible to use the projected future population as indicated in the basic concept of the municipality.

B. Future Projections of Business Activities, etc.

Concerning business waste, it is desirable to make the forecast considering the relevant conditions, such as changes in the number of employees and business establishments and shifts in economic conditions.

(2) Future Projections of Waste Generation Amount

First, make an estimate of how the amount of waste generated will change in the future if the control of waste discharge and recycling is not promoted, and improvements toward the formation of a sound material-cycle society are not made.

As a projection method, the amount generated per person per day (g/person/day) can be calculated based on past results, and the actual results can be estimated in the future using methods such as the trend method*[1], and then multiplied by the projected future population to forecast the amount generated.

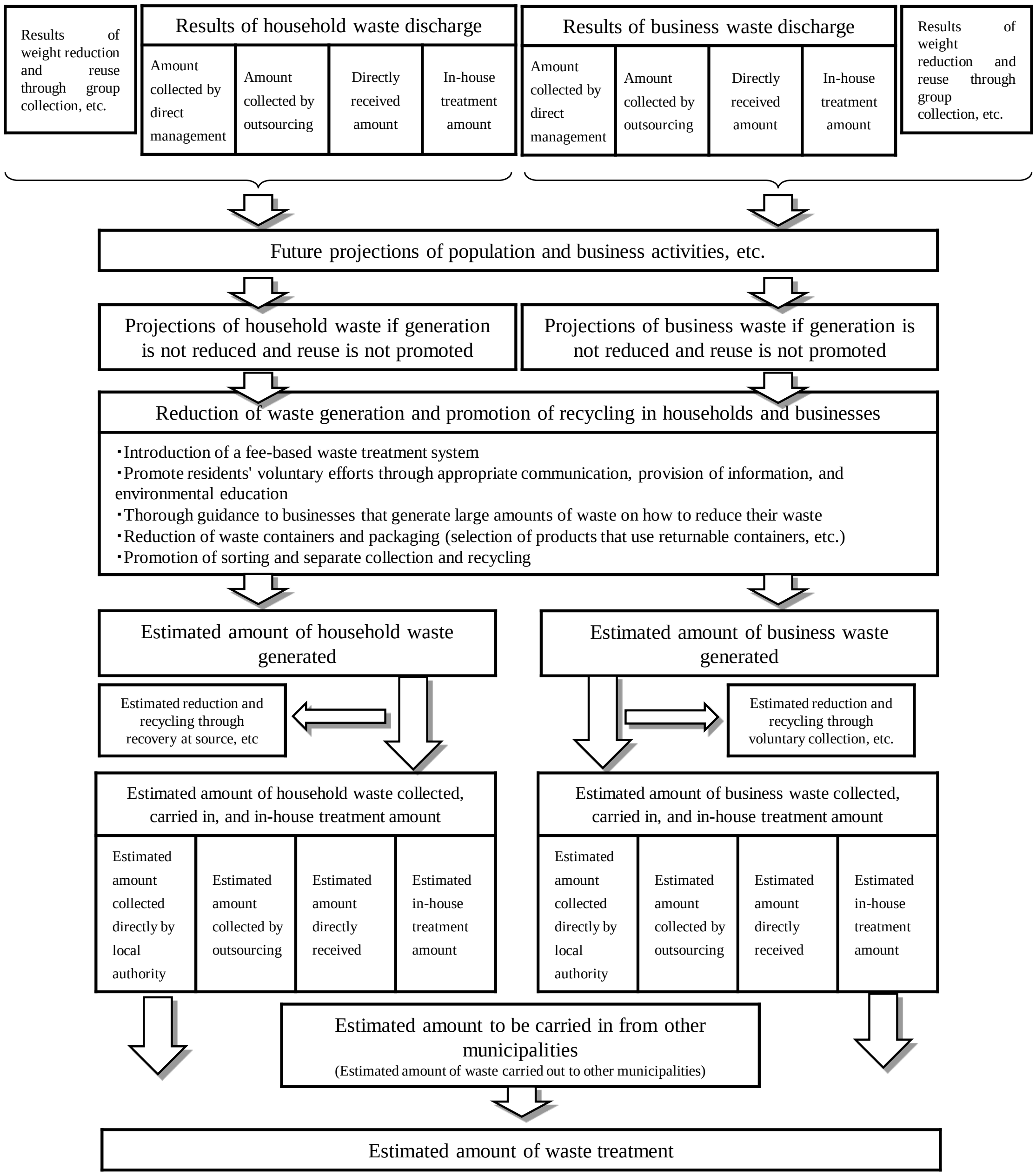
Next, it is necessary to set targets based on the policies to be implemented to reduce waste generation and promote recycling in households and business establishments. Specifically, targets for the amount of waste produced are set based on the effects of generation control through the introduction of fee-based waste treatment and the implementation of public awareness programs. The target values for recycling must be set based on changes in the classification of waste sorting and separate collection.

Based on the above, the amount of waste generated by type of waste (for example, combustible waste, non-combustible waste, recyclables, bulky waste, specially-controlled general waste, etc.) after achieving the set target, is projected after considering the effects of measures for each type of waste, such as collection (directly or outsourced), directly received at the recycling facility, and group collection.

In order to clarify the treatment systems and quantities to achieve the target values, it is desirable to prepare a flow diagram showing the quantities from discharge to recycling and final disposal in the target year or intermediate target year.

Preparation of a time-series graph to compare the forecast values in the case where the current situation is maintained without the previously considered improvements toward the formation of a sound material-cycle society, and the target values to be achieved through various measures, will make it easier to explain to residents.

*1: The trend method is a type of chart analysis that focuses on the chronological changes, such as rising, falling, and leveling off, to forecast the amount generated in the future.
*2: The cohort factor method is a method for calculating the future population by calculating the annual changes in the population by age for each demographic factor (death, birth, and population movement).



*: With regard to waste collection, it is desirable to classify recyclables into paper, metal, glass, and plastic containers and packaging in order to set targets for resource recycling and reuse, as well as to estimate the amount of waste discharged by type (combustible, noncombustible, recyclables, etc.), corresponding to separate collection.
Source: Ministry of the Environment "Waste Management Basic Plan Formulation Guidelines" (2016)

Figure 1-28 Examples of Methods for Projecting the Future Amount of Waste Generated and Treated

(2) Municipal Separate Collection Plan

The municipal separate collection plan is set by municipalities for implementing separate collection of waste containers and packaging based on the *Containers and Packaging Recycling Act*. The plan is formulated every three years for a five-year term, and has been formulated nine times since 1997.

An outline of the 9th Municipal Separate Collection Plan is shown in Table 1-18. The total number of municipalities is 1,741 (including special cities) and all of them have formulated their respective 9th Municipal Separate Collection Plan, and it is expected that all municipalities will carry out some kind of waste containers and packaging separate collection during the five years from FY2020 to FY2024.

Table 1-18 Outline of the 9th Municipal Separate Collection Plan

Item	Contents
Outline	Set by municipalities for implementing separate collection of waste containers and packaging based on the *Containers and Packaging Recycling Act* and the *Plastic Resource Recycling Promotion Act*.
Plan period	Five-year period from FY 2020 to FY 2024
Scope of application	All municipalities can formulate municipal separate collection plans at their own discretion. (Disposal of municipal waste is an autonomous task of municipalities, and separate collection is not mandatory, but instead introduced and implemented based on local conditions.)
Target of separate collection	Article 2 of the Ministerial Ordinance on the Separate Collection of Containers and Packaging Waste (Ordinance of the Ministry of Health and Welfare No. 61 of 1995) stipulates the following categories for sorting in consideration of the promotion of recycling: steel containers, aluminum containers, glass containers (sorted into three colors: colorless, brown, and other), paper beverage containers, cardboard containers, paper containers and packaging, PET bottles, plastic containers and packaging (only white styrofoam food trays can be sorted and collected).
Matters to be formulated	・Projected amounts of waste containers and packaging to be discharged in each fiscal year ・Matters related to measures to promote reduction of waste containers and packaging discharged ・Type of waste containers and packaging that are to be sorted and collected and the classification of sorting pertaining to collection of the waste containers and packaging ・The amount of waste containers and packaging that conform to the specified sorting standards obtained in each fiscal year and the expected amounts of waste containers and packaging specified by the ordinance of the competent ministry prescribed in Article 2, paragraph 6 of the *Containers and Packaging Recycling Act* (steel containers, aluminum containers, glass containers (colorless, brown, etc.), cardboard, paper containers for beverages, paper

Item	Contents
	containers and packaging, PET bottles, plastic containers and packaging) ・Basic matters concerning the party that implements separate collection ・Matters related to the development of facilities used for separate collection ・Other important matters concerning implementation of separate collection of waste containers and packaging
Projected implementation of separate collection	Pet bottles FY2020: 1,724 municipalities (99.0%) → FY2024: 1,724 municipalities (99.0%) Estimated amount of separate collection: 312,000 tons → Estimated amount of separate collection: 317,000 tons Plastic containers FY2020: 1,390 municipalities (79.8%) → FY2024: 1,398 municipalities (80.3%) Estimated amount of separate collection: 726,000 tons → Estimated amount of separate collection: 726,000 tons Paper containers and packaging* FY2020: 863 municipalities (49.6%) → FY2024: 865 municipalities (49.7%) Estimated amount of separate collection: 101,000 tons → Estimated amount of separate collection: 103,000 tons

*: In addition to the above-mentioned 865 municipalities (FY2024) that have positioned paper containers and packaging in their separate collection plans, there are many municipalities that collect paper containers and packaging as miscellaneous waste, etc., together with paper other than containers and packaging for recycling.

Source: Ministry of the Environment, “Guide to Formulating Municipality Separate Collection Plans (Ninth Revised Edition)” (2019).
Ministry of the Environment Website, “Results of the Estimated Amount of Separate Collection From 2020 Based on the Containers and Packaging Recycling Act” https://www.env.go.jp/press/107515.html (accessed January 30, 2022) https://www.env.go.jp/press/107515.html （accessed January 30, 2022）

(3) Inter-Municipal Waste Treatment Plan

Inter-municipal waste treatment refers to the practice when several municipalities jointly implement the treatment and disposal of waste, thereby reducing the environmental burden and costs.

Since the issuance of the plan titled “Regarding the Inter-municipal Waste Treatment Plan” (Ministry of Health and Welfare, May 28, 1997), all prefectures have formulated plans for inter-municipal waste treatment, and prefectures and municipalities have been making efforts for inter-municipal waste treatment and the consolidation of waste treatment facilities.

As a result, a total of 438 blocks for inter-municipal waste treatment were established nationwide (as of 2020). As of 2013, the number of waste incineration facilities in 245 of these blocks had decreased compared to the time when the plan was formulated, and a certain degree of success has been achieved in terms of inter-municipal waste treatment and consolidation. On the other hand, there have been cases where inter-municipal waste treatment and consolidation have not advanced due to factors such as the belief that there is little merit in doing so and the difficulty in coordinating among municipalities and with residents.

Japan's population is currently in a declining stage, and it is expected that the financial position of the national and municipalities will become more difficult and that there will be a shortage of manpower for waste treatment. In addition, the total amount of waste generated is also on a downward trend, making it extremely difficult to continue with the conventional waste treatment system. The inter-municipal waste treatment plan has been formulated based on the fact that it will be necessary to consider a stable and efficient waste treatment system from a medium to long-term perspective. An outline of the inter-municipal waste treatment plan is shown in “Guidance on Inter-municipal Waste Treatment and Consolidation”, prepared by Ministry of the Environment, in 2020.

Table 1-19 provides an outline of the inter-municipal waste treatment system, and Figure 1-29 shows the flow of efforts needed to develop inter-municipal waste treatment and consolidation and the implementing bodies for these efforts (for more details on inter-municipal waste treatment, refer to “Topic 2-3.4: Inter-Municipal Waste Disposal”).

Table 1-19 System of Inter-Municipal Waste Treatment Plan

Item	Contents
Outline	The prefecture and the municipalities in its jurisdiction collaborate to formulate an inter-municipal waste treatment and consolidation plan.
Plan period	In principle 10 years
Necessity of the inter-municipal waste treatment	(1) Ensure sustainable and appropriate treatment ・Establishment of a stable and efficient waste treatment system ・Renewal of aging waste treatment facilities ・Improving the cost efficiency of waste treatment ・Securing human resources and transfer of technology through cooperation among prefectures and municipalities (2) Promotion of climate change measures ・Energy conservation at waste treatment facilities ・Recovery and utilization of waste energy (3) Promotion of waste recycling and biomass utilization ・Utilization of waste biomass (4) Strengthening disaster countermeasures ・Ensuring the continuity of waste treatment operations in the event of a disaster ・Focusing investment on strengthening facilities and systems (5) Creation of new value for the region
Inter-municipal Waste Treatment Plan Contents	(1) Plan period (2) Creation of an inter-municipal waste treatment block demarcation (3) Waste treatment system in each block (4) Estimation of current and future emissions of dioxins (5) Waste treatment methods during the transitional period until the completion of inter-municipal waste treatment (6) Where to use RDF when it is produced (7) Other matters (transportation method, amount recycled, amount of waste generated, sorting method, etc.) (8) How to follow up on the inter-municipal waste treatment plan
Points to consider when formulating the plan	・The body that formulates the plan ・Evaluation of the previous inter-municipal waste treatment plan ・Future projections of the population and waste generation ・Review of the setting of inter-municipal waste treatment block demarcation ・Consideration of the waste treatment system for each block

Source: Ministry of the Environment "Guidance on Inter-municipal Waste Treatment and Consolidation" (2020)

(1) Notice of the Ministry of the Environment: "Inter-municipal Waste Treatment and Consolidation of Waste Disposal Facilities to Ensure Sustainable and Appropriate Waste Disposal" (March 29, 2017)

- Request to formulate a plan for wide area waste treatment and consolidation by the end of FY2021
- Request to establish an efficient waste treatment system in accordance with the inter-municipal waste treatment and consolidation plan

National government

(2) Formulation of inter-municipal waste treatment and consolidation plan (study groups in prefectures, etc.)

- Evaluation of the previous inter-municipal waste treatment and consolidation plan
- Future projections of the population and waste generation
- Review of the setting of inter-municipal waste treatment block demarcation
- Consideration of the waste treatment system for each block

*Formulate or revise based on the actual situation and intentions of the municipality

Municipality

(3) Consideration within the inter-municipal block (municipal block meetings, etc.)

- Research on the feasibility of inter-municipal waste treatment and consolidation (estimation of benefits, etc.)
- Determination of municipalities to participate in inter-municipal waste treatment and consolidation

Municipalities that make up the inter-municipal block (with the cooperation of the prefecture)

(4) Review and coordination between municipalities

[Matters to be reviewed and adjusted]

- Organizational structure
- Waste treatment facilities to be developed
- Waste treatment flow
- Selection of candidate sites for construction of facilities
- Cost sharing
- Sorting and charging for waste
- Waste collection and transport
- Waste treatment methods during the transitional period
- Schedule for inter-municipal waste treatment and consolidation. etc.

*At the same time, promote understanding among residents

Implementation of inter-municipal waste treatment and consolidation

Municipalities that will participate in inter-municipal waste treatment and conslidation (with the cooperation of the prefecture)

Source: Ministry of the Environment "Guidance on Inter-municipal Waste Treatment and Consolidation" (2020)

Figure 1-29 Action Flow and Actors for Inter-Municipal Waste Treatment and Consolidation

2.4 Plan for the Development of Waste-related Facilities

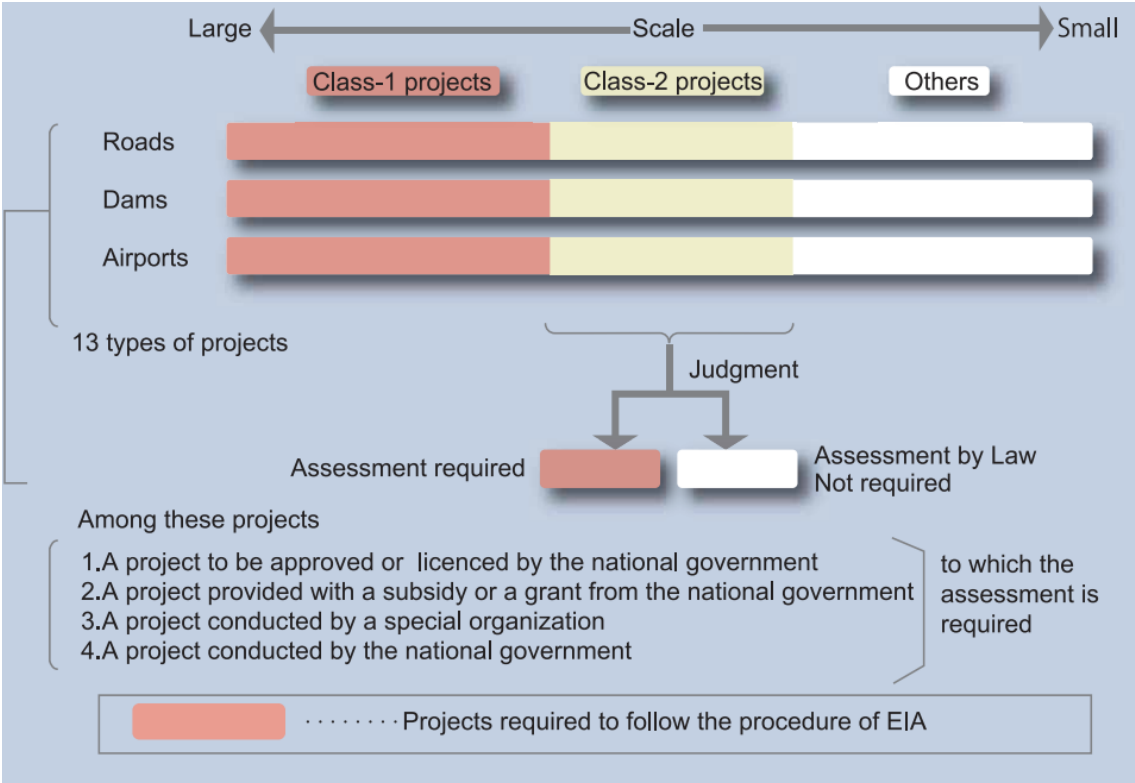
(1) Technical Guidelines for Environmental Impact Assessment

Environmental assessments in Japan are broadly classified into four types of assessments, including legal assessments, and the content of the assessment differs depending on the type and scale of the project. The information necessary for implementation of an assessment, such as the flow of assessment and items to be surveyed, is provided in detail in the guidelines. As for the field surveys conducted for the assessment, detailed measurement methods are defined.

When developing a facility such as a waste incineration plant or a landfill site, an environmental assessment is often conducted to investigate, predict, and evaluate the environmental impact on the surrounding area. The implementation of environmental assessment also plays an important role in building consensus with the surrounding residents. In Japan, as shown in the table below, there are four types of assessment: 1) assessment based on the *Environmental Impact Assessment Act*, 2) assessment based on local government ordinances, 3) assessment based on the *Waste Management Act*, and 4) voluntary assessment.

1) Assessment based on the Environmental Impact Assessment Act

Thirteen (13) types of projects are identified in the *Environmental Impact Assessment Act* as targets of this assessment. Depending on the scale of the target facility, there are two main types of projects: Class 1 projects are those for which environmental assessment is mandatory, and Class 2 projects are those for which the need for environmental assessment is judged individually, as shown in the following figure. A landfill site is classified as a Class 1 project for an area of 30 ha or more, and a Class 2 projects for an area of 25-30 ha. On the other hand, intermediate treatment facilities (incineration plants, etc.) are not subject to assessment under the *Environmental Impact Assessment Act*.



Source: Ministry of the Environment "Environmental Impact Assessment in Japan" (2020)

Figure 1-30 Projects Subject to the Environmental Impact Assessment Act

2) Assessment Based on Local Government Regulations

For projects that are not required to be assessed under the *Environmental Impact Assessment Act*, an environmental assessment must be conducted if the project is subject to the assessment ordinance of the municipality. Each municipality has its own environmental assessment ordinance that defines the scale of projects that require environmental assessment, and also establishes technical guidelines for environmental impact assessment to ensure that environmental impact assessment and post-implementation studies of waste treatment facilities are properly conducted based on scientific knowledge.

3) Assessment Based on the Waste Management Act

Table 1-20 shows an outline of the Guidelines for Living Environment Impact Studies for Waste Treatment Facilities, which show how to conduct assessments based on the *Waste Management Act*. These guidelines cover items related to people's lives, such as air quality, noise, and odor, as the living environment.

Table 1-20 Outline of the Guidelines for Living Environment Impact Studies for Waste Treatment Facilities

Item	Contents
Outline	Technical guidelines for environmental impact assessment to ensure that environmental impact assessment and post-implementation studies of waste treatment facilities are properly conducted based on scientific knowledge.
Date of formulation	1998 (revised in 2006)
Applicable facilities	Incineration facilities, landfill sites, other facilities (crushing and sorting facilities, manure treatment facilities, sludge dewatering facilities, etc.)
Plan to assessment	Environmental impact assessment items, actions subject to environmental impact assessment, timing of environmental impact assessment, regions where environmental impact assessment is to be conducted, surveys, forecasts, evaluations, environmental conservation measures, follow-up assessment, etc. Organization of survey items → Setting of the area to be surveyed → **Survey** Understanding of current status → **Projection** → **Assessment** Impact analysis → Preparation of living environment impact survey form Flow of environmental impact assessment
Examples of environmental impact assessment items	Examples of survey items stated in the Guidelines for Living Environment Impact Studies of Waste Treatment Facilities <u>Incineration Facilities</u> Air quality, noise, vibration, odor, water quality <u>Landfill</u> Air quality, noise, vibration, odor, water quality, groundwater

Source: Ministry of the Environment, "Guidelines for Living Environment Impact Studies of Waste Treatment Facilities" (2006)

4) Voluntary Environmental Assessment

For projects which are not subject to environmental assessment under municipal ordinances or the *Waste Management Act*, the business operator may voluntarily conduct an assessment, also known as a voluntary assessment or mini-assessment. In particular, for waste treatment facilities and landfill sites projects, it should not be considered that an assessment is not necessary because these projects are not targeted in the relevant laws and regulations, and it is customary to conduct voluntary environmental assessments for these projects.

The following pictures show examples of actual surveys in an environmental assessment.

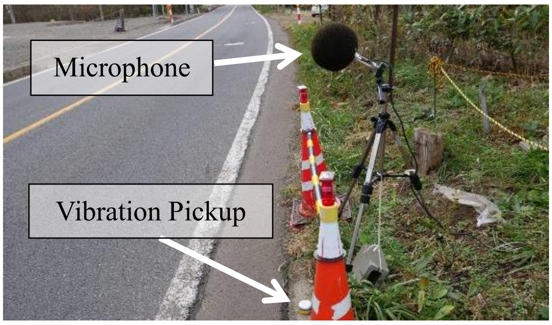


Photo 1-11 Roadside Noise and Vibration Surveys

Photo 1-12 Installed Sound Level Meter and Vibrometer

Photo 1-13 Balloon Release for Upper-level Meteorological Survey*

Photo 1-14 Odor survey

Photo 1-15 Collecting river Water for Water Quality Survey

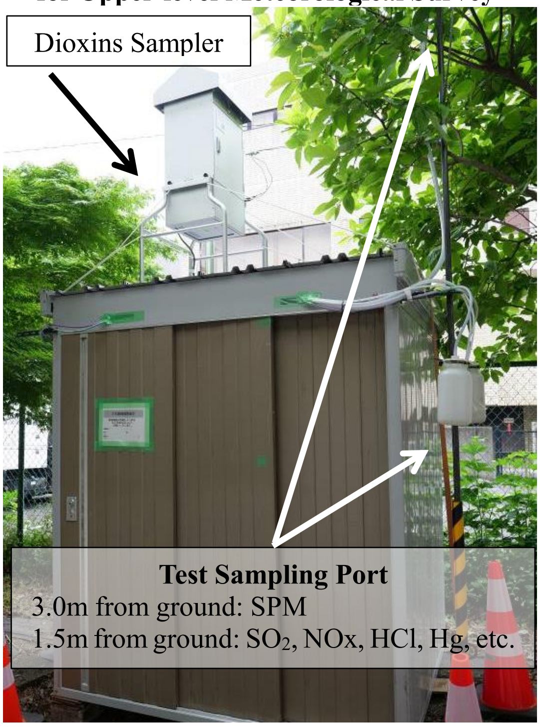


Photo 1-16 Simple installation Shed for Measuring Air Quality

Photo 1-17 Road Traffic Volume survey

*: The upper-level meteorological survey is carried out to predict the dispersion of exhaust gases from incineration facility chimneys. A small GPS-equipped device is attached to a balloon to measure air temperature and wind speed at different altitudes (the equipment is not recovered).

Source: Yachiyo Engineering Co., Ltd.

Activities Related to Environmental Assessment

Column: Environmental and Social Considerations in Developing Countries

In Japan, impact assessments are mainly conducted from the environmental perspective, but in projects for developing countries, social factors such as resettlement, indigenous peoples, living and livelihoods are of greater importance. For example, waste pickers who make a living by sorting and selling recyclables at disposal sites, will lose their jobs if open dumping sites are closed, and they will need support. In some cases where necessary land acquisition results in resettlement of residents, it may be required to pay them compensations.

JICA has released the Guidelines for Environmental and Social Considerations, which describes the process of environmental and social considerations, as well as a checklist of items by category and items to be monitored in each category. Examples of check items are shown in the table below. There is a need to investigate environmental and social considerations that match the nature of the project, the policies of the country, and the characteristics of the site.

Table 1-21 Categories and Items in Checklists

Category	Item
1. Permits approval and consultations	Environmental assessment and environmental permits, Explanations to, and consultations with the local stakeholders
2. Pollution control measures	Air quality (including greenhouse gas), Water quality and water use, Waste, Soil contamination, Noise and vibration, Subsidence, Odor, Sediment
3. Natural environment, protected areas	Protected area, Ecosystem and biodiversity, Hydrology, Topography and geology, Management of abandoned sites
4. Social environment	Resettlement, Living and livelihood, Heritage, Landscape, Ethnic minorities and indigenous peoples, Working conditions (including occupational safety)
5. Others, impacts during construction	Accident prevention measures, Monitoring

*: When using the checklist, appropriate items are selected and checked depending on the sector and nature of the project.

Source: JICA "Guidelines for Environmental and Social Considerations" (2022)

Table 1-22 Monitoring Items

Category	Item
1. Permits and approvals, consultations	Response to conditions set by authorities
2. Pollution prevention measures	Air quality, Water quality and water use, Waste, Noise and vibration, Odor
3. Natural environment protected areas	Ecosystem and biodiversity
4. Social environment	Resettlement, Living and livelihood
5. Others, Grievances	Number and contents of complaints

*1: Monitoring items are selected according to the sector and nature of the project.

*2: For air quality, water quality, noise and vibration, specify whether emission levels or environmental levels. It also should be noted that the monitoring items in the construction phase are different from those in the operation phase of the project.

Source: JICA "Guidelines for Environmental and Social Considerations" (2022)
(English) https://www.jica.go.jp/environment/guideline/ei8tc50000005dzu-att/guideline_202201_e.pdf

(2) Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities)

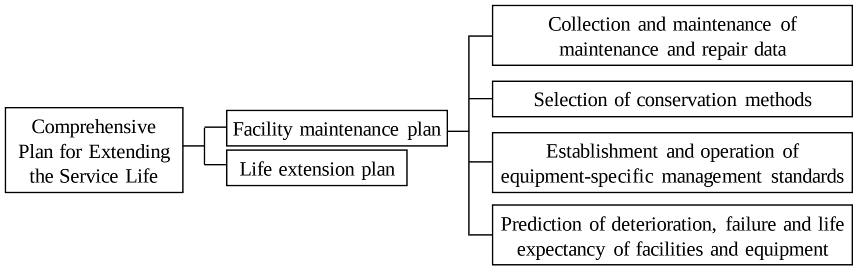
Waste treatment facilities are projects that place a high burden on the public administration due to the high cost of construction and the need for obtaining the residents' acceptance of the facility. Therefore, this plan has been formulated with the aim of ensuring that the facilities that have been developed will be in operation for as long as possible. In the Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities, it is required to extend the service life of waste treatment facilities by sustaining all the functions of the facilities over the long term through appropriate operation management, periodic maintenance, and functional diagnosis noting the unique role of the waste treatment facilities in the management of the waste.

Waste treatment facilities often operate under conditions where the facilities, equipment, and components that make up the facilities are exposed to high temperatures, high humidity, and corrosive gases, and are prone to wear and tear due to mechanical movement. Therefore, the performance of waste treatment facilities deteriorates and wears out more rapidly than other urban facilities, and the service life of the facilities as a whole is considered to be shorter than that of other urban facilities. Although the service life of concrete buildings is about 50 years, some waste treatment facilities have been decommissioned entirely after about 20 years, including buildings that can still be used, because of deterioration in plant performance. On the other hand, waste incineration plants have a possibility of operating for more than 30 years, by implementation of proper daily operation and suitable periodic maintenance, appropriate annual periodic inspections and maintenance, and periodic updating of core facilities.

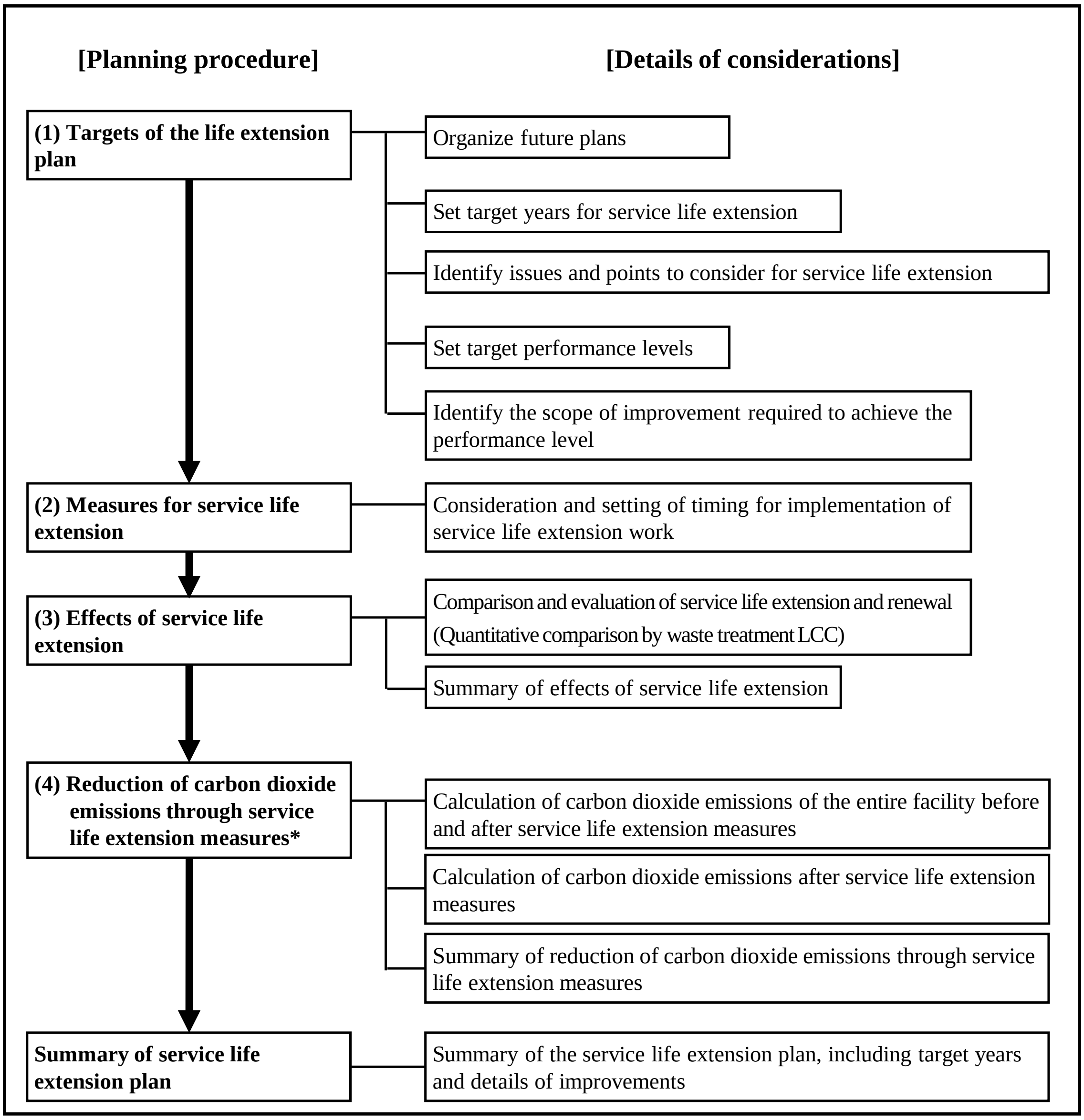
An outline of the Guidance on Creation of Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (waste incineration facilities) issued by Ministry of the Environment is shown in Table 1-23. The plan is designed to preserve and extend the service life of such facilities through systematic inspections, investigations, repairs, and improvements based on foresight into the condition of facilities, including aging, from a long-term perspective. Municipalities formulate a facility maintenance plan to evaluate and improve the overall operational condition of the facility based on periodic maintenance records and functional diagnosis data of facilities and equipment. Based on the data accumulated through the operation of the facility maintenance plan, a life extension plan is developed, and facilities should be renewed at appropriate time intervals. Furthermore, as for main facilities and equipment, a detailed maintenance plan is developed with reference to the current condition of the facilities, track records of past repair and maintenance, and patterns of degradation and malfunction. A Comprehensive Plan for Extending the Service Life is developed with detailed plans for facility maintenance and life extension, which can in turn be used to prepare long-term budget plans and plans for applying for subsidy from the Ministry of the Environment. As shown in Figure

1-31, in order to apply for life extension work as a project eligible for a subsidy from the Ministry of the Environment, it is also required to calculate the effect of carbon dioxide emission reduction by renewal of facilities and equipment from the point of view of global warming countermeasures.

Table 1-23 Outline of Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities)

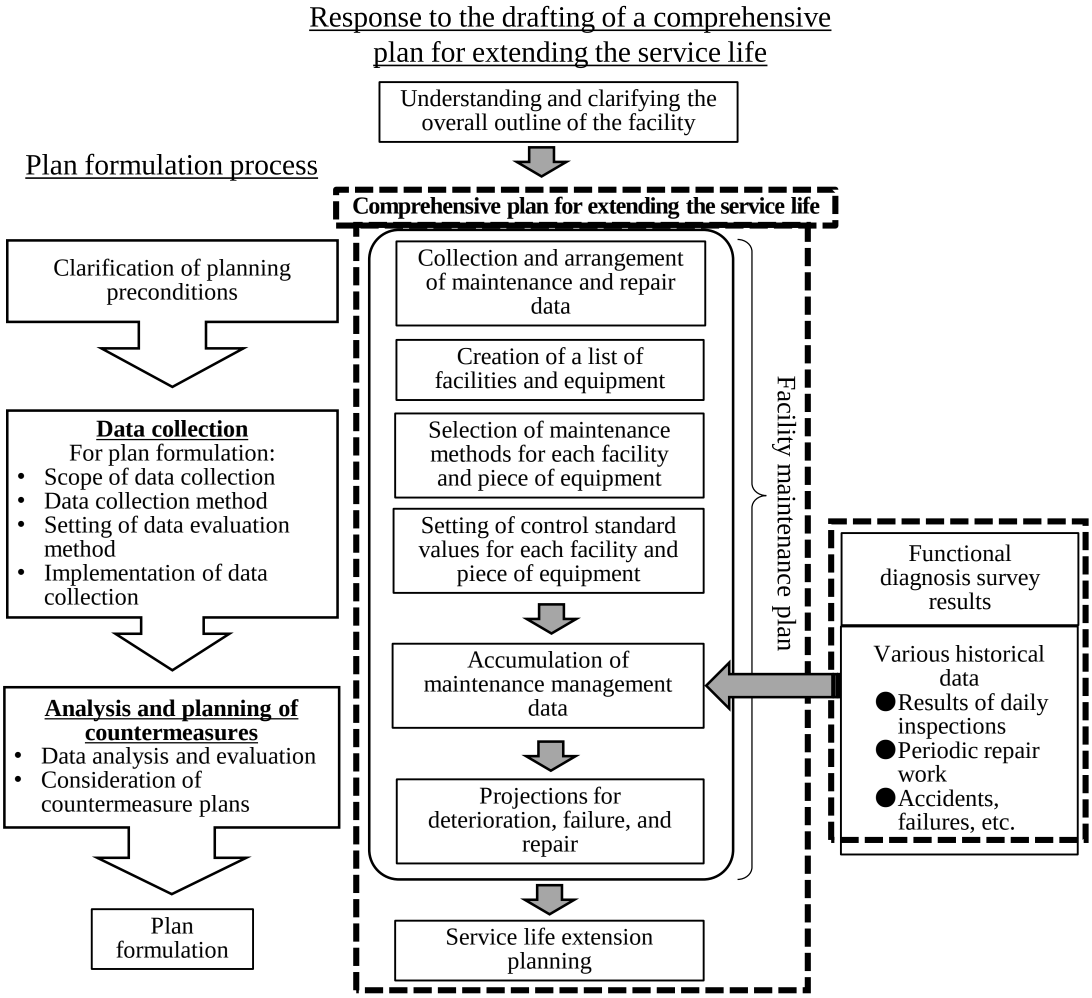
Item	Contents
Outline	The purpose of this plan is to extend the service life of waste treatment facilities by introducing the concept of stock management, proper daily operation and management, appropriate annual inspections and maintenance, and plan for periodic renewal of major facilities and equipment.
Applicable facilities	Waste treatment facilities in general
Plan structure	
Details to be considered for service life extension	1. Organize future plans 2. Set target years for service life extension 3. Identify issues and points to consider for service life extension 4. Set target performance levels 5. Identify the scope of improvement required to achieve the performance level 6. Comprehensive coordination of regional units

Source: Ministry of the Environment, "Guidance on Creation of Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities Applications)" (2021)



*: This is mandatory if the core facility improvement project is to be implemented with a grant.
Source: Ministry of the Environment, "Guidance on Creation of Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities Applications)" (2021)

Figure 1-31 Flow of Service Life Extension Planning (Waste Incineration Facilities)

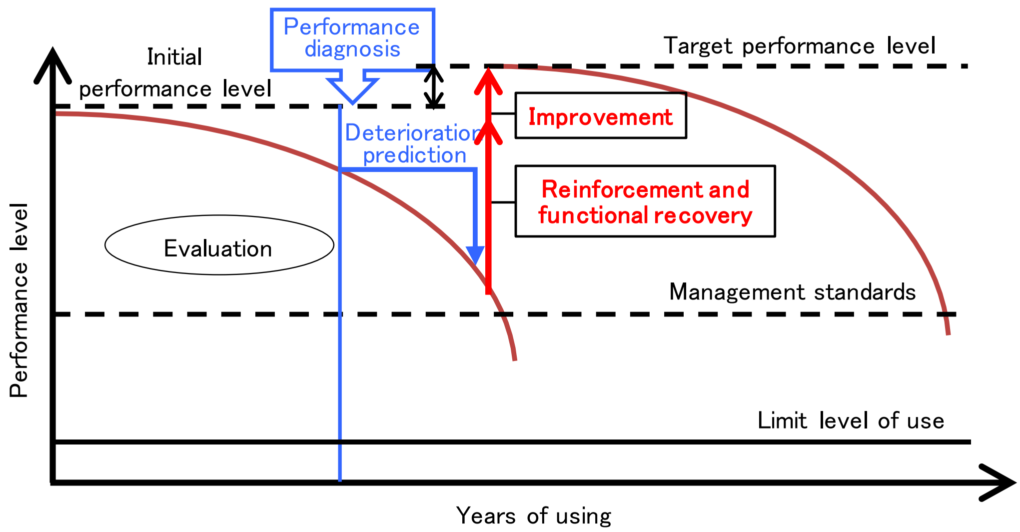


Source: Ministry of the Environment, “Guidance on Creation of a Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities Applications)” (2021)

Figure 1-32 Framework of Comprehensive Plan for Extending the Service Life

Column: What is Stock Management?

In stock management, in order to extend the service life of facilities, at the time of performing routine maintenance, functional diagnosis is conducted before the required performance level of a facility's plant and equipment declines below the management level. Based on the results of the functional diagnosis, functional maintenance measures and life extension measures are implemented to effectively utilize and extend the service life of existing facilities, and at the same time, reduce life cycle costs. This kind of technical system and management method is called stock management. Stock management can be expected to have a variety of benefits, such as reducing the burden on municipalities by extending the service life of facilities, reducing lifecycle costs, improving safety, enhancing functions, and securing the trust of residents in the facilities.



Source: Ministry of the Environment, "Guidance on Creation of Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities Applications)" (2021)

Figure 1-33 Performance Degradation Curves and Control Levels

Topic 2. Legislation and Government Policy Pertaining to Waste

Contents

1 History of Waste Management in Japan

Amid the various steps toward establishing a modern society - namely improving public health, preserving living environments, and establishing a sound material-cycle society -, Japan has confronted many waste management-related problems associated with economic growth, industrialization, urbanization, and changing lifestyles among other factors, and on each occasion has established or amended legislation to support countermeasures to deal with these problems.

This section introduces the history of waste management during the modernization process, specifically how Japan dealt with issues and needs of times through legislation. This section also includes an overview of active legislation pertaining to waste management.

1.1 Changes in Social Conditions in Japan, and Issues and Legislation Pertaining to Waste Management

Japan has confronted many issues stemming from drastic changes in the lifestyles and on each occasion, Japan has established necessary countermeasures and legislations in an effort to resolve them, which has formed today's modern society.

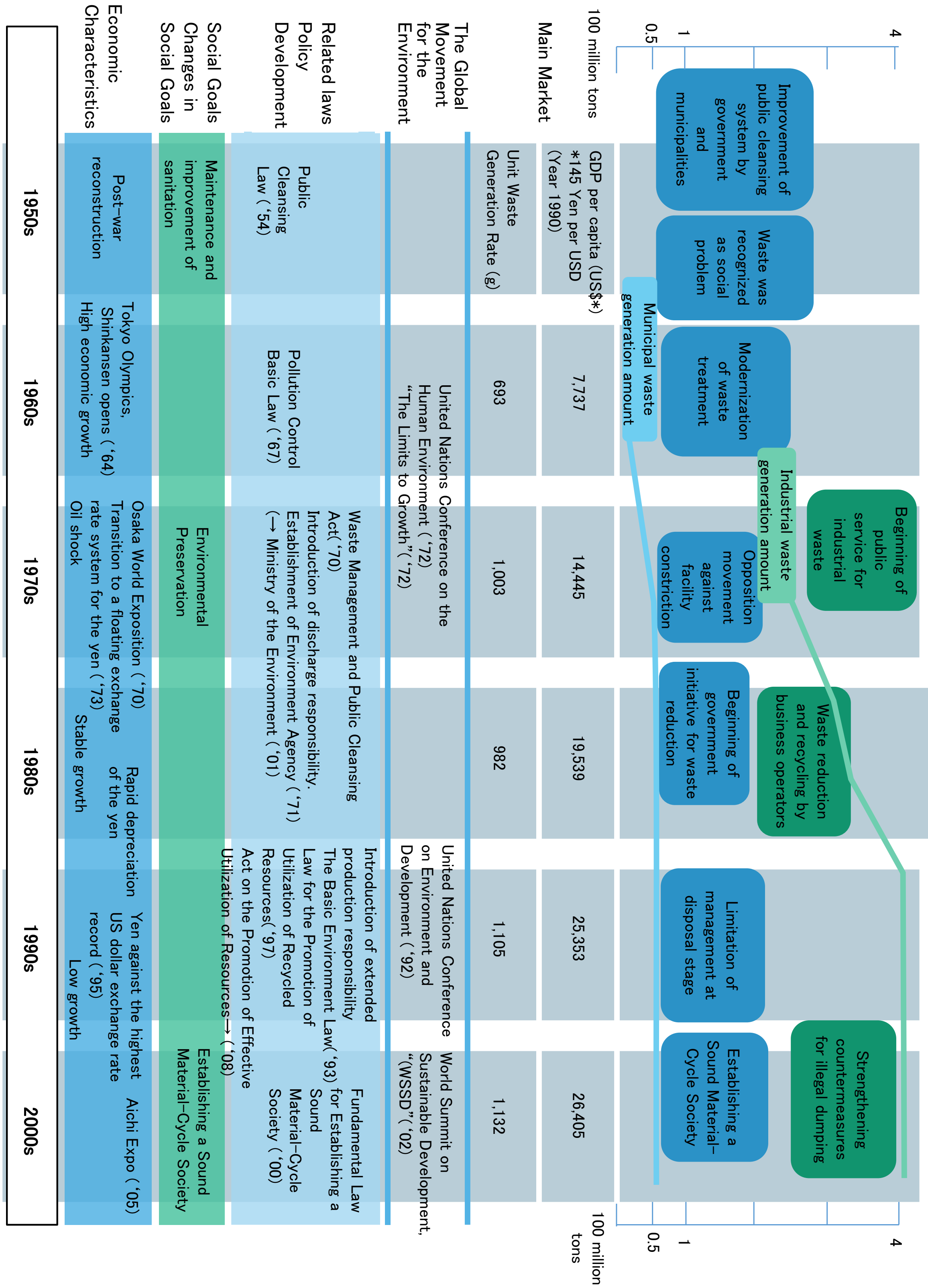
Since the late 19th century, the social environment in Japan has changed as modernization progresses, and residents' lifestyles and living environments have changed accordingly. Although Japan has successfully created a highly convenient society, it has also confronted many waste management-related issues from one era to the next. "Waste management" is also referred to as "waste treatment" in the law, and the two are synonymous.

Table 2-1 Changes in the Social Situation in Japan and Issues and legislation Related to Waste Mnagement

Period	Major Issues	Laws Enacted
Post-war period to the 1950s	• Waste management for environmental sanitation • Maintenance of a healthy and comfortable living environment	• Public Cleansing Act (1954)
1960s to 1970s	• Increase in the amount of industrial waste and emergence of pollution problems as a result of rapid economic growth • Waste management for environmental protection	• Act on Emergency Measures concerning the Development of • Living Environment Facilities (1963) • Waste Management Act (1970) • Revision of the Waste Management Act (1976)
1980s	• Promotion of the development of waste management facilities • Environmental protection required for waste management	• Wide-area Coastal Environment Development Center Act (1981) • Private Sewerage System Act (Johkasoh Law) (1983)
1990s	• Waste generation control and recycling • Establishment of various recycling systems • Management of hazardous substances (including dioxins) • Introduction of a proper waste management system to cope with diversification in the type and nature of waste	• Revision of the Waste Management Act (1991) • Act to Promote the Development of Specified • Facilities for the Disposal of Industrial Waste (1992) • Japanese Basel Act (1992) • Basic Environment Act (1993) • Containers and Packaging Recycling Act (1995) • Revision of the Waste Management Act (1997) • Home Appliance Recycling Act (1998) • Act on Special Measures against Dioxins (1999)
2000-	• Promotion of 3R measures aimed at the establishment of a sound material-cycle society • Enhancement of industrial waste management • Enhancement of illegal dumping regulations	• Basic Act for Establishing a Sound Material-Cycle Society (2000) • Construction Recycling Act (2000) • Food Recycling Act (2000) • Revision of the Waste Management Act (2000) • Act on Special Measures concerning Promotion of Proper • Treatment of PCB Wastes (2001) • Automobile Recycling Act (2002) • Act on Special Measures concerning Removal of Environmental Problems Caused by Specified Industrial Wastes (2003) • Revision of the Waste Management Act (2003 to 2006, 2010) • Small Home Appliance Recycling Act (2013) • Revision of the Waste Management Act (2015, 2017, 2020) • Plastic Resource Circulation Act (2022)

Public health improvement
Pollution problems and living environment protection
Establishment of a sound material-cycle society

Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2017)



Source: Based on the Ministry of the Environment "Japan's Experience in Promotion of the 3Rs" (2005)

Figure 2-1 History of Waste Management in Japan

(1) Japanese Society Prior to Modernization (up to the Early 19th Century)

Prior to Japan's modernization in the mid-late 19th century, the country had very little contact with other countries, and its industrial structure was based on agriculture, mainly the rice cultivation. Rice, vegetables, and other crops were generally consumed where they were produced. Additionally, because farmers in rural areas collected and used kitchen waste, sewage, ash, and other valuable waste from cities to effectively complement and improve soil in rice and vegetable fields, cities formed strong relationships with surrounding rural areas, and zones for regional circulation were developed. Consequently, as kitchen waste and sewage did not remain in urban areas it was possible to create such sanitary urban environments with relatively few infectious diseases occurring.

During this era, important efforts were undertaken to establish a sound material-cycle society. In the absence of modern industrial activity, tradespeople made many things by hand, so people treasured what they had, and merchants not only reused things but also repaired them frequently.

Waste management during this era involved collection, transport, and disposal, and under the established system, officially certified contractors collected the waste, and private entities disposed of it in designated locations. Laws and regulations prohibited the dumping of waste outside designated locations, and efforts were made to convert land where waste was disposed of into new rice fields.

(2) From the Advent of Modernization to the Assurance of Public Health (Late 19th Century and Early 20th Century)

When the push towards modernization began amid changes to Japan's system of government in the late 19th century and early 20th century, people and goods moved around more freely, and an influx of Western culture inspired people to adopt Western lifestyles. This caused an increase in both the amount and types of waste generated, and unsanitary conditions began to appear in various places as people exhibited new behaviors such as disposing of waste in places like vacant land.

Additionally, the mismanagement of dumping site lead it to become the breeding grounds of flies, mosquitos, and mice, as well as the frequent exchange with foreign countries brought cholera, pestilence, and other infectious diseases from abroad, resulting in outbreaks that prompted recognition of the importance of properly managing waste dumping sites. In other words, the assurance of public health came to be recognized as a priority issue. In light of these circumstances, the *Waste Cleaning Act* was enacted in 1900 and the implementation of waste management service was made an obligation of the municipalities. The waste was either disposed by the waste generators themselves or collected and disposed of by private waste treatment companies. The act stipulated that waste should be incinerated as much as possible (Article 5 of the Enforcement Regulations of the *Waste Cleaning Act*), making incineration the standard method of waste disposal, but most waste was burned in the open. In 1933, 93% of the cities covered by the act (113 out of 122 cities) had at least one incinerator, and incineration accounted for about 50% of the total waste treatment in Japan. At the same time, incineration technology was still in its infancy and incinerator performance was inadequate.

However, in 1941, with the outbreak of the Pacific War, the enforcement regulations were revised, and the mandatory incineration of waste was deleted, as it was considered incompatible with the effective use of resources. In wartime, material scarcity was very severe, and everything was being saved; waste was being reused, and resources were being recycled.

(3) From the Establishment of a Modern Society to the Improvement of Public Health (1945 to the 1950s)

Japan underwent many transformations in the course of its reconstruction after World War II. Consequently, Japan's economy developed swiftly, and people moved to cities, causing a rapid increase in population density and requiring waste countermeasures in urban areas.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 2-1 Collecting Waste from Households (1957)

Additionally, the necessity of appropriate management of waste and sewage was not well understood during this era, and waste and sewage were regularly dumped in rivers, the ocean or in the open (at Open dump sites) causing the generation of populations of flies and mosquitoes to soar, the spread of infectious diseases, and occurrence of other public health problems. Furthermore, regarding waste management service, although the *Waste Cleaning Act* required municipalities to implement such services, the roles and responsibilities of the central government, prefectural governments, residents, and other relevant entities were unclear. Thus, cooperative relationships among the stakeholders were not sufficiently formed, and problems surrounding municipal waste grew more serious. In light of these circumstances, the *Public Cleansing Act* was enacted in 1954.

The following are descriptions of problems with municipal waste during each stage of the waste management service.

1) Waste Collection and Transport

Primary waste collection from individual households was done manually with handcarts. Thus, collectors could only collect a limited amount of waste within a small range, and were unable to keep pace with the rapidly increasing amount of waste discharged. Additionally, the work of transferring waste from handcarts to motor vehicles to be transported to incineration plants and landfill sites (Open dump sites) was done on streets and in other public places, causing public health problems such as waste scattering in the living environments.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 2-2 Bringing Waste to the Collection Point (1957)

2) Intermediate Treatment

Incineration operations were suspended during the war, and facilities were being restored, as the war damage had rendered many of them inoperable. On the other hand, the urban population, which had been drastically reduced due to the war rapidly grew. As a consequence, the amount of generated waste significantly increased and much of that waste was not being properly managed. Therefore, in 1954, the *Public Cleansing Act* was enacted in order to drastically solve the urban waste problem, and waste disposal was promoted mainly in urban areas.

3) Final Disposal

Waste was being transported to landfill sites without any incineration treatment. At the landfill sites soil cover application and other aspects of landfill management were not implemented properly. As a result of these conditions gases generated by the fermentation of kitchen waste and other organic waste caused many problems at the landfill sites such as spontaneous combustion, odors, and breeding of flies and other pests.

(4) From Rapid Development on Route to Modernization (High Economic Growth) [Emergence of Pollution Problems and Efforts to Preserve Living Environments] (1960s and 1970s)

As the postwar reconstruction drew to a close, Japan entered an era of rapid economic growth. Lifestyles changed substantially during this era as a result of developments stemming from the economic boom, including increasing incomes, the rapid diffusion of home appliances, and changing consumer behavior and methods of retail amid the emergence of supermarkets and convenience stores. Additionally, the swift expansion of business activities caused the amount of waste discharged to increase accordingly, and the development of an economic structure based on mass production and mass consumption further accelerated the increase and diversification of municipal waste.

Source: Tokyo Metropolitan Government

Photo 2-3 Tokyo's Streetscapes Developing with Economic Growth (1967)

Vigorous production activities also caused the rapid increase and diversification of waste discharged from factories. Different kinds of waste were discharged in the process of producing products; thus, waste grew increasingly diverse. Additionally, massive amounts of waste from construction were generated by urban development and other factors; the greater the level of industrial activity, the greater the amount of waste associated with industrial activities.

Furthermore, rapid industrialization associated with high economic growth caused pollution from organomercury, cadmium, and other harmful substances discharged from factories and other industrial locations, causing widespread health problems among local residents. Additionally, the proliferation of products made of plastic resulted in even greater amounts of waste. Plastic does not decompose; thus, it not only remains in the soil over the long term when it is dumped in landfills, but it also damages incinerators because it gives off intense heat and releases harmful substances when it is incinerated. For these and other reasons, plastic is a major factor in air pollution and other forms of contamination.

Confrontation with residents surfaced as many waste related problems associated with economic growth spread. In light of these circumstances, the *Waste Management and Public Cleansing Law* (*Waste Management Act*) was enacted in 1970.

The problems with municipal waste during each process of waste management service are described hereafter.

1) Waste Collection and Transport

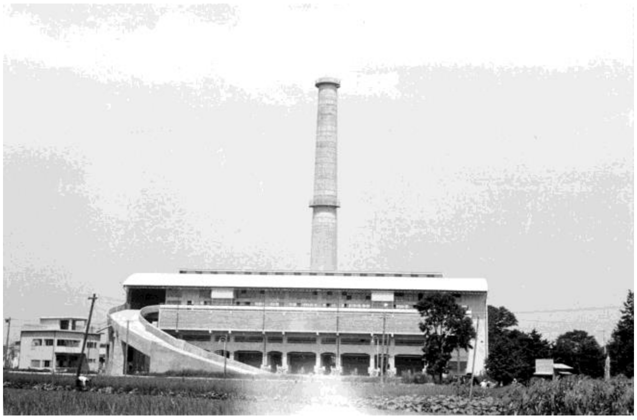
As changing lifestyles resulted in the generation of a large amount of diverse waste, especially in urban areas, efficient collection and transportation became an issue, and waste collection using collection vehicles was promoted.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 2-4 Vehicles at the Beginning of Collection by Vehicle

2) Intermediate Treatment

The situation required assurance of sanitation and the establishment of incineration plants as a means for treating large amounts of waste. As pollution became a problem during the process of industrialization, incineration treatment required technology for properly treating massive amounts of diverse waste.



Source: Tokyo Metropolitan Government Bureau of Environment

Photo 2-5 The Incineration Plant was Undergoing a Technological Revolution
（Shakujii Incineration Plant in Tokyo）
(Completed in 1958)

3) Final Disposal

Direct dumping into landfills was implemented alongside incineration treatment because the incineration waste treatment capacity alone was insufficient for the massive amounts of waste generated. Consequently, landfill sites had adverse effects on surrounding areas, such as generating odors, flies, and mosquitoes in large numbers and became major problems. Therefore, the situation required the establishment of facilities capable of proper disposal of the different types of disposal waste without impacting surrounding environments.

Worldwide Developments (1960s and 1970s)

The problem of environmental destruction associated with economic growth became apparent throughout the world, mainly in advanced countries, which began to recognize the need for global-scale efforts to conserve the environment. In 1972, the first UN Conference on the Human Environment - a meeting of high-level government officials from around the world to discuss environmental problems - was held in Stockholm. At the conference, the Declaration of the United Nations Conference on the Human Environment and the Action Plan for the Human Environment, which recognize environmental problems as global-level issues shared by humankind, were adopted.

(5) From the Development of a Modern Prosperous Society to the Transition to a Sound Material-Cycle Society (1980s and early 1990s)

Japan achieved high economic growth and developed into one of the world's major economic powers.

Although a modern society had been established and people had access to prosperous lifestyles, the pursuit of a more materially prosperous and highly convenient society gave way to economic activities based on mass production, mass consumption, and mass disposal.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 2-6 Collection Vehicle with Compaction Function (Compacter)

Consequently, the price of achieving a consumption-oriented society was a persistently increasing amount of waste, and further diversification of types of waste amid an increasingly varied array of home appliances and other products resulting in waste that was difficult to treat properly. In particular, waste from plastic products increased amid an increase in single-use plastic products, expanded use of plastic containers and packaging, and the proliferation of plastic bottles.

The following are descriptions of problems with municipal waste during each process of waste management service.

Source: Tokyo Metropolitan Government Bureau of Environment
Photo 2-7 Modern Waste Treatment Plant
(Meguro Incineration Plant in Tokyo
(Completed in 1991)

1) Intermediate Treatment

Dioxins, which can potentially harm the human body, became a major issue throughout Japan. Given that incineration treatment plants are a source of dioxins, various institutions conducted research into dioxins. Legislation and regulations on dioxins countermeasures (the *Law Concerning Special Measures against Dioxins* (1999)) covering not only waste treatment plants, but also negative impacts on the general environment and the human body was established, and operators were expected to implement countermeasures based on the legislation and regulations.

2) Final Disposal

The rapid increase in waste caused a strain on the capacity of existing landfill sites, which became a major problem as existing landfill sites nationwide had less than 10 years before becoming full.

Additionally, illegal dumping of industrial waste became a serious issue. Although the *Waste Management Act* stipulates that waste-generating business operators are responsible for treatment of industrial waste, there were cases in which dishonest waste treatment operators illegally dumped industrial waste in pursuit of undue profits.

<u>Worldwide Developments (1980s and Early 1990s)</u>

To mark the 20th anniversary of the UN Conference on the Human Environment, the United Nations invited approximately 180 countries to participate in the UN Conference on Environment and Development in Rio de Janeiro in 1992. At the conference, the Rio Declaration on Environment and Development, which set out principles for sustainable development, was adopted, along with Agenda 21, the targeted action plan accompanying the declaration.

(6) From the Maturation of a Modern Society to the Establishment of a Sound Material-Cycle Society (mid-1990s and 2000s)

Japan had achieved economic development, as well as maturity in the areas of ensuring public health and methods and systems of proper treatment of waste. However, the situation called for Japan - which, despite its status as an industrial powerhouse, remained reliant on huge amounts of imports for lack of natural resources - to cease being a society based on mass production, mass consumption, and mass disposal, and instead to establish a sound material-cycle society that espouses a much more balanced utilization of raw materials and reduces the impacts on the environment. Additionally, the global community had come to expect the expansion of international cooperation focused on establishing sustainable societies.

In light of these circumstances, the *Basic Act for Establishing a Sound Material-Cycle Society* was enacted in 2000, along with several laws promoting recycling.

Worldwide Developments (mid-1990s and 2000s)

In the global community, in 1997, five years after the UN Conference on Environment and Development, a Special Session of the UN General Assembly was held in New York. At the special session, the Programme for the Further Implementation of Agenda 21 was adopted. Additionally, in 2000, Millennium Development Goals (MDGs) were adopted to set out common worldwide targets in the area of development. Furthermore, at the 2002 World Summit on Sustainable Development in Johannesburg, participants not only verified the level of achievement of Agenda 21, but they also broadly discussed various development issues in the global community - namely poverty, medical care, and education - as well as measures to achieve Millennium Development Goals in and beyond the area of the environment.

2 Legislation Pertaining to Waste Management

Japan has established important legislation to respond to changes in social conditions and issues and needs that emerged in each era, which include improving public health, implementing pollution countermeasures, and promoting proper treatment and recycling of waste.

This section introduces transition in legislation pertaining to waste management as well as the background, details of regulations, and other aspects of the legal structure and legislation.

2.1 Changes in Legislation Pertaining to Waste Management

(1) From Improving Public Health to Resolving Pollution Problems and Preserving Living Environments

Japan's basic law pertaining to waste management has changed from the *Waste Cleaning Act* to the *Public Cleansing Act*, and finally to the *Waste Management Act* based on the different roles required of waste management in different eras. The laws demonstrate Japan's transition from the era aiming to improve public health to a time when the focus is on preserving living environments.

The first law pertaining to waste was the *Waste Cleaning Act* (1900). In light of the subsequent worsening of public health problems caused by the rapid increase in municipal waste associated with postwar economic development and increasing urban population density, the *Public Cleansing Act* was enacted in 1954 for the purpose of improving public health, and the *Waste Cleaning Act* was repealed.

As Japan entered its period of high economic growth in the 1960s, the further increase and diversification of municipal waste, pollution caused by hazardous waste, and other social problems prompted the 1970 repeal of the *Public Cleansing Act* and concurrent enactment of the *Waste Management Act*. This concurrent act details requirements to conserve living environments in addition to improving public health as stated in the former *Public Cleansing Act*.

Waste Cleaning Act (1900-1954)

Purpose: An act with 11 articles, but no explicit purpose

Characteristics: Positioned waste collection and disposal as the responsibility of municipal governments.

Public Cleansing Act (1954-1970)

Purpose: To improve public health through the sanitary treatment of waste in order to clean living environments.

Characteristics: Sets out provisions under which the central and prefectural governments provide financial and technical assistance, obliges residents to cooperate with municipal waste collection and disposal efforts, and sets out other provisions in addition to existing municipal waste collection and disposal systems.

Waste Management and Public Cleansing Law (since 1970) [Waste Management Act]

Purpose: To preserve living environments and improve public health, mainly through waste minimization, but also by cleaning living environments and properly sorting, storing, collecting, transporting, recycling, treating, and disposing of waste.

Characteristics: Categorizes waste into two categories: industrial waste and municipal waste. Positions treatment of municipal waste as the responsibility of municipalities as in previous legislation, and positions treatment of industrial waste as the responsibility of waste-generating business operators.

(2) Establishing a Sound Material-Cycle Society

Japan had begun to shift the focus of its waste management from preserving living environments to establishing a sound material-cycle society. Accordingly, Japan amended the *Waste Management Act* and established many relevant laws and regulations with a focus on specific materials and products in an effort to improve recycling and reduce final disposal amounts.

In the 1970s, the social structure based on mass production, mass consumption, and mass disposal continued to progress as Japan sought greater material wealth. Consequently, the amount of waste generated continued to increase and the remaining capacity of landfill site was shortened. These and other problems made it necessary to concentrate efforts toward radical solutions. Given that the focus of policy had shifted to reducing amounts of waste generated and recycling, the *Waste Management Act* was amended. Furthermore, the *Basic Act for Establishing a Sound Material-Cycle Society* and other laws on recycling were enacted in due order, and a shift toward forming a sound material-cycle society was promoted.

Amendments to the Waste Management Act (1991)

"Waste minimization" and "sorting and recycling" were added to the purpose of the act.

Law for the Promotion of Effective Utilization of Resources (1991)

The law sets out regulations, most important of which are to create a system for business operators to collect and recycle waste voluntarily, and to mandate environmental consideration in product design and manufacturing, with the aim of ensuring the effective utilization of resources as well as reducing the generation of waste and conserving the environment.

Various Laws on Recycling (since 1995)

Various laws on recycling were enacted to further promote recycling.

- Containers and Packaging Recycling Law (1995)
- Home Appliance Recycling Law (1998)
- Food Waste Recycling Law (2000)
- Construction Material Recycling Law (2000)
- End-of-Life Vehicles Recycling Law (2002)
- Small Home Appliance Recycling Act (2013)
- Plastic Resource Recycling Promotion Act (2022)

Basic Act for Establishing a Sound Material-Cycle Society (2000)

The *Basic Act for Establishing a Sound Material-Cycle Society* was enacted to shift away from an economic system based on mass production, mass consumption, and mass disposal, and instead to promote the formation of a sound material-cycle society in which the 3Rs (Reduce, Reuse, Recycle) are implemented and proper waste disposal and treatment are ensured. The act clearly states the aims of a sound material-cycle society - namely limiting consumption of natural resources and reducing environmental impact - codifies the cyclical use of resources and the priority of waste treatment (in order of Reduce, Reuse, Recycle, Thermal Recovery, Proper Disposal), and otherwise sets out basic principles for establishing a sound material-cycle society. Additionally, the Fundamental Plan for Establishing a sound material-cycle society to be formulated under the law, sets out clear numerical targets for resource productivity (incoming materials), ratios of recycled resources to natural resources used (materials circulation), and final disposal amounts (outgoing waste) to earnestly drive forward the establishment of a sound material-cycle society.

2.2 Legal Structure Pertaining to Waste Management

(1) Japan's Legal Structure Pertaining to Waste Management

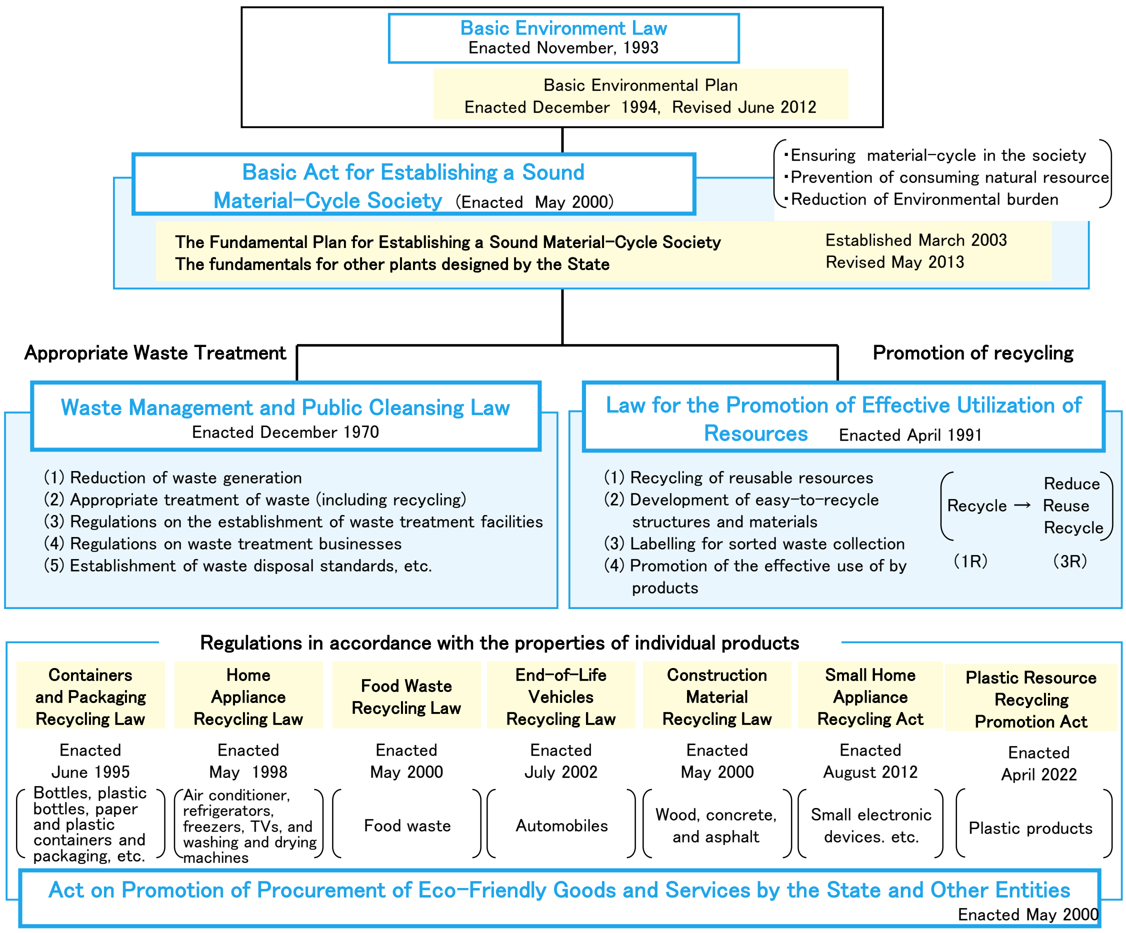
It is important to develop a legal framework that provides an institutional basis for the implementation of measures as well as a direction for improvement to address various issues. In Japan, the *Basic Act for Establishing a Sound Material-Cycle Society*, the *Waste Management Act*, and other laws pertaining to waste management were established based on the *Basic Environment Law*. Laws on recycling individual items have also been established to improve recycling.

The *Waste Management Act* - Japan's basic law of waste management - has been revised as appropriate to respond to the improper treatment of waste, illegal dumping, and other issues that appeared in each era. Establishing legislation is a key measure for resolving the issues Japan faces.

Various laws on recycling have been enacted in an effort to improve recycling and establish a sound material-cycle society, and also in response to the increasing severity of the strain on landfill sites. Laws and systems function effectively in part because these laws on recycling clearly state the roles and responsibilities of all relevant entities.

The legal laws and regulations pertaining to waste management was established to support the formation of a sound material-cycle society, and comprises the *Basic Act for Establishing a Sound Material-Cycle Society* - which sets out the basic philosophies and approaches to forming a sound material-cycle society based on the *Basic Environment Law*, which sets out the core elements of environmental policies - and the individual laws that embody the acts.

Many laws have been established toward the formulation of a sound material-cycle society. The *Waste Management Act* aims to preserve living environments and improve public health through efforts such as waste minimization and proper treatment of waste. The *Law for the Promotion of Effective Utilization of Resources* (the *Effective Resource Utilization Promotion Act*) aims to ensure the effective utilization of resources, reduce the generation of waste, and conserve the environment. The seven laws on recycling were enacted to correspond to the properties of individual items. The *Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities* (the *Act on Promoting Green Purchasing*) aims to establish a society capable of sustainable development by having public agencies take the lead in promoting the procurement of products and services that help reduce environmental impact.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 2-2 Legal Framework for a Sound Material-Cycle Society

(2) Basic Act for Establishing a Sound Material-Cycle Society

1) Intent of the Act

The act is a basic framework for promoting the establishment of a sound material-cycle society that strives to limit resource consumption and reduce environmental impact by promoting the effective reuse and recycling of materials in all processes from production to distribution, consumption, and disposal.

2) Background

The amount of waste generated in Japan has remained at a high level since waste increased rapidly during the period of high economic growth; consequently, the strain on landfill sites, the rise in illegal dumping, the generation of hazardous waste in treatment processes, and more issues have become serious social problems. Therefore, there is an urgent need to shift away from an economy and society based on mass production, mass consumption, and mass disposal, and instead to form a sound material-cycle society in which the 3Rs (Reduce, Reuse, Recycle) are implemented and proper waste treatment and disposal are ensured.

The following shows data pertaining to waste management published in 2000, the year the act was enacted.

State of Waste Management in 2000, the year the Basic Act for Establishing a Sound Material-Cycle Society was enacted

[1] Amount of waste generated remains at a high level

→In the past several years, the amounts of municipal waste and industrial waste have respectively hovered at around 50 million tons and 400 million tons annually

[2] Demand for further promotion of recycling

→In FY1996, roughly 10% of municipal waste and roughly 42% of industrial waste was recycled

[3] Difficulty finding sites for waste treatment plants and landfill sites

→In FY1996, landfill sites for municipal waste and industrial waste had respectively 8.8 years and 3.1 years remaining, before becoming full

[4] Rise in illegal dumping

→In FY1998, 1,273 cases of illegal dumping were recorded, a 460% increase from FY1993

3) Overview

Name of act: Basic Act for Establishing a Sound Material-Cycle Society

Enacted: 2000

Purpose: To set out a basic framework for, and illuminate a path toward achieving a sound material-cycle society.

Overview of act: The act sets out basic principles (e.g., priority of policies) and responsibilities of relevant entities for the formation of a sound material-cycle society, and sets out basic matters for formulating the Fundamental Plan for Establishing a Sound Material-Cycle Society and for policy for formulating a sound material-cycle society, among other matters.

•Vision for a Sound Material-Cycle Society:

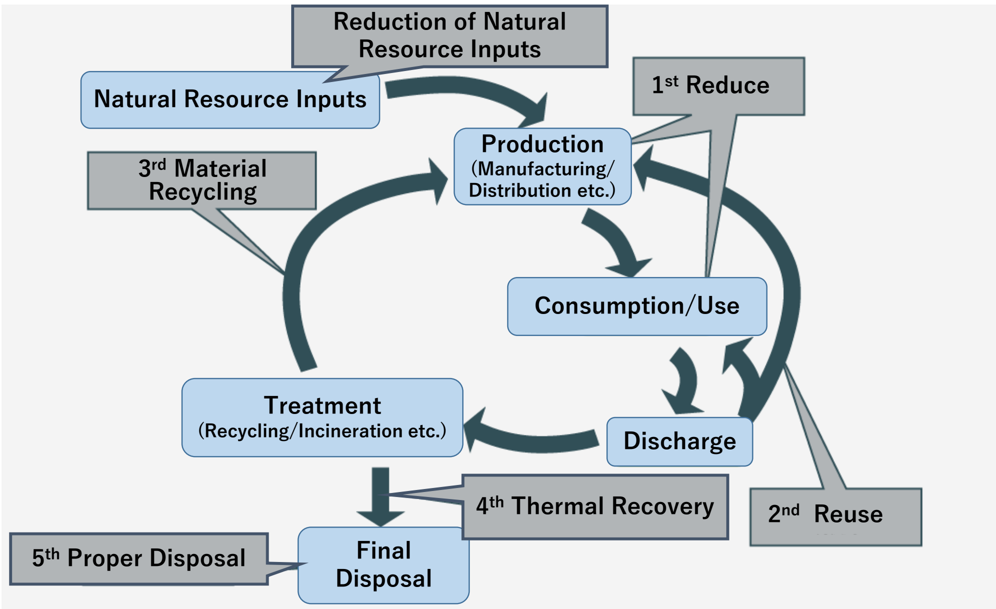
Promote the formation of a sound material-cycle society in which the consumption of natural resources and the impact on the environment are limited and reduced to the extent possible through the reduced generation of waste and the like, the cyclical reuse of circular resources, and the assurance of proper waste treatment and disposal.

•Circular resources within the scope of the act:

With all waste - regardless of value - as the target of the act, the act positions the recyclable portion of waste as circular resources, and encourages the cyclical reuse of circular resources.

•Priority of policy:

Codified by the act: in order of Reduce, Reuse, Recycle, Thermal Recycle (Thermal Recovery), and Proper Disposal.



Source：Ministry of the Environment “Establishing a sound material-cycle society” (2010)

Figure 2-3 Sound Material-Cycle Society Schematic Diagram

• EPR (Extended Producer Responsibility):
The concept that producers are physically or economically responsible for their products in all processes from production and use to disposal and recycling. It encourages producers to develop and produce products that are less likely to be disposed of or are easily recycled.

Source: Basic Act for Establishing a Sound Material-Cycle Society (2000)

4) Targets of the Act

The act defines the respective responsibilities of the central government, municipalities, business operators, and residents. In principle, the act describes the responsibilities of the central government (e.g. formulating the five-year Fundamental Plan for Establishing a Sound Material-Cycle Society), and also clarifies the waste-generating responsibilities of consumers, namely residents and businesses. The law further defines the waste management responsibilities of the producers through inclusion of "extended producer responsibility"; a level of responsibility imposed on producers that extends to the time when the products they produced have become waste after being used by the consumers.

(3) Waste Management and Public Cleansing Law

The *Waste Management Act* was enacted in 1970 as a comprehensive revision of the *Public Cleansing Act*, which was intended to improve public health. The law is the core regulation for waste management, with the aim of protecting the living environments in addition to improving public health.

1) Background

Cases involving contamination of the environment were occurring in major urban areas and elsewhere due to the discharge of massive amounts of industrial waste associated with factors such as expanded economic and social activity. However, treatment of such massive amounts had become too difficult under the existing *Public Cleansing Act*, which held municipalities responsible for waste treatment and did not set out clear provisions for industrial waste. Accordingly, the situation called for a full-scale revision of the *Public Cleansing Act*.

2) Overview

Name of law: Waste Management and Public Cleansing Law (Waste Management Act)
Enacted: 1970
(Amended: 1976, 1991, 1997, 2000, 2003, 2004, 2005, 2006, 2010, 2015, 2017, 2020)

Purpose: To preserve living environments and improve public health through waste minimization and proper waste treatment (e.g., transport, disposal, recycling) and maintaining cleanliness in living environments.

Overview of law: The act defines waste and sets out provisions for issuing licenses for waste treatment operators, licenses for constructing waste treatment plants, and waste treatment standards, among other matters.

Table 2-2 Overview of Waste Management Act

<table>
<tr><td rowspan="3">Definitions</td><td colspan="2">Waste is garbage or unwanted matter in solid or liquid state (excluding radioactive substances)</td></tr>
<tr><td>Municipal waste</td><td>Industrial waste</td></tr>
<tr><td>All waste other than industrial waste</td><td>Cinders, sludge, waste oil, waste plastics, and the like among waste generated in conjunction with business activities</td></tr>
<tr><td>Responsibility for treatment</td><td>Waste must be treated such that it presents no obstacles to the preservation of living environments, according to basic plans for municipal waste treatment formulated by municipalities.</td><td>Business operators must fulfill their responsibilities by themselves or by contracting a licensed operator.</td></tr>
<tr><td rowspan="3">Waste collection, transport, and treatment</td><td>Municipal mayor licensing system</td><td>Prefectural governor licensing system</td></tr>
<tr><td>Licenses are granted when the capacities of plants and applicants satisfy the criteria, and when the details of applications comply with municipal waste treatment plans</td><td>Licenses are granted when the capacities of plants and applicants satisfy the criteria</td></tr>
<tr><td>Municipal mayors (supervision) collect reports, conduct witnessed inspections, issue orders for improvement, issue orders to take measures, etc.</td><td>Prefectural governors (supervision) collect reports, conduct witnessed inspections, issue orders for improvement, issue orders to take measures, etc.</td></tr>
<tr><td rowspan="3">Treatment plants</td><td>Prefectural governor licensing system (however, notification required when municipalities construct plants)</td><td>Prefectural governor licensing system</td></tr>
<tr><td colspan="2">Licenses are granted when plans for construction fulfill technical standards, and when plans for construction and maintenance include proper consideration on preservation of the living environments of local communities</td></tr>
<tr><td colspan="2">Prefectural governors (supervision) collect reports, conduct witnessed inspections, issue orders for improvement, issue orders to take measures, etc.</td></tr>
</table>

Source: Waste Management and Public Cleansing Law (1970)

*: In Japan, waste is defined as fitting into one of two broad categories: municipal waste or industrial waste. (Refer to "Topic 1-1.1 Definition and Categorization of Waste)

3) Major Amendments

The *Waste Management Act* has been amended several times in order to consistently ensure the proper treatment and disposal of waste in light of many factors, including social circumstances conditions in a given era. The major amendments are as follows.

■Amendments Pertaining to Social Circumstances

1991 amendment: Large-scale illegal dumping and dioxin-related problems emerged amid factors such as the expansion of the economy and society based on mass production and mass consumption, an escalating appetite for consumption in pursuit of convenience, and changes in the industrial structure; consequently, the act was amended to clearly indicate minimization of waste, sorting and reuse of waste, and the like as the purpose of waste treatment.

At the time, roughly 2,000 waste incineration plants were in operation, giving rise to dioxin-related problems stemming from incineration. Additionally, given the limited land area available in Japan on which landfill sites can be feasibly developed, illegal dumping was occurring due to lack of landfill sites.

2010 amendment: A series of regulatory permits were issued to waste-generating business operators, and regulations were tightened, including requiring waste treatment operators to issue manifests.

The scope of eligibility for licenses to import waste was expanded to include companies which can contract out for proper treatment, in cases where importing waste would help them fulfill their social responsibilities and reduce environmental impact throughout Asia.

2015 amendment: In light of lessons and knowledge learned from disasters such as the Great East Japan Earthquake, the act was amended in an effort to expand measures for dealing with disaster waste to enable seamless responses for waste treatment in every stage from preparation during normal times to measures in the event of, and in the aftermath of large-scale disasters.

■Amendments Pertaining to Harmful Substances and Pollution Problems

1976 amendment: The act was amended to set out technical standards for constructing new landfill sites for waste.

1991 amendment: The act was amended in an effort to strengthen regulations pertaining to waste treatment operators and waste treatment plants.

2006 amendment: The act was amended to set out standards for treating waste including asbestos.

2010 amendment: The act was amended to oblige operators to publish information pertaining to plant maintenance in order to promote understanding of waste treatment plant safety.

■**Amendments Pertaining to Industrial Waste**

Amendments from 1991 to 2017: Made the manifest system more rigorous.

2010 amendment: Strengthened the system for recognizing excellent waste treatment operators.

Amendments from 1976 to 2010: Strengthened penal provisions for illegal dumping and the like.

Amendments from 1976 to 2017: Strengthened guidance and supervision, etc.

(4) Effective Resource Utilization Promotion Act

1) Background

Japan is not a natural resource-rich country, and resource depletion had become a global issue. In light of these and other factors, circumstances required the establishment of a sustainable circular economic system in which there is harmony between the environment and the economy after shifting away from the current economic and social system based on mass production, mass consumption, and mass disposal. Therefore, efforts to promote recycling by business operators became necessary in order to strengthen initiatives toward achieving the 3Rs.

2) Overview

Name of act: Law for the Promotion of Effective Utilization of Resources (Effective Resource Utilization Promotion Act)

Enacted: 1991

Purpose: To comprehensively promote the reduction of the generation of byproducts and the like, the reuse of parts and the like, and the reuse of used products and the like as raw materials.

Overview of act: The act sets out priority matters for business operators, including 3R measures in the product manufacturing stage, 3R considerations in the product design stage, labeling for sorting and separate collection, and the establishment of systems for voluntary collection and recycling by manufacturers.

Targets: Lines of business and products for which designated 3R efforts are deemed necessary in Cabinet Orders (10 lines of business, 69 articles)

Source: Law for the Promotion of Effective Utilization of Resources (1991)

3) Responsibilities of Relevant Entities

a. Business Operators

・Rationalize the use of raw materials to reduce the generation of used articles and byproducts

・Promote the use of used articles and byproducts as recycled resources/parts

b. Consumers

・Use products for a long time

・Use products made with recycled resources or recycled parts

・Cooperate with sorting and separate collection

・Cooperate with measures implemented by the central government, municipalities and business operators

c. Central Government

・Implement measures to secure funding and the like

・Promote the use of recycled resources in items procurement and the like

・Promote science and technology

・Strive to seek the understanding of residents

d. Municipalities

・Promote the effective use of resources in line with the social and economic circumstances of individual areas

(5) Containers and Packaging Recycling Law

Refer to “Topic 3-3.4 (1) Containers and Packaging Recycling Law.”

(6) Home Appliance Recycling Law

Refer to “Topic 3-3.4 (2) Home Appliance Recycling Law”

(7) Food Waste Recycling Law

The *Food Waste Recycling Law* promotes the recycling of food waste by setting out the roles and responsibilities of all relevant entities with a focus on food waste, an area where recycling efforts have not advanced, and sets out a new system for the promotion efforts.

1) Background

Food waste is discharged by food products manufacturers, food distributors, members of the food service industry, and individual households. In 1996, roughly 20 million tons of food waste was being discharged annually along with municipal waste and industrial waste, and food waste comprised roughly 30% of municipal waste.

Japanese businesses were throwing away massive amounts of food products in the manufacturing and distribution stages due in part to consumers' overemphasis on freshness, and consumers were leaving food uneaten. Despite the fact that food waste generated in this manner can be recycled as fertilizer, livestock feed, and the like, in reality large amounts of the food waste were disposed of without being used. Consequently, the strain on remaining landfill capacity and problems surrounding waste treatment grew more severe.

2) Overview

Name of law: Law for Promotion of Recycling and Related Activities for Treatment of Cyclical Food Resources (Food Waste Recycling Law)

Enacted: 2000

Amended: 2007, 2014

Purpose: To reduce the amount of food waste ultimately disposed of and promote the recycling of circular resources from food waste as fertilizer, livestock feed, and the like, through controlling and reducing the amount of food waste generated by business operators in food-related fields.

Overview of law: The law sets out basic matters pertaining to reduction in the generation amount of food waste and recycling and thermal recovery of the recyclable portion of food waste (circular resources from food waste) by all entities, in addition to requiring business operators involved in the manufacturing, wholesaling, or retailing of food products or in food service to take measures to promote the recycling of circular resources from food waste.

Target: Food waste (e.g., residue from the processes of manufacturing or processing food products, or preparing food, that cannot be used as food; food that is unsold or uneaten in the stages of distribution or consumption of food products)

Source: Law for Promotion of Recycling and Related Activities for Treatment of Cyclical Food Resources (2000)

3) Roles and Responsibilities for each Entity

a. Business Operators in Food-related Fields

- Reduce the generation of food waste
- Make efforts to recycle circular resources from the food waste
- Implement thermal recovery during treatment of circular resources from food waste that cannot be recycled
- Make efforts to reduce the amount of food waste

b. Residents

- Reduce the generation of food waste by improving methods of purchasing food products and preparing food
- Promote recycling by using recycled products

c. Central Government and Municipalities

- Make efforts to secure necessary funding, gather information, conduct research and development, and the like
- Use education and public relations activities in pursuit of the understanding and cooperation of residents
- Make efforts to promote the recycling of circular resources from food waste in line with social and economic conditions

4) System for Recycling Food Waste

The law established the following systems to promote recycling.

Registration system: A registration system for businesses that produce fertilizers and livestock feed using recycled food resources as raw materials.

Certification system: A system to certify plans for the implementation of recovery projects by related parties, the use of fertilizers and livestock feed obtained from recovery projects, and the use of agricultural, livestock, and fishery products produced by the use of the recovery projects' products.

(8) Construction Material Recycling Law

The *Construction Material Recycling Law* was enacted as part of the effort to counter illegal dumping given that construction waste comprises most of illegally dumped waste, and also to promote the recycling of construction waste, which is relatively easy to recycle.

1) Background

In FY1995, fragments of concrete and asphalt-concrete, wood scraps, and other construction waste generated during construction work accounted for roughly 20% of all industrial waste discharged. Construction waste also comprised roughly 70% of all illegally dumped waste in FY1999.

Many buildings were updated during the 1960s in Japan, and the amount of construction waste increased accordingly. Factors such as the subsequent updating of even more buildings gave rise to an increase in construction waste; consequently, the strain on landfill sites, improper treatment and disposal, and other problems grew more severe.

2) Overview

Name of law: Construction Material Recycling Law

Enacted: 2000

Purpose: To promote the sorting and recycling of specified construction materials generated during demolition work and other forms of building construction

Overview of law: The law obliges contractors of construction projects of a certain scale or greater to separate waste materials during demolition, reuse or recycle these materials, and sets out contract procedures for the clients and contractors of the project, as well as other matters.

Targets: Specified construction materials (concrete, construction materials made from concrete and steel, wood, asphalt-concrete)

Source: Construction Material Recycling Law (2000)

3) Target Construction Projects

Building demolition: Floor area of 80 m^2 or greater

Building construction/expansion: Floor area of 500 m^2 or greater

Building repairs/renovations (e.g., remodeling): Contract amount of JPY 100 million or more

Other construction work pertaining to structures (e.g., civil engineering works): Contract amount of JPY 5 million or more

(9) End-of-Life Vehicles Recycling Law

See "Topic 3-3.4 (3) End-of-Life Vehicles Recycling Law"

(10) Small Home Appliances Recycling Act

The *Small Home Appliances Recycling Act* promotes the recycling of the recyclable metal content of small electronic devices by setting out the roles and responsibilities of all relevant entities with a focus on small devices that contain a large amount of recyclable metals. Additionally, the effective use of rare metals found in the devices has recently emerged as an important issue.

1) Background

Mobile phones, digital cameras, watches, hair dryers, and other small electronic appliances contain many useful metals such as iron, aluminum, copper, and precious metals; however, most of them were discharged as waste and collected by municipalities along with other municipal waste. The municipalities salvaged only some of the metals (e.g., iron, aluminum) from the used small electronic devices, and dumped the majority of that waste in landfills without recycling them.

Because small electronic devices also contain harmful metals such as lead, proper treatment is necessary; however, used devices were targeted by illegal junk collectors who were performing improper treatment and disposal both inside and outside Japan.

2) Overview

Name of act: Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment (Small Home Appliances Recycling Act)

Enacted: 2012

Purpose: To ensure the proper treatment of waste and the effective use of resources by taking measures to promote the recycling of used small electronic devices, given that a considerable portion of metals and other useful materials in the devices were disposed of without being recovered.

Overview of act: The act promotes the recycling of used small electronic devices without the need for waste treatment business licenses by allowing entities that engage in the business of recycling used small electronic devices to prepare recycling business plans and submit them to the competent minister for approval.

Targets: Computers, mobile phones, digital cameras, watches, hair dryers, and the like (designated by Cabinet Order as electronic equipment and other electrical machinery and appliances used by general consumers in their everyday lives that can be efficiently collected and transported when they become waste, and are in particular need of recycling)

Source: Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment (2012)

3) Roles and Responsibilities for each Entity

a. General Consumers

・Sort and discharge used small electronic devices

・Deliver to retailers contracted by either municipalities or certified business operators

b. Municipalities

・Separate collection of used small electronic devices

・Deliver to certified business operators

c. Certified Business Operators

・Accept used small electronic devices

・Recycle used small electronic devices

d. Waste-generating Business Operators

・Sort and discharge used small electronic devices

・Outsource treatment to certified business operators or entities capable of proper recycling

e. Retailers

・Cooperate with efficient collection from consumers through efforts such as setting up municipal collection boxes

f. Manufacturers

・Reduce the expense of recycling by finding design solutions and innovating with parts and raw materials

・Use materials obtained through recycling

(11) Act on Promoting Green Procurement

The *Act on Promoting Green Procurement* promotes the preferential purchasing of environmentally and socially conscious products and services toward the formation of a sound material-cycle society.

It is very important to raise awareness among the purchasers of products and services to be environmentally conscious in order to support and promote the environmental efforts of the providers of the products and services.

1) Background

Climate change, environmental pollution, resource depletion, insufficient waste treatment, and other environmental problems are caused by economic activity based on mass production, mass consumption, and mass disposal. Therefore, in order to effectively utilize limited resources and pass them on to the next generation, it is essential to re-examine how the economy and society should be, and to transform into a sound material-cycle society where sustainable development is possible.

The formation of a sound material-cycle society requires efforts from the suppliers of recycled products as well as efforts from consumers. In other words, it is necessary to promote green purchasing - thinking about the environment, carefully considering the necessity, selecting products and services with as little impact as possible on the environment, and preference in purchasing from business operators working to reduce environmental impact - when purchasing products and services. The hope is that green purchasing makes overall economic and social activity more environmentally friendly by changing the consumer behavior and encouraging suppliers to develop products and services with less environmental impact

2) Overview

Name of act: Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Act on Promoting Green Procurement)

Enacted: 2000

Purpose: To create and develop a market for products made from recycled resources and other products that help reduce environmental impact

Overview of act: The act sets out provisions for the procurement of eco-friendly goods and services by the central government and other organizations (municipalities are obliged to make such efforts), and requires business operators and residents to select eco-friendly goods and services whenever possible.

Targets: Specified procurement items (282 items in 22 sectors as of February 2021)

1. Paper	9. Air conditioners, etc.	17. Other textile products
2. Stationery	10. Water warmers, etc.	18. Facilities
3. Office furniture, etc.	11. Illumination	19. Disaster stockpiling products
4. Imaging equipment, etc.	12. Automobiles, etc.	20. Public Works
5. Electronic computers, etc.	13. Fire extinguishers	21. Services
6. Office equipment, etc.	14. Uniforms, work clothes, etc.	22. Garbage bags, etc.
7. Mobile phones, etc.	15. Interior and bedding	
8. Home appliances	16. Work gloves	

Source: Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (2000)

3) Responsibilities of Relevant entities

a. Central Government

・When procuring goods and services, the central government must make efforts to select eco-friendly goods and services while devoting attention to the proper use of budgets in order to promote a shift in demand toward eco-friendly goods and services.

b. Municipalities

・Municipalities shall endeavor to take measures to shift demand toward eco-friendly goods and services in line with the social and economic circumstances of individual areas.

c. Business Operators and Residents

・Business operators and residents shall make efforts to select eco-friendly goods and services whenever possible

3 Policies Pertaining to Waste Management

In Japan, the Ministry of the Environment has taken the lead in adopting important measures to respond to issues such as proper waste treatment, pollution control and efficient waste management.

This section introduces some of the key policies pertaining to waste management that have been effective in Japan.

3.1 Standards and Guidelines for Proper Waste Treatment

The Ministry of the Environment has established technical standards and guidelines for waste treatment plants, landfill sites, and other facilities in line with the related laws in order to respond to pollution problems, implement proper waste treatment, and achieve other goals.

The standards and guidelines are both set out in laws and provided as requirements for municipalities to fulfill in order to obtain grants for developing facilities; therefore, nearly all facilities are planned and developed under the assumption that they must satisfy the standards and guidelines.

Japan has confronted many problems related to waste treatment plants and landfill sites, and has made efforts to resolve those problems using technical methods with technical and financial support from the Ministry of the Environment.

(1) Technical Standards in the Waste Management Act

It is essential to improve the safety and reliability of waste treatment when developing and operating waste treatment plants, and therefore the minimum technical standards that must be fulfilled in order to preserve living environments around the plants have been established. Standards for municipal waste treatment facilities such as incineration facilities, as well as other treatment plants are defined in the enforcement regulations of the *Waste Management Act*. The requirements for final disposal sites have been established in the Ministerial Orders covering the technical standards for final disposal sites for both types of municipal and industrial wastes (refer to Tables 2-3 through 2-5).

The standards for municipal waste treatment plants were established in 1971, and the standards for landfill sites were established in 1977, and were preconditions for receiving state subsidies until the new structure guidelines were formulated in 1979.

Additionally, the *Waste Management Act* and other legislation were amended to strengthen and clarify the technical standards in response to dioxins emissions and other social problems.

Table 2-3 Technical Standards for Municipal Waste Treatment Plants

No.	Description			
1	Safety in terms of structural strength			
2	Measures against corrosion			
3	Measures against the scattering of waste and emission of foul odors			
4	Measures against noise/vibrations			
5	Measures against water contamination			
6	Requirements for incinerator facilities	Waste feeders		
		Combustion chamber conditions	At least 800°C	
			Retention for at least 2 seconds	
			Isolation from outside air	
			Auxiliary burner	
			Combustion air supply facilities	
		Measuring/recording temperatures		
		Cooling tower installation (200°C or lower)		
		Measuring/recording temperatures inside dust collectors		
		Exhaust gas treatment facilities		
		Measuring/recording CO concentration		
		Separation and storage of soot and bottom ash		
		Ash removal facilities	Measures against scattering/spills	
			Ash melting conditions	Melting temperatures (melting point or above)
				Exhaust gas treatment facilities
			Burning incineration residue	At least 1,000°C
				Measuring/recording temperatures
				Exhaust gas treatment facilities
			Solid fuel storage facilities	Ignition prevention measures
7	Requirements for wastewater treatment facilities			
8	Observance of treatment capacity			
9	Incinerator operation and maintenance conditions	Standardizing input waste		
		Isolation from outside area/supply of fixed amounts of waste		
		Combustion gas temperature (at least 800°C)		
		Ignition loss (10% or less)		
		Furnace startup method		
		Furnace shutdown method		
		Measuring/recording combustion gas temperatures		
		Cooling towers (200°C or lower)		
		Measuring/recording gas temperatures before entering dust collectors		
		Soot removal		
		CO concentration (100 ppm or less)		
		Measuring/recording CO concentration		
		Dioxins concentration (below regulatory limits)		
		Measuring/recording dioxins concentration and amount/concentration of soot and smoke		
		Exhaust gas treatment		
		Treatment of exhaust gas treatment water		
		Separating soot and incinerator ash		
		Ash melting temperatures (melting point or above)		
		Firing temperature (at least 1,000°C)		
		Uniformity during cement solidification, chemical treatment		
		Proper management of solid fuels Measures against fires		

No.	Description
10	Measures against mosquitoes, flies, etc.
11	Wastewater treatment
12	Function inspections, inspections of soot and smoke and water quality
13	Maintenance obligations
14	Retention of records (3 years)

Source: Ministry of Health and Welfare “Waste management and Public Cleansing Law Enforcement Regulations Article 4” (1971)

Table 2-4 Technical Standards for Landfill Sites for Municipal Waste (From Article 1-1 of the Ministerial Order that Sets out Standards for Landfill Sites)

No.	Item	
1	Clarifying the scope of landfill sites and establishing perimeter enclosures to prevent entry	
2	Installing notice boards and the like to indicate that the sites are landfill sites	
3	Measures against landslides/subsidence	
4	Measures against municipal waste spills	Safety in terms of structural strength
		Measures against corrosion
5	Measures against contamination of public water areas/groundwater by leachate	
6	Measures against surface water infiltration into landfill sites	

Source: Prime Minister's Office and Ministry of Health and Welfare Ordinance No. 1 “Paragraph 1 of Article 1 of the Ministerial Ordinance Establishing Technical Standards for landfill” (1977)

Table 2-5 Technical Standards for Operation and Maintenance of Landfill Sites for Municipal Waste (From Article 1-2 of the Ministerial Order that Sets out Standards for Landfill Sites)

No.	Item
1	Measures against municipal waste scattering/spills
2	Measures against foul odors
3	Measures against fires
4	Measures against mice, mosquitoes, flies, and other pests
5	Clarifying the scope of landfill sites and establishing perimeter enclosures to prevent entry
6	Installing notice boards and the like indicating that sites are landfill sites
7	Scheduled inspections of retaining walls, etc.
8	Operating and Maintaining seepage control works
9	Scheduled inspections of seepage control works
10	Inspections of water quality
11	Measures against water quality deterioration
12	Measures against rainwater inflow
13	Operating and Maintaining regulating reservoirs
14	Operating and Maintaining leachate treatment facilities
15	Operating and Maintaining open channels and other facilities
16	Installing ventilation systems
17	Measures for landfill sites where landfill disposal has been completed
18	Measures for closed landfill sites
19	Measuring/recording remaining landfill capacity
20	Recording/storing data on types/amounts of municipal waste disposed in landfill sites and landfill site operation and maintenance

Source: Prime Minister's Office and Ministry of Health and Welfare Ordinance No. 1 “Paragraph 2 of Article 1 of the Ministerial Ordinance Establishing Technical Standards for landfill” (1977)

(2) Performance Guidelines for Waste Treatment Plants

1) Incineration Plants

Structure Guidelines for Waste Treatment Plants were formulated in 1979 to serve as technical standards for the structure of plants to be developed under state subsidies. Additionally, in light of technological advances and other factors, the guidelines were revised in 1986, and commentary on the guidelines was published the following year by the Japan Waste Management Association.

In response to subsequent pollution problems and other factors, the structure guidelines were eventually strengthened and clarified as technical standards in the *Waste Management Act*, and waste treatment technology became more diverse due to factors such as the development of new technologies; accordingly, in 1998, the structure guidelines were abolished, and new performance guidelines were formulated. The following is indicated in the general provisions of the performance guidelines.

I. General Provisions

Modern Japanese society is based on mass production and mass consumption, and the discharge of massive amounts of waste has created social problems, including increased environmental impact and strain on landfill sites. Additionally, as anxiety and distrust grew among residents of Japan, it has become extremely difficult to secure the waste treatment plants needed to properly treat the waste.

Therefore, in order to further preserve living environments, it is essential to develop waste treatment plants while promoting the minimization and recycling of waste and improving the safety and reliability of waste treatment.

From this perspective, the *Waste Management and Public Cleansing Law* has set out standards for the structure and operation and maintenance of waste treatment plants as the minimum technical standards that must be fulfilled in order to preserve living environments. Additionally, given that state subsidies firmly require the smooth promotion of advanced waste treatment based on the effective use of the government's financial resources, and considering the prompt introduction of new technologies, the following performance guidelines set out matters that waste treatment plants to be developed under state subsidies should have and methods for verifying the performance, in addition to matters set out in relevant laws and regulations.

Source: Ministry of the Environment "Performance Guidelines for Waste Treatment Facilities for Government-Subsidized Waste Treatment Facility Improvement Projects" (1998)

Table 2-6 shows matters pertaining to the performance of waste incineration plants. The matters are simpler than the structure guidelines, and require plants to have the capacity for stably sustaining the planned waste treatment and thermal recovery.

Table 2-6 Performance Guidelines for Waste Incineration Plants (Matters Pertaining to Performance)

Item	Description
Waste treatment capacity	Plants shall have the capacity to process waste in accordance with the planned quality and amount into incineration residue or solidified materials of the planned properties.
Properties of incineration residue	The ignition loss of incineration residue (excluding fly ash from dust collection) shall be no more than 5% in waste incineration plants that operate continuously, and no more than 7% in waste incineration plants that operate intermittently. However, this does not apply to carbonization plants.
Stable operation	Waste incineration plants that operate continuously shall have the capacity for continuous stable operation for at least 90 days per system. Waste incineration plants that operate intermittently shall have the capacity for stable operation for all planned working days over periods of at least 90 days per series.
Effective use of residual heat, etc.	At waste incineration plants that operate continuously, it shall be possible to generate electricity, supply heat outside the plants, and otherwise use residual heat and the like effectively.

Source: Ministry of the Environment “Performance Guidelines for Waste Treatment Facilities for Government-Subsidized Waste Treatment Facility Improvement Projects” (1998)

2) Landfill Sites

Guidelines for Landfill Sites for Waste were formulated in 1979 to serve as technical standards for the structures of landfills to be developed under state subsidies for final disposal sites. Additionally, in light of technological advances and other factors, the guidelines were revised in 1988, and commentary on the guidelines was published the following year by the Japan Waste Management Association.

In response to subsequent pollution problems and other factors, the structure guidelines were eventually strengthened and clarified as technical standards in the *Waste Management Act*. In light of this and other factors, in 2000, the structure guidelines were abolished, and new performance guidelines were formulated. The following is indicated in the general provisions of the performance guidelines.

Article 1: General Provisions

Given the importance of developing waste treatment plants while improving the safety and reliability of landfill sites for waste, the *Waste Management and Public Cleansing Law* has set out standards for the structure, maintenance, and decommissioning of waste treatment plants as the minimum technical standards that must be fulfilled in order to preserve living environments (hereinafter referred to as the "Ministerial Order on Standards"). Additionally, given the firm requirements of the smooth promotion of advanced waste treatment and consideration of prompt introduction of new technologies, these guidelines set out matters pertaining to the performance that landfill sites for municipal waste above the capacity specified in the Ministerial Order on Standards should have, and methods for verifying the performance.

Notably, in cases such as landfill disposal in bodies of water, the performance guidelines do not require the installation of equipment or facilities deemed unnecessary in the Ministerial Order on Standards.

Additionally, in order to make landfill sites highly safe and reliable, it is necessary not only to comply with these guidelines, but also to conduct site investigations in advance, and implement construction management, operation and maintenance, and the like appropriately.

Source: Ministry of the Environment "Guidelines for the Performance of Landfill Sites" (2000)

3) Changes

The standards for municipal waste treatment plants established in 1971, and the standards for landfill sites established in 1977, have been updated in line with advances in technologies and required technological levels. Table 2-7 shows changes in technical standards and performance guidelines.

Table 2-7 Changes in Technical Standards and Performance Guidelines

Year	Incineration plants	Landfill sites
1971	*Technical Standards* formulated	—
1977	—	*Technical Standards* formulated
1979	*Structure Guidelines for Waste Treatment Plants* formulated	*Guidelines for Landfill Sites for Waste* formulated
1986	*Structure Guidelines for Waste Treatment Plants* revised	—
1988	—	*Guidelines for Landfill Sites for Waste* revised
1998	*Performance Guidelines for Waste Treatment Plants* formulated	—
2000	—	*Performance Guidelines for Landfill Sites for Waste* formulated

Column: Japan Waste Management Association

The Japan Waste Management Association is a public interest incorporated association whose purpose is to contribute to the promotion of public benefit by preserving the living environment and improving public health for residents. The Japan Waste Management Association conducts surveys, research, and other activities necessary for the efficient operation of waste management services by municipalities and improvement of technology in order to smoothly promote waste management services nationwide. In addition to publishing technical books on waste management, such as planning and design guidelines for waste treatment facilities, the association convenes the National Conference on Urban Cleaning Research and Case Studies every year to exchange information and opinions on surveys, research, and other related topics.

The Japan Waste Management Association was founded in 1947 as the "Municipal Waste Management Association" and changed its name to the "The Japan Waste Management Association" in 1956. The association has been operating as a corporate juridical person approved by the Ministry of Health and Welfare (currently Ministry of Health, Labor and Welfare) since 1976 and became a public interest incorporated association in 2012. As of 2022, 388 municipalities and 147 associations are regular members of the association, which mainly conducts research and study, dissemination and awareness-raising, and technical guidance and consultation services related to the waste management service in order to assist the municipalities to implement efficient and smooth waste treatment services.

3.2 Thermal Recovery

Power generation and other forms of residual thermal utilization have long been implemented at waste incineration plants in Japan, but the low efficiency of power generation has been an issue; consequently, although residual thermal has been used for swimming pools and other community facilities in the vicinity of some waste incineration plants, most of the power is consumed within the plants. At present the utilization of energy from incineration power generation is promoted because of the enhanced caloric content of waste associated with changes in lifestyles, and the improvement in power generation efficiency brought about by technical innovations.

Incineration power generation is positioned as part of global warming countermeasures to realize a low-carbon society, because it can serve as a new energy source to replace fossil fuels on the strength of the effective use of resources by reusing waste.

Thermal recovery in the waste treatment process is positioned in the *Basic Act for Establishing a Sound Material-Cycle Society* as cyclical usage (thermal recovery), the first step after the 3Rs, and is widely promoted as a measure when reuse or recycling are not possible.

As the development of waste incineration plants for thermal recovery is eligible for subsidies for promoting the formation of a sound material-cycle society, the central government is providing financial support to promote the development of such facilities. Based on the relevant laws and regulations related to renewable energy as outlined hereafter, the use of recovered energy is being promoted by providing business support and promoting the use of new energy, and by ensuring stable sales of renewable energy obtained from waste.

(1) New Energy Act

Name of act: Act on Special Measures Concerning the Promotion of New Energy Usage (New Energy Act)

Enacted: 1997

Purpose: To encourage residents of Japan to make efforts to use new energy, and to smoothly promote the use of new energy in order to contribute to ensuring a stable and appropriate supply of energy in line with economic and social environments in Japan and the rest of the world.

Overview of the act: The act requires consumers and business operators to make efforts to introduce new energy, and sets out measures for financial support for business operators that introduce new energy through investment subsidies for small and medium-sized enterprises and the like, with a focus on accelerating the introduction to the market of new energy that is ready for practical application but is held back by factors such as economic efficiency, and promoting further technology development with an eye on the long term.

Targets: The Cabinet Order has positioned photovoltaic power generation, wind power generation, clean energy vehicles, waste fuel production, waste power generation, waste thermal utilization, temperature difference energy, natural gas cogeneration, fuel cells, and solar thermal utilization as “new energy utilization.” Subsequent amendments have added biomass fuel power generation and thermal utilization, and snow and ice thermal utilization, and have excluded waste power generation from waste plastic.

Source: Act on Special Measures Concerning the Promotion of New Energy Usage (1997)

(2) Feed-in Tariff (FIT) Act

Name of act: Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities (FIT Act)

Enacted: 2011

Amended: 2016

Purpose: To promote the use of renewable energy sources as energy sources for electricity by taking special measures for the procurement of renewable electricity energy from electric power utilities in terms of price, duration, and other factors, in view of the increasing importance of using renewable energy sources as energy sources to ensure a stable and appropriate supply of energy in line with economic and social environments in Japan and the rest of the world and to reduce the environmental impact of supplying energy.

Overview of act: The act obliges electric power companies to respond to applications from renewable energy power producers for electricity supply agreements at the procurement price and duration set by the government. Additionally, in principle, the expenses incurred by electric utilities when purchasing electricity associated with the operation of the system will be widely borne by the public as taxes (surcharges).

Targets: Renewable energy sources (solar, wind, hydro, geothermal, biomass (plant- and animal-derived organic matter that can be used as an energy source), and excluding crude oil, petroleum gas, combustible natural gas and coal as well as products made from them)

Source: Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities (2011)

3.3 Pollution Countermeasures (for Dioxins, etc.)

In response to dioxins becoming a social problem, the Ministry of the Environment took the lead in establishing an investigative commission of experts to discuss countermeasures. Based on the experts' opinions, the relevant laws and regulations regarding the technical standards for plants, emission standards and environmental quality standards for the general environment were established and amended.

When pollution and other problems that threaten human life and health occur, the necessary laws are established and comprehensive countermeasures are implemented through technical and regulatory methods based on the results of the experts' investigations.

Dioxins became a major social issue in the wake of research results showing that they have adverse effects on the environment and human health. In response, measures such as limiting dioxins emitted from the stacks (chimneys) of incineration plants and improvements to waste incineration plants have been promoted based on Guidelines for the Prevention of Dioxins Emission from Waste Treatment. These guidelines were compiled starting in 1997 by a commission investigating measures to reduce dioxins during waste treatment. Amendments were then made to the *Air Pollution Control Act* and the *Waste Management Act*. Basic Guidelines for the Promotion of Dioxins Countermeasures were formulated at the ministerial conference on countermeasures against dioxins held on March 30, 1999. The government has been promoting these countermeasures, including drastically lowering dioxin emissions.

On July, 1999, the *Law Concerning Special Measures against Dioxins* was enacted to remove dioxins from the environment and prevent pollution of the environment by dioxins. The law sets out principal standards for measures pertaining to dioxins as well as countermeasures for contaminated soil (for more details on dioxin-related problems, refer to Topic 5-3: Dioxins Problems).

Accordingly, as a result of the development of technology for countermeasures, the improvement of incineration plants, and the strengthening of regulations, dioxins emissions from waste incineration plants decreased about 99% from 1997 to 2011.

Name of law: Law Concerning Special Measures against Dioxins
Enacted: 1999
Purpose: To set out standards to serve as the basis for measures pertaining to dioxins, necessary regulations, soil contamination countermeasures, and more in order to remove dioxins from the environment and prevent pollution of the environment by dioxins which are substances that may have a serious impact on human life and health.
Target: Dioxins (polychlorinated dibenzofurans, polychlorinated dibenzo-para-dioxins, coplanar polychlorinated biphenyls)

Source: Law concerning Special Measures against Dioxins (1999)

3.4 Inter-Municipal Waste Disposal

Against a backdrop that includes the need to secure a certain scale of treatment capacity to promote efficient and proper waste treatment, dioxins countermeasures, and waste power generation, Japan has promoted inter-municipal waste disposal as a national policy, and has achieved a certain degree of success.

In the past several years, depopulation has made it increasingly difficult for municipalities to implement waste treatment on their own; thus, inter-municipal waste disposal is being considered as a measure to ensure sustainable and proper treatment into the future as well as stable waste management over the medium to long terms.

When considering the introduction of inter-municipal waste disposal, it is crucial to take into account that the content of the plan and framework must beneficial to all the participating entities and that the issues can be resolved.

Waste management is an inherent obligation of each municipality, with each municipality being responsible for waste management in its own region. On the other hand, some municipalities may find it difficult or inefficient to fulfill their waste management responsibilities on their own due to their locations, population sizes, industrial structures, or other regional characteristics. For such municipalities, an exception is allowed to form a partial-affairs association or wide area union to assume responsibility for waste treatment in a wider area. Under this idea, inter-municipal waste disposal refers to the joint provision of waste management services by multiple municipalities, and the central government issued notifications to prefectural governments in 1997 and 2019 to promote the broadening and consolidation of waste treatment (for an overview of inter-municipal waste treatment plans, refer to Topic 1-2.3 (3) Inter-Municipal Waste Treatment Plan). Summaries of the notifications are as follows.

(1) Summary of the 1997 Notification

1) Background

In order to promote proper waste treatment, the situation required responses to; developing incineration facilities above a certain size (100 ton/day) and efficiently use waste heat generated from the facilities, the difficulty of securing landfill sites associated with factors such as increasing amounts of waste generated, the growing need for recycling, and the need for dioxins countermeasures and other advanced environmental conservation measures.

2) The Need for Inter-Municipal Waste Disposal

Plans for inter-municipal waste disposal are considered based on the following needs.

Table 2-8 Needs of Inter-Municipal Waste Disposal (1997 Notification)

No.	Need	Summary
1	Reduce dioxins	Increasing the scale of incineration plants will make it possible to develop facilities with low dioxins emissions.
2	Promote material recycling	Expanding target waste collection areas will help promote material recycling and reduce amounts of waste incinerated.
3	Promote thermal recycle	Developing larger plants will enable efficient residual thermal utilization at waste incineration plants, helping promote thermal recycle.
4	Measures to secure landfill sites	Efforts to secure landfill sites serving wider areas.
5	Reduce the cost of public services	Consolidating waste treatment plants and expanding treatment areas will help reduce the cost of public services.

Source: Ministry of the Environment "Inter-municipal plan for waste treatment" (Number 173) (1997)

(2) Summary of the 2019 Notification

1) Background

After the 1997 notification was issued, all prefectural governments formulated inter-municipal waste disposal plans and promoted efforts toward wide-area and consolidation of waste treatment. However, the circumstances surrounding waste treatment in Japan had changed substantially in the two-plus decades since the 1997 notification.

In order to ensure sustainable and proper treatment into the future, it was necessary to reconsider what constitutes stable, efficient waste treatment systems over the medium and long term in light of present and future factors such as social circumstances.

2) Purpose

To formulate plans for wide-area and consolidation for ensuring sustainable and proper treatment to serve as the basis for promoting the establishment of stable and efficient waste treatment systems.

3) The Need for Wide-Area and Consolidation

Plans for inter-municipal waste disposal are considered based on the following needs.

Table 2-9 Needs of Inter-Municipal Waste Disposal (2019 Notification)

No.	Need	Overview
1	Ensure sustainable and proper treatment	Developing waste incineration plants and streamlining operation and maintenance will help ensure sustainable and proper treatment in terms of securing finances and personnel.
2	Promote climate change countermeasures	Promoting not only energy savings but also improvements in power generation efficiency and thermal utilization rates at waste incineration plants will help reduce energy consumption throughout waste treatment systems as well as greenhouse gas emissions.
3	Promote waste recycling and biomass utilization	Collecting organic waste across broad areas yields the necessary amounts for material and energy use, helping promote biomass utilization.
4	Strengthen disaster countermeasures	Establishing waste treatment systems that serve broad areas and using waste incineration plants as local disaster risk reduction centers provides independent, decentralized supplies of electricity, heat, and more during disasters.
5	Create new value for communities	Efficiently recovering waste energy can allow incineration plants to function as local energy centers.

Source: Ministry of the Environment "Inter-municipal expansion of waste treatment and consolidation of waste treatment facilities to ensure sustainable and appropriate treatment" (Number 1903293) (2019)

(3) Outcomes of Inter-Municipal Waste Disposal

Table 2-10 lists the outcomes of inter-municipal waste disposal. Comparing FY 1998 to FY 2017, the number of waste incineration plants has decreased by 40% and the average capacity of the plants has increased from 109 ton/day to 164 ton/day. In addition, a significant reduction in total dioxins emissions has been achieved. Thus, inter-municipal waste disposal in Japan has been successful in reducing dioxins emissions effectively by promoting efficiency in waste treatment through consolidating facilities into larger-scale facilities.

Table 2-10 Outcomes of Inter-Municipal Waste Disposal

Item	FY1998	FY2017	Outcome
Number of waste incineration plants	1,769	1,103	Roughly 40% reduction
Plants treating at least 100 ton/day	550 (Roughly 30% of the total)	593 (Roughly 50% of the total)	Expansion of plant scale
Average plant capacity	109 ton/day	164 ton/day	
Dioxins emissions	1,550 g-TEQ/year	22 g-TEQ/year	Achieved target of 33g-TEQ/year

*TEQ: Toxicity Equivalency Quantity
Source: Ministry of the Environment "Prepared based on *Guidance on Inter-municipal and Consolidation*" (2020)

(4) Issues in Inter-Municipal Waste Disposal

Although the central government's notifications have advanced inter-municipal waste disposal and produced some outcomes, there are also cases in which inter-municipal waste disposal has not progressed. According to the results of a survey conducted by the Ministry of the Environment to municipalities, the reasons for this lack of progress can be broadly classified into the three categories as shown in Table 2-11. It is important to sort out and verify the advantages and disadvantages of inter-municipal waste disposal in advance, and to evaluate efficiency, personnel, funding, and other aspects of waste collection and transport, plant operation and management, etc.

Table 2-11 Examples of Reasons for Lack of Progress in Wide-Area and Consolidation

Reason for lack of progress in wide-area/consolidation	Percentage of responses	Detailed description
Advantages to wide-area/consolidation deemed to be too few	3/12 (25%)	Few advantages in terms of cost (e.g., increase in plant development costs associated with purchasing land for developing waste treatment plants serving wide-areas, increase in waste collection and transport costs associated with longer collection and transport distances)
		Little incentive to implement wide-area/consolidation (subsidies for promoting the formation of a sound material-cycle society are granted even for infrastructure life extension and developing disaster-resilient waste treatment plants)
		Consolidation of facilities creates difficulty sustaining waste treatment operations when plants shut down during disasters
		Waste becomes difficult to collect and transport during wide-area/consolidation if areas subject to wide-area/consolidation are too large
Coordination between municipalities is difficult	7/12 (58%)	Difficulty coordinating the timing of waste treatment plant development (particularly when consolidated facilities are scheduled to go into service at different times)
		Difficulty coordinating waste treatment methods (particularly when different municipalities presently deploy different waste treatment methods)
		Changes in waste policy when new municipal mayors take office
		Changes in waste policy when municipalities merge
		Difficulty coordinating potential sites for plant construction
		Difficulty coordinating cost-sharing
		Difficulty coordinating sorted waste categories
		Difficulty coordinating waste collection days
Difficulty coordinating with residents	2/12 (17%)	Difficulty gaining residents' understanding for increasing transport distances for direct receiving
		Difficulty getting residents' understanding for consolidating treatment of waste from different municipalities to a single location

Source: Ministry of the Environment "Guidance on Inter-municipal and Consolidation" (2020)

Column: Osaka Bay Phoenix Project

1. Background

Ongoing high-density land use in inland areas of the Kinki region (Population: roughly 20 million, Area: roughly 27,000 km^2) has made it difficult to secure landfill sites. Under these circumstances, the Osaka Bay Phoenix Project was planned and implemented to fulfill two social demands: proper waste treatment and urban revitalization.

The project, which was funded by local governments and port authorities in the Kinki region, sought to create landfills in Osaka Bay as a means of final disposal of waste from the major urban areas of the region, and to use the reclaimed land to improve the functions of ports and harbors.

Source: Osaka Bay Regional Offshore Environmental Improvement Center "Osaka Bay Side Phoenix Project" (2021)

Photo 2-8 Reclaimed Land off Kobe Coast

2. Purpose

(1) To preserve living environments in the Osaka Bay region through proper landfill disposal of waste generated in the broad target areas of the region.

(2) To contribute to the balanced development of the region through the orderly improvement of ports and harbors by using the land created by the landfills.

3. Plan Overview

Under the Osaka Bay Phoenix Project, four landfill sites were established in Osaka Bay to accept waste generated across a wide-area - 171 municipalities in six prefectures in the Kinki region.

The following advantages and disadvantages of inter-municipal waste disposal, and important points to remember when introducing and sustaining inter-municipal waste disposal are offered as lessons learned from implementing the Osaka Bay Phoenix Project (results of interviews with Osaka Bay Regional Offshore Environmental Improvement Center and others).

Source: Osaka Bay Regional Offshore Environmental Improvement Center "Osaka Bay Side Phoenix Project" (2021)

Photo 2-9 Reclaimed Land off Izumiotsu Coast

Advantages of Inter-municipal Waste Disposal

- Consolidating waste treatment and disposal streamlines plant development and operation.
- The larger the scale of the plant, the more economically efficient it becomes, i.e., advantages of economies of scale.
- Plants can be operated more consistently over longer periods of time after inter-municipal waste disposal.

Disadvantages of Inter-municipal Waste Disposal

- Decision-making takes more time because there are more stakeholders.
- Awareness of the need to secure remaining landfill capacity and new landfill sites could weaken because plants can be operated more consistently over longer periods of time.
- Risks that were not initially envisioned (including changes in social circumstances) could arise because plants can be operated over longer periods of time.

Important Points to Remember when Introducing Inter-municipal Waste Disposal

- There should be no major differences between waste management policies and efforts within the participating municipalities..
  (For example, it feels fairer when there are no disparities between required resident cooperation toward waste reduction or burden for the expense of waste treatment when charges are introduced.)
- Wide-area should cover municipalities with strong social unity. (Unity and acceptance are easier to achieve when stakeholders have shared understanding and awareness.)

Important Points to Remember when Sustaining Inter-municipal Waste Disposal

- Continue to hold briefings for local interest parties to sustain both the consensus reached between them and stakeholders' understanding.
- Modify the system in response to changes in social circumstances.

Photo 2-10 Ship to Transport Waste
(The roof is closed after departure to prevent waste scattering)

Photo 2-11 Transfer of Waste from Ship to Truck
(Reclaimed Land off Osaka Coast)

Source: Yachiyo Engineering Co., Ltd.

Photo 2-12 The Dumping of Waste into the Landfill (Reclaimed Land off Osaka Coast)

Photo 2-13 Water Treatment Facilities Installed in the Landfill (Reclaimed Land off Osaka Coast)

Source: Yachiyo Engineering Co., Ltd.

3.5 3R Promotion

In order to reduce consumption of natural resources and minimize waste, Japan has long engaged in efforts related to the 3Rs, including reducing waste, reusing unwanted articles, sorting recyclables, and group collection (voluntary resource collection systems run by local residents and others). Furthermore, amid a growing awareness of the importance of establishing a society capable of sustainable development, efforts toward establishing a sound material-cycle society have been promoted, namely through the enactment of the *Basic Act for Establishing a Sound Material-Cycle Society* in 2000.

Under these circumstances, Japan drafted the 3R Initiative in 2004. Since then, efforts to promote the 3Rs have been enhanced inside and outside Japan, and Japan has shared its wealth of knowledge and experience with 3Rs activities with many other countries in an effort to spearhead the formation of a global-scale sound material-cycle society.

(1) The 3R Initiative

Japan drafted the 3R Initiative with the aim of establishing a sound material-cycle society through the 3Rs (reducing the generation of waste (Reduce), reusing waste (Reuse), and recycling waste (Recycle)) based on the recognition that the 3Rs - which initiate to promote the effective use of resources to achieve a balance between the environment and the economy - will become even more important in the future.

(2) Initiatives at G7/G8 Summits

The 3R Action Plan was adopted at the G8 summit held in Sea Island, Georgia, USA in June 2004. In response to the adoption of the plan, the 3R Initiative was formally launched at the 3R Initiative Cabinet Ministers Meeting held in Tokyo in April 2005.

3R Action Plan	1. Promote a 3R shift for economically viable waste
	2. Reduce barriers to the international distribution of recycled materials and products
	3. Encourage cooperation among governments, the private sector, NGOs, and other stakeholders
	4. Promote science and technology adapted to the 3Rs
	5. Develop human resources and cooperate with developing countries

The G8 Summit held in Saint Petersburg, Russia in July 2006 confirmed the commitment to optimize resource recycling based on the 3R Initiative and the idea of setting targets, as appropriate considering resource productivity. The 3R Action Plan also appeared on the agendas of subsequent summits, including the G8 Summit held in Toyako, Hokkaido, Japan in 2008, and the G7 Summit held in Schloss Elmau in Bavaria, Germany in 2015.

These discussions and activities over many years formed the foundation of the G7 Common Vision to Enhance Resource Efficiency and Promote the 3Rs and the Toyama Framework on Material Cycles - a proposal of ambitious actions by G7 countries - which were adopted at the G7 Toyama Environment Ministers' Meeting in May 2016. The G7 Ise-Shima Leaders' Declaration contains a pledge to support the Toyama Framework. G7 Common Vision to Enhance Resource Efficiency and Promote the 3Rs and ambitious actions are shown in Table 2-12.

Table 2-12 G7 Common Vision to Enhance Resource Efficiency and Promote the 3Rs and Ambitious Actions

<table>
<tr><th colspan="2">G7 Common Vision to Enhance Resource Efficiency and Promote the 3Rs</th></tr>
<tr><td colspan="2">✓ Our common goal is to achieve a society in which resources, including stock resources, are used efficiently and sustainably over the entire life cycle by reducing the consumption of natural resources and promoting the use of recycled materials and renewable resources in order to keep them within the environmental capacity of the Earth, while respecting the relevant concepts and approaches.
✓ Such a society will not only provide solutions to the problems of waste and resources, but also create a sustainable low-carbon society in harmony with nature that can generate employment, enhance competitiveness, and achieve green growth.</td></tr>
<tr><th colspan="2">Ambitious Actions by G7 Countries</th></tr>
<tr><td>Goal 1:
Leading domestic policies for resource efficiency and the 3Rs</td><td>✓ Comprehensive integration and promotion of policies on resource efficiency and the 3Rs, climate change, extreme weather events, harmful substances, disaster waste, natural environment conservation, and more.
✓ In addition to regulatory approaches, use of voluntary initiatives by business operators and the like
✓ Proper treatment and recycling of disaster waste, development of disaster-resilient waste treatment plants, etc.
✓ Cooperation among various local entities (symbiosis between industry and local communities), consumer measures</td></tr>
<tr><td>Goal 2:
Promotion of global resource efficiency and the 3Rs</td><td>✓ Share best practices, the best available technology (BAT), and useful lessons with other countries through the G7 alliance and other organizations
✓ Support for capacity building for resource efficiency and resource circulation policies in developing countries
✓ Support for countries and regions experiencing major natural disasters
✓ Encourage proactive efforts in upstream industries to reuse and recycle, including the use of renewable resources</td></tr>
<tr><td>Goal 3:
Steady and transparent follow-up</td><td>✓ Establish a transparent follow-up process domestically including sharing of calculation methods, indicators, and the results of reviews.
✓ Continue to share progress, challenges and lessons learned on implementation of the Framework, through workshops and other fora.</td></tr>
</table>

Source: Ministry of the Environment Website "G7/G8 initiatives on 3Rs and resource efficiency"
http://www.env.go.jp/recycle/circul/3r_g7g8.html (accessed January 22, 2022)

(3) Promotion of the 3Rs in Asia

In 2006 and 2008, Japan held the Asia 3R Conference, an administrative-level meeting for Asian countries to share information on the 3Rs. Additionally, in November 2009, the Regional 3R Forum in Asia and the Pacific was established as a further development of the Asia 3R Conference. The objectives of the forum include promoting high-level policy dialogue on the 3Rs, promoting support for the implementation of 3R-related projects in Asian countries, sharing systems, technologies, and other information useful for the promotion of 3Rs, and creating a network among stakeholders.

The forum has been held regularly since the first meeting in Tokyo in November 2009, and has been hosted by the Japanese Ministry of the Environment, among others.

Table 2-13 Regional 3R Forum in Asia and the Pacific

No.	Date	Host country	Participants	Theme
1st	November 2009	Japan	15 Asian countries	Adoption of the Tokyo 3R Declaration on the Establishment of the Asia 3R Promotion Forum
2nd	October 2010	Malaysia	22 Asian and Pacific island countries	3Rs for a Green Economy and a sound material-cycle society
3rd	October 2011	Singapore	23 Asian and Pacific island countries	Technology Transfer to Promote the 3Rs: Adaptation, Implementation, and Expansion of Proper Technologies
4th	March 2013	Vietnam	31 countries in the Asia-Pacific region	Future 3R Efforts Based on the “Future We Want” Rio +20 Outcome Document
5th	February 2014	Indonesia	33 countries (ASEAN, Pacific island countries, East Asia, South Asia, etc.)	Framework for Multilayered Coordination and Cooperation as a Foundation for 3R Promotion in the Asia-Pacific Region
6th	August 2015	Maldives	39 countries (ASEAN, Pacific island countries, East Asia, South Asia, etc.)	3R Industry: The Course of Next-Generation 3R for Resource-Efficient Societies and Sustainable Tourism Development in the Asia-Pacific Region
7th	November 2016	Australia	41 countries (Asian countries, Pacific island countries, etc.)	Advances in the 3Rs and Resource Efficiency for the Sustainable Development Agenda 2030
8th	April 2018	India	41 countries (Asian countries, Pacific island countries, etc.)	Achieving Clean Water, Land, and Air through the 3Rs and Resource Efficiency: Vision for the 21st Century in the Asia-Pacific Region
9th	March 2019	Thailand	Roughly 40 countries (Asian countries, Pacific island countries, etc.)	The 3Rs as a Means of Achieving Self-Sufficient Economies: Implications for Sustainable Development Goals
10th	November-December 2020	Webinar format	30 countries (Asian countries, Pacific island countries, etc.)	Promoting a Circular Economy in the Asia-Pacific Region to Achieve the SDGs during the COVID-19 Pandemic

*: The name of the forum was changed to “3R and Circular Economy Promotion Forum in Asia and the Pacific” at the 10th meeting.

Source: Ministry of the Environment Regional 3R Forum in Asia and Pacific Website “Regional 3R Forum in Asia and the Pacific” https://www.env.go.jp/recycle/3r/en/index.html (accessed January 19, 2022)

Column: The Regional 3R Forum in Asia and the Pacific

The Regional 3R Forum in Asia and the Pacific was first held in Tokyo in 2009 under the joint sponsorship of the Ministry of the Environment of Japan and the United Nations Centre for Regional Development (UNCRD) (its original name was "Asia 3R Promotion Forum"). Since then, a total of 10 international meetings have been held in Malaysia, Vietnam, Indonesia, Australia, India, Thailand, and other countries. With 39 participating countries at present and the adoption of the Hanoi 3R Declaration (2013) and the Bangkok 3R Declaration (2019), the 3Rs are gaining momentum in the Asia-Pacific region every year.

At the first meeting of the Asia 3R Promotion Forum held in Tokyo in 2009 (pictured on the right), representatives and experts from 15 Asian countries (including ministers) and 16 international organizations participated, and the Tokyo 3R Declaration on the Establishment of the Asia 3R Promotion Forum was adopted.

The objectives of the forum are to promote high-level policy dialogue on the 3Rs; to promote dialogue and collaboration among countries, international organizations, and aid agencies for the implementation of 3R projects; to share 3R best practices, methods, technologies, and policy tools; to strengthen networks among central and local governments, experts, and other stakeholders; and to disseminate national 3R strategies. Each meeting of the forum has been attended by a wide range of stakeholders.

Notably, the Institute for Global Environmental Strategies (IGES), which participates in the forum as a policy advisor, has highlighted that "although the formation of legal systems is progressing, steady expansion of policy implementation capacity and institutional and technological infrastructure that meets local needs are expected", and has identified the following matters pertaining to 3R promotion in developing countries.

System and Governance

- Establish a formal waste collection and treatment mechanism for waste and circular resources
- Build the capacities of local governments to reliably enforce regulations
- Specify policy priorities and directionality in addition to financial support from central

governments

- Follow up on policy implementation and continuously review plans
- Establish the roles and responsibilities of relevant people in order to achieve goals

Development of Recycling Industry Infrastructure

- Promote technological and industrial infrastructure that ensures environmental management
- Develop social infrastructure as well as technologies and industries in line with actual conditions
- Develop an excellent recycling industry with scale and capital strength

Nurturing the Market for Waste Recovery and Reuse

- Prevent end-of-life products from being sent through inappropriate, even if inexpensive, treatment methods based solely on their economic value or value as resources
- Shift from recycling for cost recovery to sustainable resource circulation
- Recognize the need to change the demand coordination mechanism that relies solely on the market

The 3Rs are being deployed in developing countries around the world through JICA's training programs and technical cooperation projects, including the forum described earlier. To promote the 3Rs in developing countries, it is necessary to develop an understanding of the social and economic conditions of each country and city before coordinating with industry organizations and other stakeholders, drafting practical policies that take into account the issues described previously, and promoting them effectively.

Topic 3. Administrative Organization and Finance

Contents

1. Government Organizations Involved in Waste Management

1.1 The Structure of Government Organizations

In Japan, various geographic administrative areas have departments in charge of particular sectors. In the waste management sector, a national management system has been set up under the central government ministry, the Ministry of the Environment with divisions responsible for waste management in the local governments.

In order to ensure that a proper waste management system is in place, all concerned persons; citizens, businesses, and administrators must be proactive in fulfilling their roles and responsibilities within the system. It is essential for them to work together in developing a united front by integrating their respective actions through exchange of opinions and maintaining communication. To do this, it is important to clarify the roles and responsibilities of each person concerned.

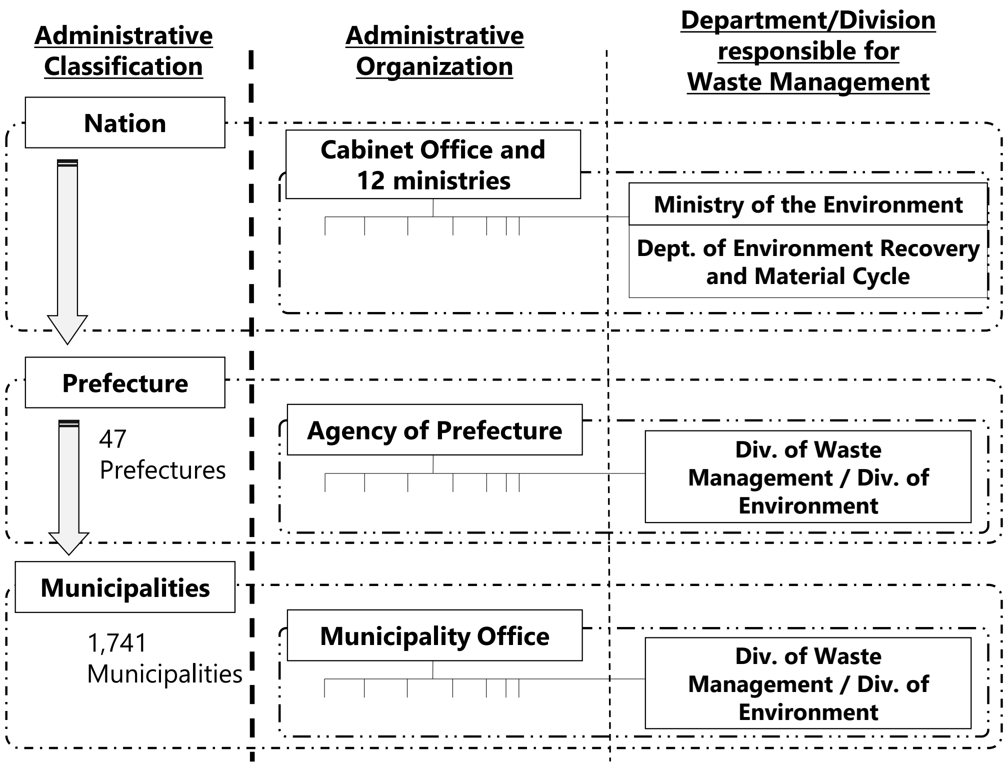
Under the central government of Japan there are 47 geographic administrative areas referred to as prefectures, major cities and districts. Within these prefectures there are different types of municipalities and special cities, and each of the prefectures, cities, towns, villages and special cities have their own administrative organization. These are the local governments responsible for administration within their administrative areas. (Special cities and municipalities number 1,741 (2020), of which 23 are special cities, 792 cities, 743 towns, and 183 villages).

Japanese government agencies are made up of the Cabinet Office and 12 government ministries, of which the Ministry of the Environment is responsible for central management of the waste management system. Other government agencies coordinate with the Ministry of the Environment and have specific responsibilities. For instance, the Ministry of Economy, Trade and Industry promotes efforts within the industrial community to construct a sound material-cycle society and controls the import/export of waste, the Ministry of Education, Culture, Sports, Science and Technology promotes environmental education, the spread of information, and research, and the Ministry of Health, Labor and Welfare works to improve public health and the working environment.

Table 3-1 Division of Responsibilities for Waste Management within the Central Government Ministries

Ministry	Division of Responsibilities
Ministry of the Environment	This is the central government ministry that supervises all of Japan's waste management administration. It coordinates with each ministry and implements all relevant policies based on the laws.
Ministry of Economy, Trade and Industry	Implements waste management activities related to trade, and promotes efforts within the industrial community to establish a sound material-cycle society
Ministry of Land, Infrastructure, Transport and Tourism	Researches the current situation of construction and building byproducts (waste), and promotes the *Construction Material Recycling Law*.
Ministry of Education, Culture, Sports, Science and Technology	Promotes environmental education, and awareness-raising activities in the whole environmental field, including waste management. Promotes development of research in the waste management field at universities and research institutes.
Ministry of Health, Labor and Welfare	Promotes initiatives related to improving public health, improving the working environment in waste management, and developing human resources.
Ministry of Agriculture, Forestry and Fisheries	Implements proper management of livestock excrement and promotion of the *Food Waste Recycling Law*.

Divisions have been set up in many prefectures and municipalities (in this text municipalities include special cities) to manage waste, and the respective responsibilities of the various levels of government agencies are determined by law.



Note: The 1,741 municipalities include cities designated by government ordinance that are at the prefectural level.

Figure 3-1 Waste Management System in Japan

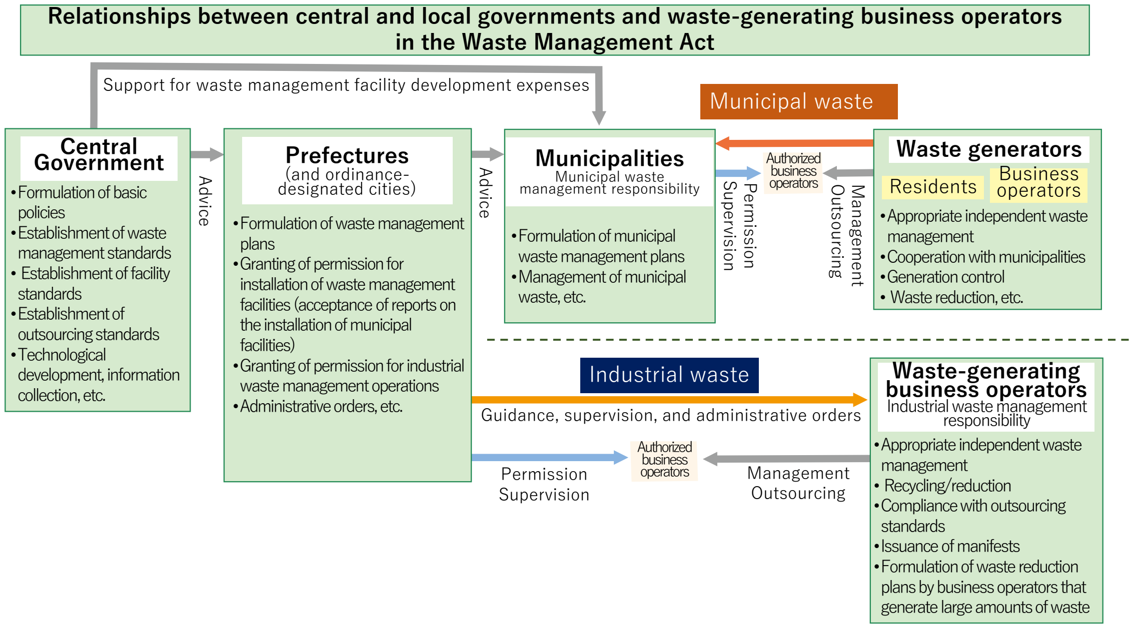
Column: Central Environment Council

The Central Environment Council is an advisory body to the Minister of the Environment, established in 2001 by the Ministry of the Environment in accordance with Article 41 of the *Basic Environment Law*. The Central Environment Council has eight subcommittees, such as the Integrated Policy Subcommittee, the sound material-cycle society Subcommittee, and the Global Environment Subcommittee etc. The Council deliberates on consultations and provides important insights regarding environmental policies and other issues, upon the request of the Minister of the Environment or other ministers.

Name of Subcommittee	Duties stipulated
Central Environment Council	1. To deal with matters stipulated in Article 15, Paragraph 3 of the *Basic Environment Law* with regard to the Basic Environment Plan 2. To study and deliberate on important matters related to environmental conservation in response to consultations by the Minister of the Environment or relevant ministers. 3. Affairs under its authority pursuant to the provisions of other laws and regulations 4. To be able to state its opinions to the Prime Minister, the Minister of the Environment, or the ministers concerned in relations to the matters mentioned above.
Integrated Policy Subcommittee	1. Matters related to the Basic Environmental Plan 2. Important matters related to the preservation of the environment (excluding those under the jurisdiction of other subcommittees).
Sound Material-Cycle Society Subcommittee	1. Important matters concerning waste treatment and recycling promotion 2. Matters related to the Fundamental Plan for Establishing a Sound Material-Cycle Society based on the provisions of the *Basic Act for Establishing a Sound Material-Cycle Society*.
Global Environment Subcommittee	Important matters concerning the preservation of the global environment

Source: Ministry of the Environment Website "List of the Central Environment Council Subcommittees" https://www.env.go.jp/council/bukai.html （accessed February 23, 2022）

The main waste management responsibilities of the central government, prefectures, and municipalities, together with the responsibilities of waste-generating business operators and individuals generating waste are shown in Figure 3-2. In addition to the responsible government agencies, both business operators and citizens generating waste also have roles to fulfill in waste management from their respective positions.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 3-2 Division of Waste Management Responsibilities among Various Entities

Table 3-2 Description of Waste Management Responsibilities among Various Entities

Entity	Responsibilities
Central government	Gathers and collates information about waste, makes laws and sets standards, and promotes the development of technology. Gives technical and financial assistance to municipalities and prefectures, so as to devise and put into effect comprehensive measures that contribute to other related entities fulfilling their responsibilities.
Prefectures (Large cities designated by government ordinance)	Give technical assistance so that municipalities can fulfil their responsibility for municipal waste treatment. Assess the current situation with industrial waste in the region concerned, devise an industrial waste treatment plan so that treatment of the waste can be carried out properly and provide leadership and supervision to the waste-generating business operators. Also, register and supervise the industrial waste businesses of industrial waste treatment operators. (Large cities designated by government ordinance have responsibilities generally equivalent to those of prefectures, due to the transfer of authority from prefectures, etc. in addition to the responsibilities of municipalities.)
Municipalities	Responsible to treat general waste generated in their respective areas and develop plans for various types of waste targeted in their cleaning operations. They also promote voluntary activities by the residents to reduce municipal waste generated and take measures to support proper treatment of municipal waste.
Waste-generating business operators	Responsible to properly treat the waste produced from their own businesses (industrial waste), by their own initiatives. Make efforts to reduce the amount of waste by promoting recycling within their businesses and treat waste properly by outsourcing it to reliable private treatment businesses. They also anticipate the contribution of their products and containers to the waste flow, and prevent treatment and recycling from becoming a problem by trying to develop environmentally friendly products and containers and providing information contributing to proper treatment methods.
Waste-generators, citizens	Work to promote waste recycling through proactive use of recycled or environmentally friendly products and by minimizing waste and sorting waste for disposal. In this way they cooperate with the policies of national and municipal entities to reduce waste and to treat it properly.

Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

1.2 Changes in the Administrative Organization of Waste Management

The government agency with jurisdiction over waste management used to be the Ministry of Health and Welfare, because of its public health perspective until 2001. However, societal changes redefined the purposes and requirements of waste management, as well as the jurisdiction of government agency. The Ministry of the Environment has been the managing agency since the rearrangement of government ministries in 2001, and a national management system has been built that includes municipalities.

Municipal waste was previously under the jurisdiction of the Ministry of Health and Welfare from the perspective of public health, along with the works related to water services. In 1971, the Environment Agency was set up with the purpose of centralizing and integrating the regulatory administration for pollution issues, which was scattered in various ministries. The Environment Agency also took over general administration relating to preserving the natural environment, conservation of the environment and related matters. But policies that the Environment Agency could actually implement were limited, and information sharing at the different levels of administration in some ministries and agencies was inefficient, making it difficult to develop an effective environmental administration.

Against this background, in January 2001 there was a rearrangement of the central government ministries and agencies during which the Environment Agency became the Ministry of the Environment. Responsibilities under the jurisdiction of the Ministry of Health and Welfare’s Water Supply and Environmental Sanitation Department were reorganized; water services were moved to the Ministry of Health and Welfare’s Health Bureau and waste treatment and cleaning related work came under the Waste Management and Recycling Department, in the Ministry of the Environment.

In addition, part of the work relating to waste was removed from the Water Quality Bureau in the Environment Agency and placed under the Waste and Recycling Policy Division and a system was set up whereby the Ministry of the Environment was put in charge of waste management.

1.3 Government Waste Management Services

Waste management is a major administrative service for which the government needs to take responsibility. In the past the government took the initiative in waste management, but now the use of private sector technology and know-how is increasing to meet a variety of waste management demands. This includes tackling the increasingly diverse waste stream, providing high-quality services, and implementing waste management in an economically efficient manner. But, even given use of the private sector, it is essential to provide government oversight in order to secure provision of government services providing proper, safe waste management.

Under the *Waste Management Act* municipalities are designated as the management entities for municipal waste operations. Thus, waste management is one of the important services municipalities must provide for citizens within the administrative area under their jurisdiction.

In addition to waste collection and the various work processes leading to final disposal, municipalities are also responsible for public awareness directed to citizens. Many municipalities have a specialized division dealing with waste management, but in the case of collection, transport and managing the operation of facilities, some municipalities do this work directly and some by outsourcing part of it to the private sector.

Also, some municipalities with relatively low populations join with other nearby municipalities and set up joint waste management (referred to hereafter as “Clean Association”). Thus, specialized associations are set up to provide government waste management services so that the municipalities can carry out their responsibility to provide waste management in an efficient way. These Clean Associations provide the government waste management services for all the administrative areas under the jurisdictions of the member municipalities. The parts of the work done directly by each municipality differs depending on each municipality’s population size and area characteristics, however each municipality is responsible for the overall waste management under its jurisdiction.

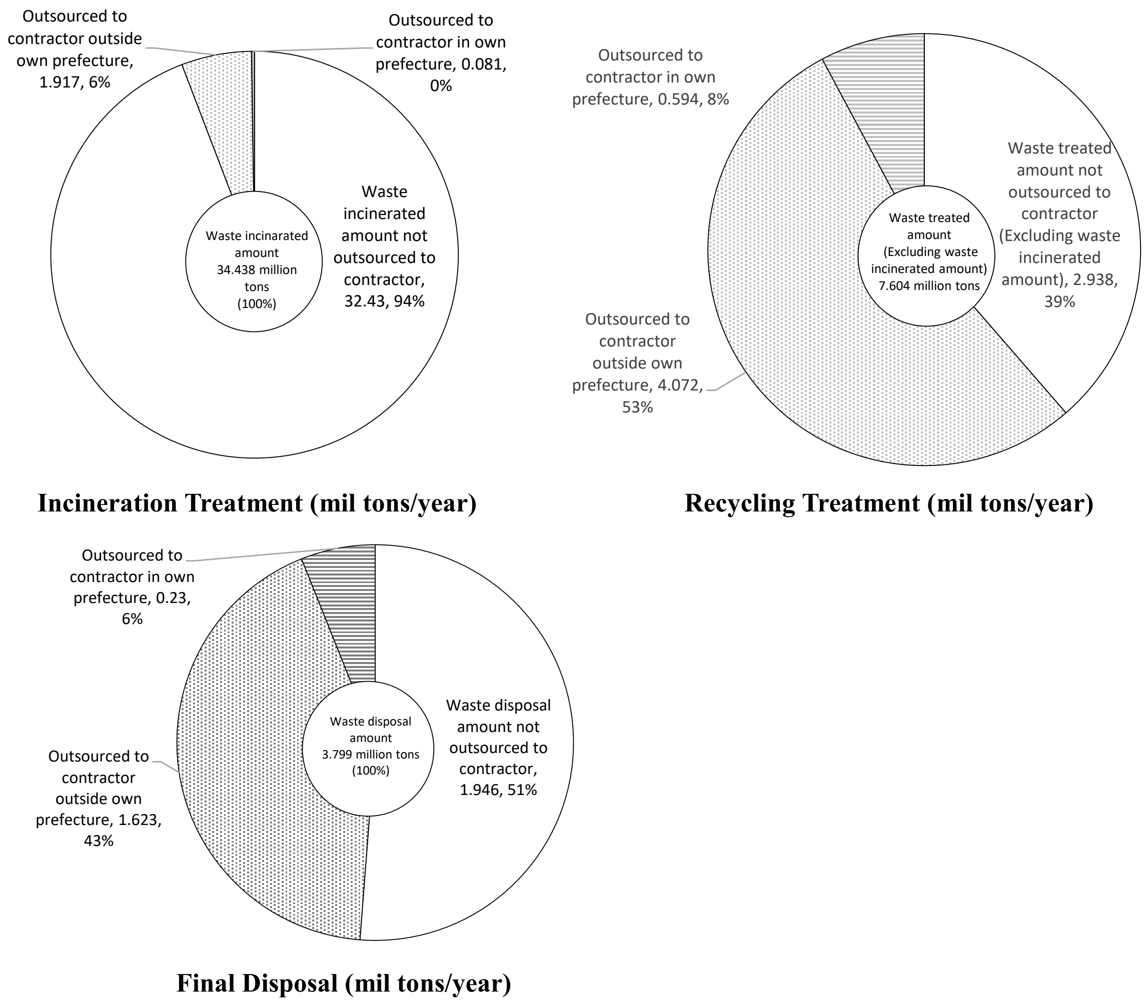
The basic approach to waste management of Japan is that waste should be treated in the locality where it is generated and as close to the point of generation as possible. This is the principal of local treatment within each area.

The status of outsourcing by municipalities for incineration treatment, recycling treatment, and final disposal is shown in Figure 3-3. The outsourcing mentioned refers to agreements under which treatment or disposal of waste takes place outside of the municipalities or Clean Associations, which do not treat or dispose of the waste by themselves, and implies that disposal does not occur within the area.

For incineration treatment, the amounts treated by outsourcing respectively within prefectures is 1,917,000 tons (5.6% of the total waste incinerated amount) and outside prefectures is 81,000 tons (0.2%), and the total amount outsourced for incineration is 1,998,000 tons (5.8%). The amount of incineration treatment not outsourced (the amount treated by municipalities or Clean Associations) is 32,430,000 tons (94.2%), so that most of the amount is treated according to the principal that treatment occurs within the area of generation and is treated in municipally owned facilities.

For recycling treatment, the amounts treated by outsourcing respectively within prefectures is 4,072,000 tons (53.6% of the total waste recycling treatment amount) and outside prefectures is 594,000 tons (7.8%) with a total treated amount of 4,666,000 tons (61.4%). The amount of recycling treatment waste that is not outsourced (the amount treated by municipalities or Clean Associations) is 2,938,000 tons (38.6%). In the case of recycling treatment, the amount rate treated at municipality owned facilities is less than that for the amount rate of incinerated treatment, but recycling is done efficiently in neighboring areas.

For final disposal, the final disposal amounts by outsourcing within prefectures is 1,623,000 tons (42.7% of total waste disposal amount) and outside prefectures 230,000 (6.1%) for a total amount of 1,853,000 tons (48.8%). The amount of final disposal treatment waste that is not outsourced (the amount treated by municipalities or Clean Associations) is 1,946,000 tons (51.2%) which means that more than half the amount is treated at facilities owned by municipalities. As of 2019, there were 285 municipalities without final disposal sites, which was about 16% of the total.



Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 3-3 Status of Outsourced Waste Treatment and Disposal

1.4 Waste Management through Outsourcing and Collaboration with the Private Sector

> There are many private sector enterprises in Japan which have the necessary technology and knowledge that can provide sufficient waste management services on behalf of municipalities. Accordingly, there are many municipalities that use private sector to provide the necessary governmental services in there administrative areas.

In many municipalities in Japan, the government administrators outsource part of the waste management service to the private sector for which the government is responsible for, such as the collection and transport of waste or the operation of facilities.

Municipalities must set up fairly large organizations within their administrations to provide citizens directly with waste management government services, and they have to ensure the necessary personnel and budget to do the work. They also need to secure and implement budgets on an ongoing basis for the operation and maintenance of equipment and facilities. For these reasons, in order to supply services for waste collection and transport efficiently and economically, many municipalities outsource waste collection and transport services to private sector collection and transport businesses. Many municipalities outsource the operation and management of their own waste treatment facilities (incineration facilities, recycling facilities, etc.) and final disposal sites to the private sector in order to ensure stable operation and management by highly skilled engineers.

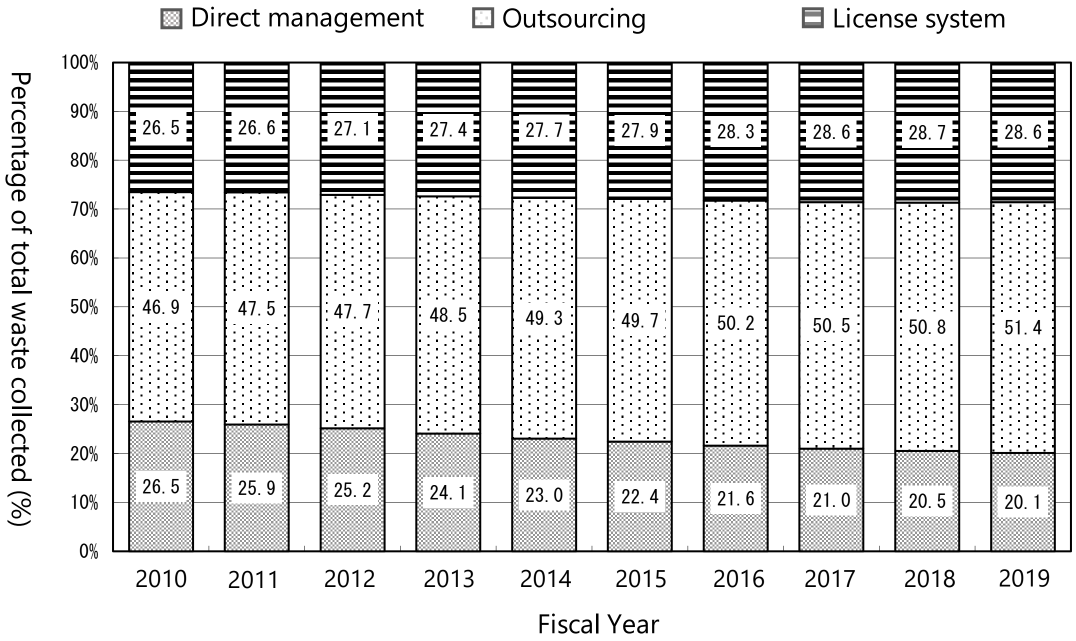
The work itself is carried out by the private sector, but the municipalities oversee the outsourced work and bear responsibility for it.

Table 3-3 The Advantages and Disadvantages of Direct Operation and Outsourcing (Collection and Transport)

Item	Direct Operation	Outsourcing
Advantages	✓ Lines of responsibility are clear ✓ Easy to align with other policies such as 3R. ✓ Easy to adjust to citizens requirements ✓ Can respond flexibly to plans ✓ Can react to unforeseen events. ✓ It is possible to provide stable employment for a large number of workers.	✓ Can use private sector technology and knowhow, and improve efficiency of collection. ✓ No large organization is needed, and administration is easy to manage. ✓ Reduction of collection costs is possible
Disadvantages	✓ A large organization must be set up and managed for collection ✓ Facilities, equipment, and personnel must always be maintained. ✓ There will be high collection costs. ✓ It is hard to raise collection efficiency (maintain staff motivation).	✓ Hard to tie down responsibility for collection ✓ Only work specified in the contract is done so flexible responses are difficult ✓ As the private enterprise is profit driven there is a danger that the quality of the collection work may fall. ✓ The government loses the opportunity to be in touch with its citizens. ✓ A pre-condition to ensure competitive selection is that there should be a number of private businesses able to provide a stable and efficient collection and transport service.

In addition to industrial waste generated from business activities, waste generated from offices and other facilities is positioned as business-related waste, and is collected separately from industrial waste and household waste. Business-related waste is transferred to treatment facilities either by the waste generators themselves or the more likely case of private companies with collection and transportation licenses.

Changes in the ratios of waste collection amount for each category is shown in Figure 3-4. The ratio of waste collection done by municipalities outsourcing is increasing annually with a corresponding tendency for the ratio of collection directly implemented by municipalities to continually decline. In 2019, the ratio of waste collection amount directly collected by municipalities was 20.1%, the ratio of municipalities' outsourced waste collection was 51.4%, and licensed businesses collected 28.6%. Thus, contractors, who entered into outsourcing agreements with municipalities to collect waste, collected over half the total collected waste, and represent the largest share.



Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 3-4 Changes in the Ratios of Waste Collection Amount for Each Category

1.5 Roles of Government, Waste-generating Businesses, and Private Sector

It is important to clarify the various roles of administration (Government, Prefectures and Municipalities), waste-generating businesses, and the private sector, and in Japan the responsibilities of each is defined by law. The plans made by local governments for waste management show the roles and responsibilities of each entity concerned, and they make aware of these plans, as each entity is required to proactively carry out their duties.

The *Waste Management Act* sets out each of the responsibilities of citizens in Article 2-4, businesses in Article 3, and the central and local governments in Article 4 respectively.

Table 3-4 The Roles of Government, Businesses and Citizens Defined in the Waste Management Act

Government Businesses Citizens	Act	Responsibility
Central Government	Article 4 3,4	The central government shall collect information about waste, keep it in orderly arrangement and use it, take measures for promotion of waste management technology development and also take suitable action for proper and smooth waste management throughout Japan. The central government shall endeavor to give the necessary technical and financial assistance to the municipalities and to the prefectural governments for adequate performance of their duties mentioned in the preceding two Paragraphs. To suppress discharge of waste and ensure their proper management, the central government, prefectural governments and municipalities shall all endeavor to enlighten both the general public and businesses on the importance of appropriate solid waste management.
Prefecture (Local Government)	Article 4 2	The prefectural governments shall endeavor to give the necessary technical advice to the municipalities under their administration to ensure their adequate performance of the duties prescribed in the preceding Paragraph and shall endeavor to grasp the conditions of industrial waste in the respective prefectures and take the necessary action for proper management of such industrial waste.
Municipality (Local Government)	Article 4	The municipalities (self-governing bodies of cities, towns and villages) shall endeavor to promote residents' voluntary activities to reduce their municipal solid waste in their respective administrative areas and take the necessary action for proper management of those municipal solid waste. They shall also endeavor to perform the management work efficiently by improving the ability of the management personnel, consolidating disposal facilities and developing operation techniques.
Businesses	Article 3	The businesses shall appropriately manage of the waste left as a result of their business activities. The businesses must endeavor to reduce the amount of waste by recycling or re-use of waste. The businesses shall assess the handling or processing difficulty of the waste generated when the products, their containers or whatever they manufacture, process and sell the like are discarded. They shall develop such products, containers or the like which are unlikely to present handling or processing difficulty, provide information on appropriate management of the waste generated when the products, their containers or the like are discarded, or take some other actions to ensure appropriate management of the said products, containers or the like without difficulty. In addition to the preceding duties in this Article, the businesses shall cooperate with the central government and local governments in their activities to reduce waste, ensure appropriate management and so on.
Citizens	Article 2 4	The citizens shall cooperate with the central government and local governments in their activities for waste reduction by restricting their waste discharge, using recycled articles or otherwise contributing toward the recycling and re-use of waste, sorting waste prior to discharge, managing of waste by themselves as far as possible and so on.

Source: Waste Management and Public Cleansing Law (1970)

The *Basic Act for Establishing a Sound Material-Cycle Society* sets out in Article 12 the responsibility of citizens, in Article 11 the responsibility of businesses, and in Article 9, 10 the responsibility of the central and local governments.

Table 3-5 The Responsibilities of Government and Waste Dischargers Stipulated in the Basic Act for Establishing a Sound Material-Cycle Society

Government Businesses Citizens	Act	Responsibility
Central Government	Article 9	The central government shall be responsible for formulating and implementing basic and comprehensive measures for the formation of a recycling-based society in accordance with the basic principles for the formation of a recycling-based society set forth in Articles 3 to 7 inclusive (hereinafter referred to as the "Basic Principles")
Local Government	Article 10	Local governments shall, in accordance with the Basic Principles, implement the necessary measures to ensure that Recyclable Resources are used and disposed of in an appropriate manner, and shall also be responsible for formulating and implementing measures for the formation of a sound material-cycle society in accordance with the natural and social conditions of the area of the local government, based on an appropriate sharing of roles with the central government.
Business	Article 11	Business Operators shall, in conducting their business activities in accordance with the Basic Principles, take necessary measures to prevent Raw Materials, etc. from becoming Wastes, etc. in their business activities, and, in the case where Raw Materials, etc. become Recyclable Resources in their business activities, they shall be responsible for making their own appropriate use of the Recyclable Resources or taking necessary measures to ensure that the Recyclable Resources are used appropriately. (2) A business operator shall have the responsibility to take necessary measures to ensure that Raw Materials, etc. become Recyclable Resources in the course of its business activities, or to dispose properly of Recyclable Resources that are not used in a recycling manner on its own responsibility. 2 Business operators engaged in the manufacture, sale, etc. of products, containers, etc. shall, in accordance with the basic principles, take necessary measures to improve the durability of products, containers, etc., enhance the system for repairing them, and otherwise take necessary measures to prevent such products, containers, etc. from becoming waste, etc., when conducting their business activities. Business Operators shall be responsible for devising the design of the Products, Containers, etc. and labeling the materials or components of the Products, Containers, etc. and for taking other necessary measures to promote the proper recycling of the Products, Containers, etc. that have become Recyclable Resources and to ensure that the proper disposal of the Products, Containers, etc. does not become difficult. 3 In addition to what is provided for in the preceding paragraph, it is necessary for the national government, local governments, business operators, and citizens to appropriately share the roles of products, containers, etc., when they become recyclable resources, in order to properly and smoothly utilize them in a cyclical manner. With respect to products, containers, etc. for which the role to be played

Government Businesses Citizens	Act	Responsibility
		by the business operator is recognized to be important in promoting the formation of a recycling-based society from the viewpoint of design and selection of raw materials for the products, containers, etc., and collection of products, containers, etc. that have become recyclable resources, the business operator that manufactures, sells, etc. the products, containers, etc. shall, in accordance with the basic principles. In this case, the business operator that manufactures, sells, etc. the products, containers, etc. shall, in accordance with the basic principles, be responsible for taking back or delivering the products, containers, etc. that have become recyclable resources, or utilizing them in an appropriate manner, as a role to be shared by the business operator. 4 With regard to circulative resources for which it is technically and economically feasible to use them in a sound material-cycle manner, and for which it is recognized that it is important to promote the sound material-cycle use in order to promote the formation of a sound material-cycle society, business operators who are able to use such circulative resources in a sound material-cycle manner shall have the responsibility to use them in a sound material-cycle manner appropriately when they conduct their business activities in accordance with the basic principles. 5 In addition to what is provided for in the preceding paragraphs, business operators shall, in accordance with the basic principles, endeavor to form a sound material-cycle society by using recycled products, etc. in their business activities, and shall be responsible for cooperating with the measures implemented by the central or local governments concerning the formation of a sound material-cycle society.
Citizens	Article12	In accordance with the Basic Principles, the citizens have the responsibility to reduce the amount of Products, etc. that become Wastes, etc. by using them for as long as possible, using recycled products, and cooperating in the separate collection of recyclable resources, and to endeavor to promote the proper recycling of Products, etc. that have become recyclable resources, as well as to cooperate with the measures taken by the central and local governments for the proper disposal of such products. 2 In addition to what is provided for in the preceding paragraph, with regard to the Products, Containers, etc. prescribed in paragraph 3 of the preceding Article, the citizens of Japan shall be responsible for cooperating with the measures taken by the business operators prescribed in the same paragraph by, in accordance with the basic principles, appropriately delivering the Products, Containers, etc. that have become recyclable resources to the business operators prescribed in the same paragraph. 3 In addition to what is provided for in the preceding two paragraphs, citizens shall be responsible for making their own efforts to form a sound material-cycle society in accordance with the basic principles and for cooperating with the measures for the formation of a sound material-cycle society implemented by the central or local governments.

Source: Basic Act for Establishing a Sound Material-Cycle Society (2000)

The roles of citizens, businesses, and government are set out in a municipal waste management basic plan made by the municipalities in order to carry out the planned measures efficiently according to the basic policies set out in the basic plan. Examples are shown below of the roles of citizens, businesses, and government in the municipal waste management basic plans of Shibushi City (population: approx. 30,000 as of October 2015).

"Aim for a Zero-waste Emission Society"

1 Basic Responsibilities and Roles of Citizens, Businesses, and the City Administration.

(1) Present Status and Issues

From the year 2000 separate collection of sorted waste for recycling commenced, followed by separate collection of sorted kitchen waste from 2004, and as a consequence the lifetime of the final disposal site has been extended.

Sorting and separate collection of recyclables have become established but there are still cases where some unsorted waste is being disposed as landfill waste. It is necessary to make more efforts to strengthen the information and guidance system in order to prevent the disposal of recyclables at the final disposal site.

Furthermore, measures such as surveillance, guidance, and treatment need to be taken promptly to resolve the issues of illegal waste dumping, littering, and scattered waste.

(2) Basic Direction

Citizens, businesses, and the city will fulfill their respective responsibilities and roles throughout the stages of products manufacturing, distribution, consumption, and disposal of the waste generated in these stages, and work together to reduce waste, as well as to recycle and reuse resources.

A The City's Basic Responsibilities and Roles

(a) In order to appropriately respond to the diversified types of waste, set up and operate a sorting and separate collection and transport system that is stable, efficient, and reliable.

(b) Provide, or ensure the provision of intermediate treatment facilities, recycling facilities (for kitchen waste, human waste), and cleaning center recycling equipment to treat or reuse waste in a quick and sanitary manner.

(c) Arrange environmental education for citizens and businesses, and raise public awareness on minimizing waste generation and recycling, and assist related voluntary activities.

(d) Adopt a procurement policy based on the *Act on Promoting Green Purchasing*, and promote effective use of resources.

(e) Formulate a separate collection plan based on *Containers and Packaging Recycling Law*, and continue to work to improve the sorting guidance system.

(f) While maintaining the designated garbage bag system, the city is considering the possibility of charging fees for business-related recyclables and a revision of fees charged for business related general waste, aiming for waste recycling and amount reduction.

(g) In order to respond to illegal dumping and littering, plan a guidance system for various groups and for citizens, and a cooperation system for relevant organizations, together with strengthening environmental patrols and supporting volunteer activities.

B Businesses' Basic Responsibilities and Roles

(a) Limit the manufacture of disposable products and excessive use of packaging, and use returnable containers. Work to minimize waste generation at the various stages of product development, manufacture, and distribution.

(b) Cooperate with the basic plan set up by the city, by thorough sorting of waste, work to reduce the waste amount generated and to recycle, and also procure recycled products using resources effectively.

(c) Take responsibility to treat waste resulting from business activities properly.

(d) For food waste produced during business activity, when possible, make compost or feed stock with a treatment machine and when self-treatment is not possible manage the waste in accordance with the City's basic plan.

(e) For products that inevitably become waste, make efforts to develop these products so that they can be properly disposed.

(f) Always use designated business waste bags.

(g) Cooperate with fees charged on industrial waste.

(h) Take part proactively in volunteer work, and also participate in city beautification projects.

C Citizens' Basic Responsibilities and Roles

(a) Limit the use of disposable products, cooperate with lite-packaging and non-packaging, use returnable containers, make long-term use of products, and in other ways work to minimize waste generation.

(b) A slogan says, "What is sorted is a resource, what is mixed is a waste", and citizens should respect the basic plan contents to neither burn nor bury waste. Instead, citizens should thoroughly sort their waste, work to reduce generation of waste and make more efforts in recycling. They should proactively join in volunteer activities, and take part in city beautification activities.

(c) Treat kitchen waste at homes and cooperate in minimizing waste generation.

(d) Promote the effective use of resources by procuring reusable products.

(e) Waste stations are managed by the hygiene unit of each residents association. Citizens join the self-governing association set up in their area of residence, and together with the other members, manage waste disposal, waste stations, etc.

(f) Citizens discharge their waste to the designated waste station, at the designated collection day and time, participate in the joint waste sorting at collection at the waste station, strictly observe the rules set up by the association at each station and cooperate together for the successful operation of the waste station.

(g) Always use the designated household waste bag.

(h) Cooperate in elimination of offences, and take prevention measures against illegal dumping, waste scattering and littering.

(i) Volunteer to attend study meetings to learn about the environment and better understand about waste treatment.

Source: Shibushi City "Shibushi City General Waste Management Basic Plan" (2016)

1.6 Residents Participation and Consensus Building

(1) Residents Participation in Waste Administration

In order to establish proper waste management systems, it is important for residents, business operators, and governments to understand their respective roles, and for the three parties to work together as one.

The governments' roles are extremely important. Governments must provide opportunities for exchanging opinions and ensure an environment for continuous communication with residents and business operators. Communication based on the disclosure of all information is extremely effective in venues for exchanging opinions.

If plans are created based on the opinions of residents and business operators, governments can plan and implement highly feasible initiatives that are understood by the residents and business operators, and encourage them to take specific actions in accordance with the plans.

Proper waste treatment depends on the cooperation of residents in properly sorting and discharging waste. Each municipality clarifies the roles of residents, business operators, and the government in its ordinances and basic plans, and stipulates what each of them should respectively do.

As an example, Table 3-6 shows the efforts required of each of residents, businesses, and Ota City municipality to reduce plastic waste, which is one of the priority policies indicated in the Ota City Municipal Waste Treatment Basic Plan (2021). In this plan, the action guideline for residents is to try to refuse or reconsider the excessive or unnecessary use of plastics, and the action guideline for businesses is to try to purchase products that can be used instead of plastics and to reconsider the use of disposable plastics. Concrete examples of these required efforts are also described. The plan also provides examples of efforts the municipality needs to make to promote actions by residents and businesses, such as the development of a 3R promotion campaign.

Thus, in order for residents, business operators, and municipalities to collaborate and take specific actions, it is necessary for municipalities to engage in discussions with the other parties and seek their opinions, and then prepare municipal plans for waste management and the environment that set out the respective roles and efforts of all three parties.

Table 3-6 Roles and Efforts of Residents, Business Operators, and Ota Municipality set out in the Ota City Municipal Waste Treatment Basic Plan

Entity	Action guideline /efforts	Details
Residents	Action guideline	Try to refuse or reconsider the excessive or unnecessary use of plastics
	Specific efforts	・Gather information on concrete methods to reduce plastic waste. ・When shopping at convenience stores (e.g., for take-out meals), refuse disposable plastic spoons, forks, etc. (except when the intended use is for hygiene purposes). ・Bring own bottles, straws, chopsticks, etc. when going out. ・Bring own bag and refuse unnecessary plastic bags. ・Choose glass bottled and canned beverages whenever possible.
Business operators	Action guideline	Try to purchase products that can be used instead of plastics
	Specific efforts	・When purchasing equipment and supplies, try to choose products that are plastic-free or products with recognized environmental performance, such as biodegradable or biomass plastics. ・Use water servers and personal cups. ・Reconsider the use of disposable plastic products at events.
Restaurant	Action guideline	Try to reconsider the use of disposable plastics
	Specific efforts	・Serve food in containers that can be used multiple times or in non-plastic containers. ・Stop using disposable tableware and use reusable items.
Municipalities	Specific efforts	・Teach resource recycling classes (environmental education) to promote collaboration ・Develop a 3R promotion campaign ・Conduct activities to promote and raise awareness at events ・Promote initiatives to reduce plastic waste ・Create a mechanism to promote reduction of plastic waste ・Examine new methods for plastic recycling

Source: Ota City “Ota City Municipal Waste Treatment Basic Plan” (2021).

(2) Environmental Education and Public Awareness Activities in Municipalities

In order to promote environmental conservation activities and environmental education, governments must create environmental education programs with content tailored to target audiences, disseminate information that is highly relevant to communities, and develop human resources for environmental education to provide opportunities for environmental education that people of all ages can take an interest in and enjoy putting into practice.

Given the increasing need for environmental conservation activities and cooperation among municipalities, business operators, and private organizations in promoting growth with the environment at the center, and to further enhance environmental education that leads to the development of people with a wealth of humanity, the *Act on the Promotion of Environmental Conservation Activities through Environmental Education* was promulgated on June 15, 2011 and came into full effect on October 1, 2012. The act specifies a framework for promotion by municipalities, enhancement of environmental education in schools, participation of private organizations and promotion of collaborative efforts in environmental administration, and more for the creation and utilization of a wide range of pragmatic human resources who are essential for promoting environmental conservation activities and environmental education.

As an example, Table 3-7 shows the environmental programs objectives and content for each target age group implemented in Yokohama City, and Table 3-8 shows examples of environmental programs for different courses. In Yokohama, the content of environmental education is devised according to the target age group (e.g., nursery school and preschool, elementary school, junior high and high school). In addition to visiting schools to give lectures, city officials also offer courses involving facility tours and the like.

Tailoring the content to the target age group in this way makes environmental education more interesting and enjoyable. Environmental issues that are familiar to residents should be taken up as themes of the courses to encourage residents to take specific actions and put what they have learned into practice on a daily basis.

To institutionalize environmental education in schools, it is essential to cooperate with the organizations in charge of school education (boards of education in the case of Japan).

Table 3-7 Targets, Objectives and Content of Environmental Education in Yokohama City

Target	Objectives and content
Nursery schools and preschools	Keep talks short, use picture cards or the like to make things easy to understand, and incorporate activities to keep children focused and engaged. Additionally, use mascot costumes, actual waste collection vehicles, and other props to help children develop a sense of familiarity with environmental issues and to foster awareness that drives them to take action in their daily lives.
Elementary school	Create opportunities for students to acquire basic knowledge about environmental issues and think about the actions needed to solve them. Then, help students develop awareness of environmental consideration (e.g., attitudes toward creating sustainable societies, sensitivities, kindness and compassion) that drives them to take action in their daily lives.
Junior high school, high school, university	Help students steadily acquire basic knowledge and correct information. Additionally, create opportunities for students to confront environmental issues and take action to solve them while helping them understand the similarities and differences in each other's ways of thinking through dialogue and discussion.
Communities and business operators	In some cases, failure to sort waste or mismanagement of collection points have caused problems in local communities; therefore, it is important for each and every person to act with awareness regarding the environment and beautification of their communities. Neighborhood association meetings and briefings for residents are examples of events that can be used to help people learn about these things.

Source: Yokohama City "Environmental Education Program" (2020)

Table 3-8 Example Themes of the Environmental Education Program in Yokohama City

Course Theme	Programs
Reducing Food Loss	Basic course: Understanding the Circumstances and Basics of Food Loss Elective: Interactive Study of Food Circulation through Composting Kitchen Waste and Growing Food Elective: Study of Waste-Free Food Preparation and Preservation Elective: Efforts by Society and Companies
Plastic Countermeasures	Basic course: Understanding the Basics of Problems with Plastic Waste Elective: Plastic in Society Elective: Microplastics Elective: Companies' Efforts Involving Plastic
What Happens to Waste	Basic course: Understanding the Flow of Waste Treatment Elective: A Full Day's Waste Collection Work Elective: Seeing/Touching a Waste Collection Vehicle Elective: How Resource Sorting Centers and Incineration Plants Work
Sorting and Recycling Waste	Basic course: Understanding the City's Sorting Rules Elective: Let's Try Sorting (Sorting Game) Elective: Efforts for Thorough Sorting Elective: Group Work: What We Can Do

Source: Yokohama City "Environmental Education Program" (2020)

Photo 3-1 Storytelling about the Environment Around us (Nursery schools and preschools)

Photo 3-2 Explanation of the Structure of the Collection Vehicle

Photo 3-3 Workshop to Confront Environmental Issues (Junior High School, High School and University Students)

Photo 3-4 Briefing Session for Residents Regarding the Cleaning of their Local Area (Local Residents)

Source: Yokohama City “Environmental Education Program” (2020)

The fact that these programs are designed to meet the needs of people of all ages, and that sustainable environmental education is rooted in local communities greatly contributes to the formation of consensus among local residents, as explained in the following pages.

(3) Methods for Building Consensus among Residents in Facility Development

1) Relationship between Governments and Residents

When waste treatment plants and landfill sites are constructed in Japan, the construction work does not start until sufficient time has been taken to explain the project to residents and gain their understanding.

Some local governments also provide explanations to residents during the construction if necessary, and continue to communicate with residents even after plants and sites are in operation. Ensuring opportunities for residents and governments to exchange opinions about impending facility or plant construction and engaging in ongoing communication in this way makes it less difficult to gain residents' understanding about waste management performed by governments. Furthermore, if good relationships can be sustained, residents are likely to become more cooperative and better educated about the project and waste management.

To build good relationships between governments and residents, it is important for both sides to understand how their respective views differ; residents should make efforts to understand the governments' explanations, and on the other hand governments should anticipate residents' questions and concerns and prepare responses accordingly.

When constructing waste treatment plants or landfill sites, it is essential to consider residents living near the planned locations of the plants and sites. Opposition from local residents or environmental groups could arise if sufficient consideration and explanation are not given to them, hindering the progress of projects.

The types of residents who oppose construction can be classified as confrontational, conditional, active, and cooperative as shown on Table 3-9, however, most conflict is caused by the confrontational type, who behave emotionally and aggressively and stand in total opposition to the construction.

Table 3-9 Residents Perspectives and Behavior by Types of Opposition

Type	Residents' perspective	Residents' behavior	Characteristics
Confrontational	Total opposition, complete revocation	Emotional, aggressive	Many conflicts stem from this type of relationship, and in the event of violent conflicts, resolution may be sought in court
Conditional	Conditional agreement	Petitioning, demanding	If residents essentially have no option but to accept the construction, they will try to resolve the conflict under conditions advantageous to them
Active	Basically opposed	Make efforts to resolve the conflict	Residents opposed to construction hold seminars and collaborate with other opposition groups while presenting alternative proposals to the government
Cooperative	Basically opposed	Make efforts to engage in cooperative discussion	The government seeks engagement from local residents, members of the general public, and academics in an effort to resolve problems

Source: Toru Furuichi, Kyoritsu Shuppan Co., Ltd. "*Haikibutsu keikaku sakutei to jumin goi* (Formulation of waste plans and consensus with residents)" (2000)

Table 3-10 presents a systematic classification of common reasons for residents' opposition to the construction of waste treatment plants and landfill sites. Reasons for opposition among residents who are categorically opposed or distrustful of the government are rooted in their fear of pollution and adverse effects on their own health; these residents identified the insufficiency of assessments, one-sided explanations, and the lack of clarity as to the reasons for site selection among the causes of complications. In the process of gaining the understanding and cooperation of residents, explanatory meetings on facility development, public inspection of assessment reports, and public hearings are held, but in many cases these meetings are informal and do not function sufficiently, and mismatches between what residents want to know and say and how operators respond create dissatisfaction and opposition among residents. Additionally, whenever things become contentious between the governments and residents, residents of all types likely become distrustful of the government. In these cases, the lack of common ground and opportunities to talk things over are issues to overcome in order to solve the problems.

The realistic course of action for building consensus to move ahead with facility development is to make efforts to shift residents who are categorically opposed or distrustful of the government into other opposition categories that may be resolvable (e.g., concerned about pollution and health problems, seeking compensation). In order to achieve this, both governments and residents must make efforts to understand each other, and must seek common ground through discussion to reach agreements. When doing so, it is necessary to recognize that governments' perspectives differ widely from residents' perspectives. It is also important for residents to listen to explanations from governments and try to understand them, and for governments to anticipate residents' questions and concerns and prepare responses accordingly.

Table 3-10 Reasons for Residents Opposition by Types (as Related by Residents)

Type	Reasons for residents' opposition	Factors behind the intractability of the conflict	Examples of issues to consider
Categorically opposed	• Residents consider waste treatment plants and landfill sites to be smelly and dirty, and they generally have a bad impression of these facilities	• Inadequate pollution control in the past causes residents unable to help but hate these facilities or view them as unwanted	• Enhancement of pollution control facilities in the project • Amenitized facilities
Distrustful of the government	• Decisions were made without residents' knowledge • Residents feel that unnecessary waste treatment plant or landfill site is being forced upon them while they are hardly receiving any other government services on a daily basis • They feel that the government will not keep their promise to control pollution or install facilities nearby • The government reneged on their promises and plowed ahead with the construction in the rush to get the waste treatment plant or landfill site up and running • The government only talks about things that appear easy to agree upon	• There are no opportunities to talk things out • There is no common ground	• Appropriate timing and content of information disclosure to residents • Provide sufficient government services on a daily basis • Disseminate about waste-related problems and the need for waste treatment plants and landfill sites, etc. • Plans that fully reflect the views of local residents
Concern about pollution and health problems	• Residents fear that pollution control facilities will be inadequate, or will create pollution or adverse effects on health • An environmental assessment either was not conducted, or was insufficient and did not provide any proof with regard to absence of pollution or adverse effects on health	• The waste treatment plant or landfill site is the largest source of anxiety for residents. Governments may not have the capacity to provide full explanation	• Revise/enhance pollution control facilities • Enhance environmental assessments

Type	Reasons for residents' opposition	Factors behind the intractability of the conflict	Examples of issues to consider
Concern about site selection	• Residents feel that reasons for the selection of the site are unclear, and that the selection process is not transparent • The government does not provide clear answers to simple questions put forward by the residents (e.g. why the waste treatment plant or landfill site has to be near their house or in that location)	• Site selection methods have not been established	• Clear positioning of the site in municipal comprehensive plans and city planning • Make recovery facilities attached to the project beneficial to the entire community (e.g. thermal utilization) rather than just to compensate residents nearby for the project inconvenience
Seeking compensation	This is rarely the main reason for opposition to the construction of waste treatment plants or landfill sites. Also, residents in this category are different from those who seek conditional agreement from the start. When the conflict draws to a close, residents in this category always shift toward fighting over the conditions.		
Protective of their hometowns	• Residents cannot accept that an outsider (even if the government) can simply come into their beloved communities and change them	• Rigidly uniform response	• Develop waste treatment plants and landfill sites that are highly relevant to communities
Concerned about personal interests	• Land values will fall if the waste treatment plant or landfill site is constructed • Neighbors sold their land for higher prices	—	To ensure that land values do not fall: • Construct state-of-the-art waste treatment plants and landfill sites (facilities that offer amenities) • Consider facilities that give back in ways the community finds desirable

Source: Toru Furuichi, Kyoritsu Shuppan Co., Ltd. "*Haikibutsu keikaku sakutei to jumin goi* (Formulation of waste plans and consensus with residents)" (2000)

2) Residents Participation

It is important for governments considering and implementing plans and projects to reflect the opinions of residents at every stage of the process: basic plans, potential site selection, environmental impact assessments, and facility development plans. Additionally, governments must involve residents (including foremost those who oppose the facilities) as early as possible from the initial planning stage to create opportunities for exchanging opinions and to maintain transparency in information disclosure.

When exchanging opinions with residents, it is often effective to involve a neutral party capable of listening to the opinions of both residents and governments. In these cases, academics can fulfill the important role of bridging gaps between residents and governments.

Governments are expected to communicate appropriate information and understand residents' needs and thinking and reflect them in project plans; thus, resident participation is essential for creating opportunities for this to happen. Table 3-11 is a categorization of methods of resident participation in terms of factors such as degree of participation and power to make planning decisions. Regarding resident participation, it must be noted that circumstances differ from region to region in terms of the natural environment, land use, culture, history, political climate, the history of the relationship between governments and residents, and other factors.

One effective way to involve residents in solving the problems at hand is to establish committees comprising government representatives, academics, and residents. There are many advantages of the committee method of resident participation, including communication (governments and residents have the opportunity to communicate their thoughts to each other), assurance of consensus (matters decided by committees are guaranteed for residents through the conclusion of agreements and the like), and well defined responsibility (governments are guaranteed basic decision-making authorities regarding construction, operation and management of facilities, which makes it easier for the governments to fulfil their responsibilities). On the other hand, the representatives who are representing the residents need to be carefully selected to reflect the collective will of the residents.

The key point here is that the members of these committees include academics who are capable of listening to the opinions of both governments and residents. They do not necessarily need to be experts, but can participate as communicators and facilitators, thereby helping the committees run smoothly.

Table 3-11 Methods of Resident Participation in Terms of Degree of Participation, Power to Make Planning Decisions, etc.

Degree of resident participation	Categorization in terms of power to make planning decisions	Methods of resident participation (examples)	Relationships with residents/issues to consider
Low	Planning decisions made by the government only	・ Participation in briefings for residents ・ Participation in plant tours	・Passive ・ One-sided communication of information ・Few opportunities for reflection of residents' wishes
↓	The government takes the lead in making planning decisions (Councils, etc.)	・Participation in public hearings ・ Public inspection of city planning proposals and assessment documents/submission of written opinions	・Passive, indirect ・Residents' wishes can be reflected somewhat indirectly ・The government has the authority to make decisions that reflect the wishes of residents
High	Planning decisions are made by the government and residents together (Committees, etc.)	・ Residents have representatives on steering committees and the like ・Residents participate in meetings for dialogue and the like	・Two-way communication between residents and the government is possible ・ Residents are represented by representatives, who may not always represent the collective will of the residents. (Representative selection is also an issue) ・ Essentially, decision-making authority rests with the government. Matters decided by committees are implemented based on mutual trust between the government and residents.

Source: Toru Furuichi, Kyoritsu Shuppan Co., Ltd. "*Haikibutsu keikaku sakutei to jumin goi* (Formulation of waste plans and consensus with residents)" (2000)

Table 3-12 shows examples of what committees discuss during each stage of the project planning. During the basic plan stage, it is especially important to discuss and clarify the rules, procedures, and schedule for determining site selection matters. Residents require governments to provide objective explanations of the reasons for site selection.

Table 3-12 Examples of Committee Items of Discussion at Each Stage of Project Planning

Planning Stage	Items of Discussion
Basic plan stage	・Project overview/policy ・Consideration of ideal state of waste treatment, waste reduction, recycling ・Consideration and selection of site selection policy ・Consideration of environmental conservation measures, implementation of Initial Environmental Examination ・Investigation and consideration of surrounding environment development, facilities that give back to communities, use of former sites
Development/ implementation plan stage	・Consideration of facility design details (especially for pollution control facilities) ・Evaluation/consideration of environmental assessment ・Roles of governments and the private sector ・Consideration of specific measures for waste reduction and recycling ・Recommendations to create residents organization against facility management, and drafting of agreement with local residents ・Consideration of various problems during the construction period ・Consideration of environmental monitoring and surveillance methods
Facility operation stage	・Implementation of discussion details (recommendations) ・Revisions to plant facilities ・Government-run system for monitoring private contractors ・Measures to be taken when allowable standards are exceeded, complaint processing methods/measures to be taken in respond to damages ・Publicizing of pollutant measurements results ・Revisions to waste collection areas/incoming and outgoing transport routes

Source: Toru Furuichi, Kyoritsu Shuppan Co., Ltd. "*Haikibutsu keikaku sakutei to jumin goi* (Formulation of waste plans and consensus with residents)" (2000)

At the stage of creating a high-level plan for waste management, it is crucial to incorporate the significance and roles of future waste management in their region and to obtain the residents' consensus on the planning direction. Importantly, it is necessary to continuously implement solid waste management with the participation of residents on a daily basis. One way to gain residents' understanding is to involve them from the planning stages and to work together to create the master plan.

If the government's wishes and decisions are absolute, and residents are continually forced to accept the government's unilateral decisions, they will feel anxious and distrustful. Therefore, fair disclosure of information - including negative information, not only information that is convenient for the government - helps to increase trust between the two parties. It is important to create common ground for consensus building in this way and to convince people to agree on both the good and the bad aspects. The conditions shown in Table 3-13 should be met toward that end.

Table 3-13 Creating a Level Playing Field for Facility Site Selection

Item	Details	Relevant, specific countermeasures
Briefing	・The purpose, methodology, and expected benefits of, and possible accidents and discomforts associated with the facilities are explained to residents	・Daily communication ・Hold public hearings and briefings for residents ・Establish systems for information disclosure ・Provide opportunities for residents participation (e.g. committees)
In response to negative information	・Risks and benefits are balanced from residents' viewpoints	・Establish facilities that communities can accept (power generation, thermal utilization, regional development, regional revitalization, local recreational areas, environmental education)
	・Efforts are being made to minimize risks to the extent possible ・Even if agreements have been reached, efforts must be made to make the facility as best as possible	・Enhance pollution control facilities ・Conduct thorough environmental assessment ・Establish systems for monitoring and information disclosure ・Conclude pollution control agreements
Agreements	・In principle, residents have the right to refuse, and to request suspension of projects if they anticipate significant disadvantages in the interim stages ・Even if agreements have been reached, responsibility for dealing with problems rests with the government, not residents ・Residents must not be treated unfairly, even if they reject the project	・Create opportunities for residents participation (e.g. committees), respect minority views ・Agreement and a checking mechanism by committees at each stage of planning ・Conclude pollution control agreements and the like ・(Disclose monitoring results and other information, monitor plant and conduct inspections with residents present, establish a liaison for receiving complaints, countermeasures/compensation in response to damage)

Source: Toru Furuichi, Kyoritsu Shuppan Co., Ltd. "*Haikibutsu keikaku sakutei to jumin goi* (Formulation of waste plans and consensus with residents)" (2000)

Column: A Case of Risk Communication with Residents (Illegal Dumping in Mie Prefecture)

The Situation

In 1994, concerns about soil contamination and groundwater pollution surfaced after an industrial waste landfill site in the city of Yokkaichi, Mie Prefecture had greatly exceeded the permitted area and amount of waste disposal, and had disposed of waste other than the permitted waste materials.

In 1980, a waste disposal contractor obtained a disposal business license and started landfill disposal. The following year, 1981, the contractor applied for a permit to change its industrial waste disposal business (increasing the number of landfills the contractor operated and types of waste materials disposed). The application was based on a landfill owned by another company. The contractor then started operations using a stable final disposal site. In 1988, the then local district mayor submitted a written request to the prefectural government requesting an investigation into the actual conditions of excessive waste disposal, etc., and the prefectural government requested the contractor to submit a notification of change after conducting an investigation into the current conditions. In 1990, the contractor submitted a change notice regarding the large scale of expansion of the structure (facility), which was accepted by the prefecture. As the illegal expansion continued even after the change notification was submitted, the prefecture continued to supervise and instruct the contractor. After that, the prefecture directed the contractor to carry out a topographical survey of the disposal site, and the result of survey showed that the site area and capacity far exceeded those defined in the permit issued to the contractor. The prefectural government then did not allow the contractor to renew the permit after the disposal site permit expired (October 1994).

After the problems were discovered, the prefectural government initiated a safety confirmation survey. However, the residents' dissatisfaction with the prefectural government increased, as it gave the impression of ignoring them by prioritizing explanations to the prefectural assembly over explanations to residents, from the survey plan and interim announcement to the final announcement of the basic policy.

In response, the prefecture started risk communication with residents in 2008. Since then, the relationship between the prefecture and residents has changed from one of confrontation to one of collaboration.

(Risk communication: It is a method for stakeholders to exchange and share information and opinions on possible risks such as pollution of the living environment when constructing waste treatment facilities, etc., and to share awareness of prevention and countermeasures, aiming for mutual understanding.)

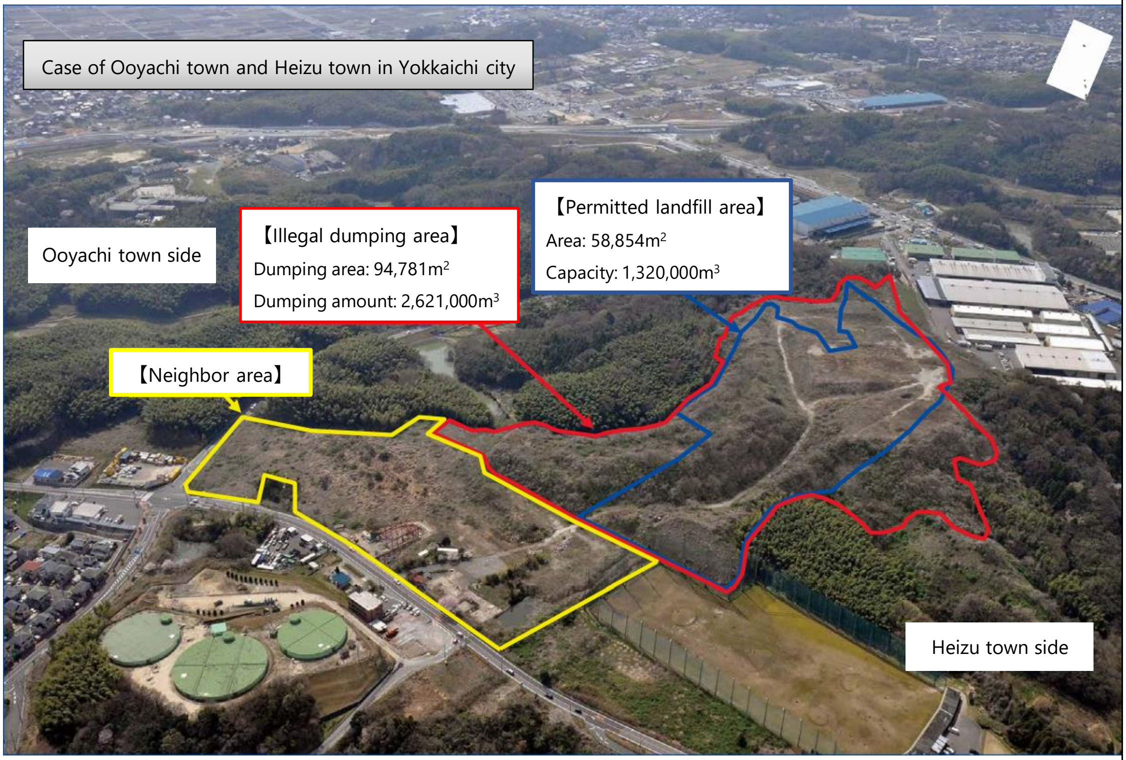


Photo 3-5 Aerial View of the Site where Illegal Dumping Occurred

<u>The Response</u>

1. Residents Participation from the Survey Phase

As described hereafter, the prefectural government proceeded with the survey with a recognition of residents as important stakeholders, and with respect for their opinions.

1. In response to residents' requirements for the survey, the government made adjustments such that waste-generating entities pay for additional surveys
2. The government responded to residents' requests for a new analytical entity to analyze material feed at survey sites
3. The government accepted residents' request to have third-party experienced academics evaluate the analysis results
4. The government selected survey sites of interest to residents

Key Point

●Given the importance of sharing current risks and straightforwardly communicating them to residents, the government held lectures for residents on risks and risk communication before conducting the new survey. This helped residents and the government develop a common understanding of the risks.

2. Risk Communication through Four-way Discussions

The safety confirmation survey revealed that standards were greatly exceeded in some cases of pollutants, and some values were far off the results of the safety confirmation survey conducted previously. Based on the results, the prefectural government set up a three-way discussion comprising itself, resident representatives, and academics (which later became a four-way discussion with the participation of the Yokkaichi municipal government), and followed the procedure listed below to engage in constructive, interactive risk communication to ensure residents' safety and security in a sustainable manner.

1. Resident representatives and the prefectural government met to identify the main issues to be discussed so that the government could develop an understanding of residents' opinions and needs
2. The issues discussed in the previous step were reviewed by a group of academics
3. Resident representatives and representatives of the academics discussed the results of the review conducted in the previous step
4. Under the four-way format the participants held thorough discussions
5. The academics' views and the prefectural government's policies were explained at four-way discussions that were open to the general public

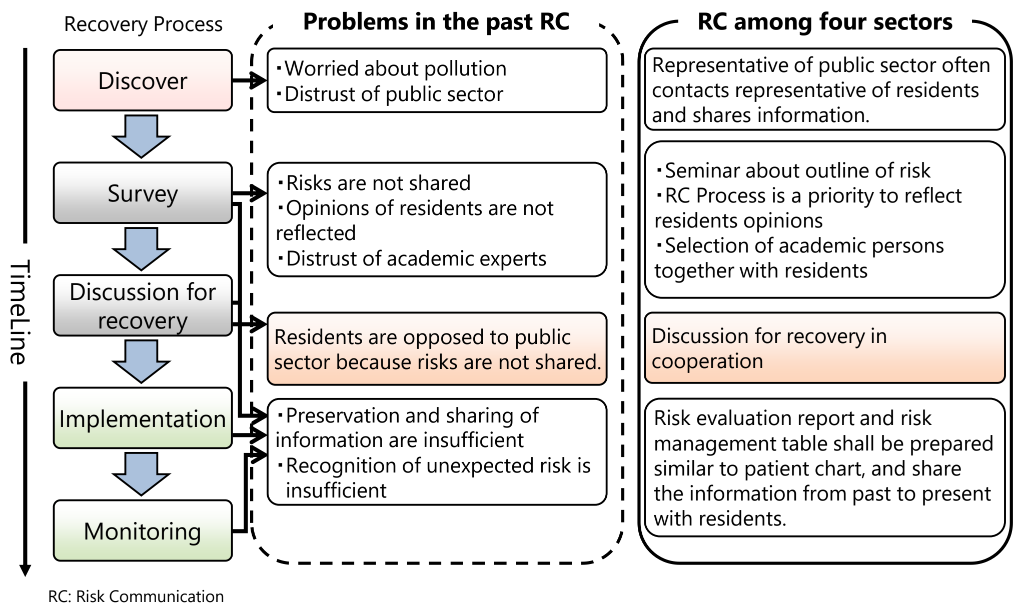
Key Points

- The residents participated in the selection of the academics, and local academics were appointed as coordinators. Accordingly, the academics gained the residents' trust, and functioned as neutral parties the residents found easy to consult with.
- The residents were given ample opportunities to speak, and the academics examined the issues they raised and exchanged opinions with them. The main opinions and agreements were recorded in risk assessment and risk management matrices that served as the basis for a series of cycles of surveys and countermeasures. This made it possible to share risk information, increased the transparency of the decision-making process, and enabled the reflection of residents' opinions in decision-making.
- While preparing the risk assessment and risk management matrices, the levels and limitations of surveys and countermeasures were explained to the residents, and a system for managing risks involving uncertainty was established by determining that residents would be intimately involved in four-way discussions if unexpected events were to occur.

The Results

Discussions were held a total of 23 times from 2008 to 2021. Some of the items on which agreement was reached with local residents during the four-way discussions are listed below.

- Invite academic experts with expertise and knowledge on how to proceed with the consultation and hear their opinions
- The prefectural government should take responsibility for conducting the survey based on the "Draft Survey Implementation Plan".
- Prepare a "risk assessment table" to ensure safety and security, and proceed with future discussions based on this table (local request).
- The framework (frame) of the "Risk Assessment Chart"
- Basic agreement on the "draft framework of countermeasure construction methods" signed between the presidents of the neighborhoods and the governor.
- Specific Countermeasure Methods



Source: Mie Prefecture "What We Gained from Environmental Restoration Efforts in the Case of Improper Treatment of Industrial Waste" (2016)

Figure 3-5 Comparison of Past Cases of Risk Communication to Risk Communication in the Case of Mie Prefecture

2. Waste Management Utilizing the Private Sector with Private Finance Initiative (PFI)

2.1 Utilization of Private Sector Resources

Municipalities are responsible for the administration of municipal waste; therefore, they have directly managed the collection, transport, intermediate treatment, and final disposal of waste. Municipalities have outsourced waste collection and transport, or facility operation and maintenance, or other parts of waste management to the private sector in order to streamline processes or enable operations that require advanced technology, among other aims.

Amid the strain on the finances of local governments, there is a need to further utilize private-sector resources to provide economical, high-quality operation and maintenance services for waste management as well as other public services.

With the strain on finances, demographic changes, the diversification of citizens' needs, and other elements, municipalities are confronted with the need for more efficient fiscal management. Under these circumstances, more municipalities are adopting project methods that introduce private-sector resources, such as the private finance initiative (PFI, facilities privately constructed and operated) and design build operate (DBO, facilities publicly constructed, privately operated) formats, for developing projects to and operate waste treatment plants, since the enforcement of the *Act on Promotion of Private Finance Initiative* (*PFI Act*) in 1999 and the publication of Guidelines for Outsourcing with the Approach of Performance-Based Ordering by the Ministry of Land, Infrastructure, Transport and Tourism in 2001.

In 2006, the Ministry of the Environment compiled the Guide to Bidding and Contracting for the Construction of Waste Treatment Plants, etc. and proposed measures to improve bidding and contracting to ensure fairness and to increase competition and transparency. Regarding the method of placing orders for waste treatment plants, the guide states that it is "effective to introduce competition not only for the construction of waste treatment plants but for projects in total, including operation (comprehensive operation works including repair work), by using expanded performance-based ordering or PFI, which calls for price competition that incorporates long-term, comprehensive operation after construction is completed."

Name of act: Act on Promotion of Private Finance Initiative (PFI Act)
Enacted: 1999
Amended: Years 2001, 2003, 2005, 2007, 2011, 2013, 2016, 2018
Purpose: To develop social infrastructure efficiently and effectively and ensure the provision of good, affordable services to residents of Japan through measures such as promoting the development of public facilities and the like using private-sector funds as well as private-sector management and technical capabilities.

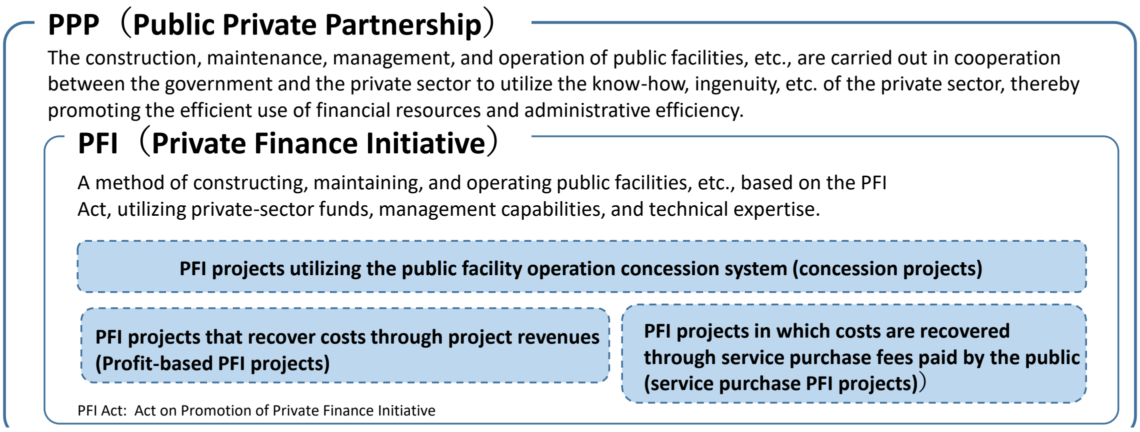
Source: Act on Promotion of Private Finance Initiative (1999)

2.2 Overview of PFI projects

Since laws have been enacted allowing the use of private sector resources, the utilization of the private sector in the development, operation, and maintenance of facilities has been promoted in the waste treatment sector as well for technical and financial reasons.

Public Private Partnership (PPP) occurs where government bodies that originally provided various services now cooperate with the private sector to carry them out. In this way, they use private sector's technology and knowhow, as well as it's originality and ingenuity, aiming at the efficient provision of state of the art services. PFI (Private Finance Initiative) is one type of PPP. PFI is one way of implementing public works, such as constructing facilities and their operation and management, using private sector finance and technical knowhow. The concept of PPP and PFI is shown in Figure 3-6.

In 1999, the *Act on Promotion of Private Finance Initiative (PFI Act)* was enacted. Since that time, besides provision of related laws and regulations, the basic direction and action plans for promotion of PFI have been formulated and the encouragement of PPP/PFI has been planned. As a result, PFI projects have been set up in many fields based on this law, and in order to plan and set up efficient projects related to building and operating waste treatment facilities the PFI method was adopted in this area too.



Source: Ministry of Land, Infrastructure, Transport and Tourism "Recommendations for public-private partnership projects (PPP/PFI)" (2020)

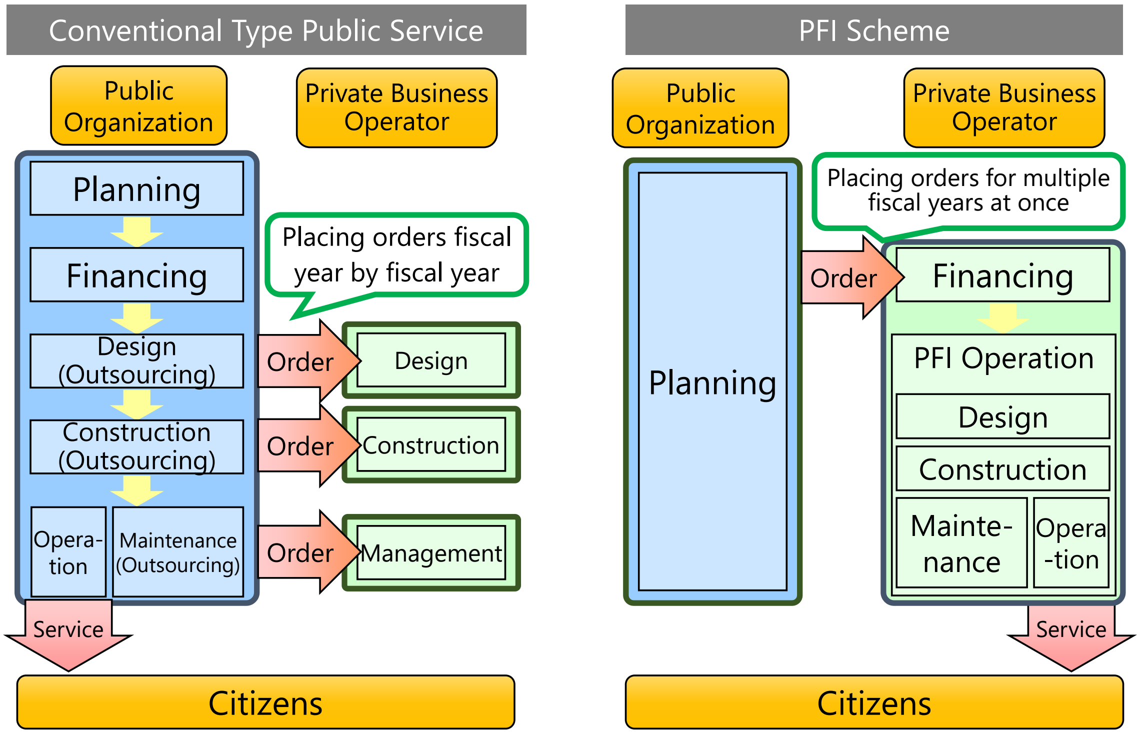
Figure 3-6 Concept of PPP and PFI

2.3 How PFI projects work

PFI projects can be divided into categories according to their content and scale, etc., and private sector resource use is planned to meet a specific local situation, after considering the characteristics and the expected effects of the PFI project.

Until recently, when a public facility was being developed as a public service, public authorities of local governments took the lead in formulating plans or projects. They then developed the public facility to provide the service by outsourcing designs or construction to a public authority or the private sector.

In place of this previous public service method, the introduction of PFI projects is being recommended to improve efficiency and financing. With PFI projects, after public bodies have formulated plans or projects, private sector technical capabilities are used. Work from design and construction to service provision is carried out as a unified whole. In addition to providing a good quality public service, private sector finance and management knowhow are used, and a low cost and economical government service is provided.

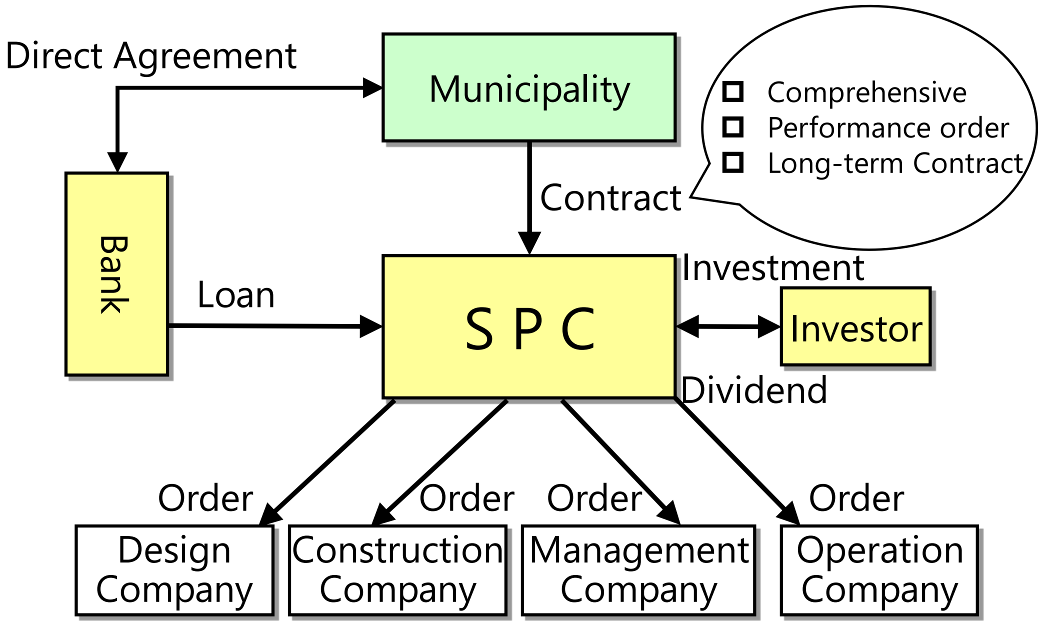


Source: Ministry of Land, Infrastructure, Transport and Tourism "Recommendations for public-private partnership projects (PPP/PFI)" (2020)

Figure 3-7 Flow of Conventional Public Works and PFI Projects

Special Purpose Companies (SPCs) are companies established to carry out one particular PFI project. SPCs use their earning power from the project as collateral to gain financing, using a funding method known as project finance, and they carry out the project by financing part of the construction and other costs by loans from financial organizations. Also, SPCs are compensated for the services they provide, being paid for construction funding and management costs by local governments.

In case the project does not proceed smoothly, the local government and the financial institution financing the SPCs will conclude a direct agreement that stipulates arrangements for the establishment and execution of security interests, withholding of the local government's right to terminate the contract, and consultation on business succession to a third party.



Source: Cabinet Office Website “Guide to the Introduction of PFI Projects: The Basics”
https://www8.cao.go.jp/pfi/pfi_jouhou/tebiki/kiso/kiso04_01.html (accessed February 8, 2022)

Figure 3-8 System of PFI Project

(1) The PFI Method

PFI projects are characterized based on the type of facility ownership. In addition to the privatized BTO (Build-Transfer-Operate), BOT (Build-Operate-Transfer) and BOO (Build-Own-Operate) models, there is the public-build-private-run DBO (Design-Build-Operate) model. Outlines of these models are shown in the following Table 3-14 and Table 3-15.

Table 3-14 Operating Entity and Owner by Project Format

Operation / Project format	Fund raising (construction expenses)	Design/ construction period	Launching of operation	Operation/ maintenance management	End of the project	After the end of the project
BOT	Private sector	Private sector	Private sector	Private sector	Transfer of ownership	Public sector
BTO	Private sector	Private sector	Transfer of ownership	Private sector	Public sector	Public sector
BOO	Private sector	Private sector	Private sector	Private sector	Private sector	Private sector
DBO	Public sector	Private sector	Transfer of ownership	Private sector	Public sector	Public sector

*1: In the table orange cell indicates that facilities are owned by the public, and blue cell indicates that facilities are owned by the private-sector operator.
*2: In the table "Private sector" refers to PFI operators.
Source: National Association of Regional PFI Website "About PFI"
http://pfi-as.jp/pfi/pfi/post_8.html (accessed February 8, 2022)

Table 3-15 PFI System

●PFI method

<table>
<tr>
<td>BTO model
Build-Transfer-Operate</td>
<td>● The private sector designs and constructs the public facility, transfers ownership of the facility to the public sector immediately after completion of construction, and the private sector operates and maintains the facility.
・BTO has been widely adopted in service purchase PFI projects and the types of facilities that are implemented under this model are diverse.
・The scope of work of the private sector during the operation and maintenance period will be considered and decided from the viewpoint of appropriateness of a long-term contract, among other factors.
● The scope of work generally includes design, construction, operation and maintenance.
<table>
<tr><td></td><td>Design</td><td>Construction</td><td>Operation and Maintenance</td></tr>
<tr><td>Scope of work</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Contract type</td><td colspan="3">Business contracts</td></tr>
<tr><td>Private contracting entities</td><td colspan="3">Mostly Special Purpose Company (SPC)</td></tr>
</table>
● Compensation is generally paid during operation and maintenance period</td>
</tr>
<tr>
<td>BOT model
Build-Operate-Transfer</td>
<td>● The private sector designs, constructs, maintains and operates the public facility, and transfers ownership of the facility to the public sector at the end of the project.
・BOT has been adopted in PFI projects where the private operator has a wide margin of discretion, such as when the private operator directly receives income from user fees.
・As the private operator has ownership of the public facility during the period of operation and maintenance management, there is a wider degree of freedom in terms of operation and maintenance management, including renovation etc.
● The scope of work and contract are the same as those of the BTO model.
● Compensation is generally paid during operation and maintenance period</td>
</tr>
</table>

<table>
<tr>
<td>BOO model
Build-
Own-
Operate</td>
<td>
● The private sector designs, constructs, and manages operation and maintenance of the public facility, and at the end of the project the facility is dismantled or demolished without transferring ownership of the facility to the public sector.
・Used in PFI projects where the operation and maintenance period can be adjusted to the demand period and useful life of the facility.
・BOO can also be used in facilities where the site on which the facility is built has a defined period of use, or are suitable for scrap-and-build at regular intervals due to damage or obsolescence.
● The scope of work and contract are the same as those of the BTO model.
● Compensation is generally paid during operation and maintenance period
</td>
</tr>
</table>

●Method other than PFI

<table>
<tr>
<td>DBO model
Design-
Build-
Operate</td>
<td>
● This is a method of placing a comprehensive order to the private sector for the design and construction of public facilities, as well as for operation and maintenance management.
・DBO is used alongside the PFI approach in facilities of the waste management sector as well as facilities of other sectors.
・The scheme is funded, ordered and owned by the public sector.
● The scope of work generally includes design, construction, maintenance and operation.
<table>
<tr><th></th><th>Design</th><th>Construction</th><th>Maintenance and Operation</th></tr>
<tr><td>Scope of work</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Contract type</td><td colspan="2">Construction contract</td><td>Business contracts</td></tr>
<tr><td>Private contracting entities</td><td colspan="2">Construction company or Joint Venture(Design company and Construction company)</td><td>Mostly Special Purpose Company (SPC)</td></tr>
</table>
● Design and construction fees are generally paid before the facility is handed over.
</td>
</tr>
</table>

Source: Cabinet Office “Based on Manual for Prioritizing Introduction of the PPP/PFI Process” (2017)

(2) Results Expected from Introducing PFI

The results expected from introducing PFI and points to consider about introducing PFI are shown in the following Table 3-16 and Table 3-17.

Table 3-16 Results Expected from Introducing PFI

Results Expected	Specific Examples
Cost reduction Under comprehensive orders large discretion can be given to private business and cost reduction can be expected.	If construction costs are lower, but management costs are higher than would otherwise be the case, the total cost will be more expensive. Among the PPP/PFI models, by using total outsourcing that is based on the idea of performance ordering, and that reaches from design and building through operation and maintenance management, as in the PFI or DBO models, the total cost can be considered and the private business can be selected based on this.
Raising the quality of service Under performance ordering private business is in a better position to provide originality and ingenuity, and improvement in service quality can be expected.	Regarding public facilities for attracting customers, rather than having public administrators themselves manage these facilities, the public sector will totally outsource the facilities management to private businesses that have ample knowhow in running facilities aimed at attracting customers. This method is based on the concept of performance ordering, that reaches from design and building through management of operation and maintenance, and can possibly raise the quality of service.
Increase in income Under performance ordering private business is in a better position to provide originality and ingenuity and an increase of income can be expected.	There is a possibility that income will increase as private business operators increase the number of customers through improving the quality of services and providing new services.
Regional revitalization Under performance ordering private business is in a better position to provide originality and ingenuity and regional revitalization can be expected.	There is a possibility that the implementation of projects by private businesses will lead to the revitalization of the region by creating new business opportunities and employment, and by creating prosperity in the region through the utilization of vacant land.

Source: Cabinet Office “Based on Manual for Prioritizing Introduction of the PPP/PFI Process” (2017)

Table 3-17 Points to Consider in Introduction of PFI

Points to Consider	Details
Careful selection of private businesses	When selecting an enterprise for outsourcing the work to, the price should not be considered alone, but the knowhow the enterprise has, and the details of the business plan should also be assessed. Under the PFI method more work will be needed to select the qualified enterprise, than was previously required and consequently more time will be needed.
Proper management of private business	A wide scope of work will be outsourced to the private sector, and if public administrators do not better understand the working system under the private sector, and do not manage and give guidance as required, there may be a decline in the quality of the public services. This must be carefully considered especially for work where needs are rapidly changing.

Source: Cabinet Office Website “Guide to the Introduction of PFI Projects: The Basics”
https://www8.cao.go.jp/pfi/pfi_jouhou/tebiki/kiso/kiso02_01.html (accessed February 8, 2022)

3. Finances Concerning Waste Management

Municipalities in Japan spend heavily to conduct proper waste management. Waste management is mostly funded by the general finances, and many subsidies are also used for improvement of waste treatment facilities.

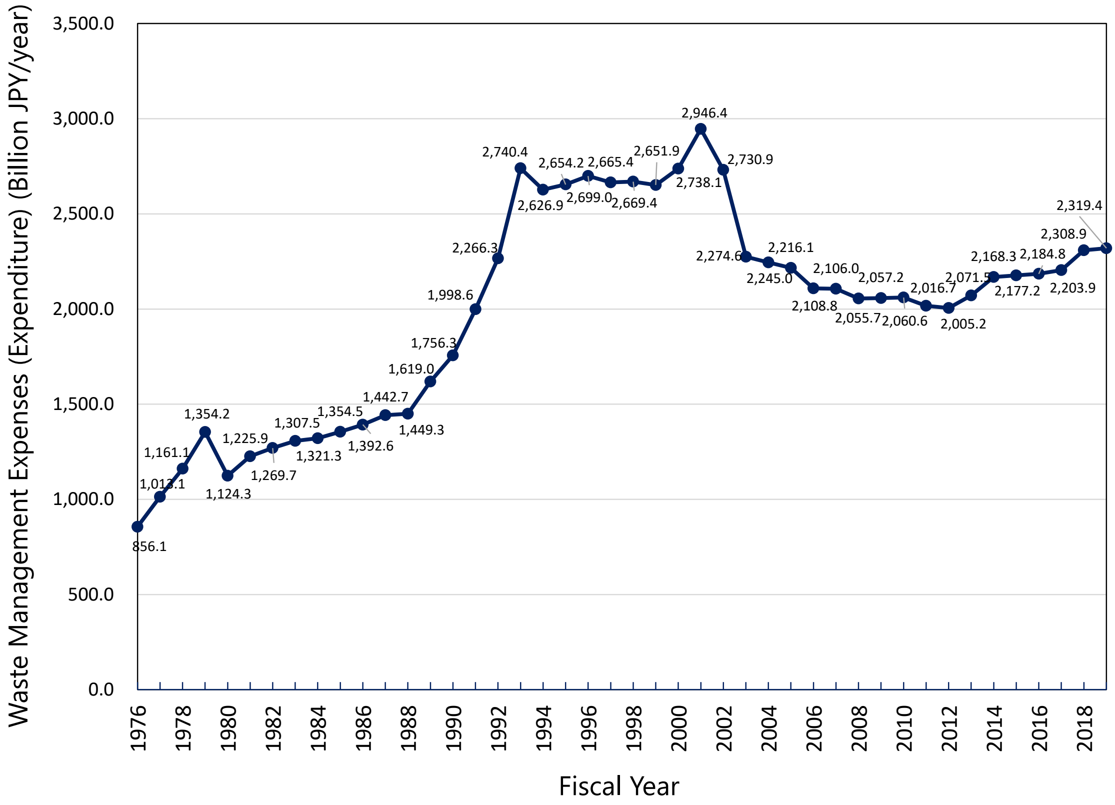
Although measures and policies based on the introduction of PFI projects and the "beneficiary pays principle" have been promoted in Japan, such measures and policies are implemented only by a small portion of the municipalities. Therefore, careful consideration should be given to the introduction of an independent accounting system for waste management services.

3.1 Financial Situation of the Central Government Concerning Waste Management

Confronted by an increasing amount of waste and the necessity to implement proper waste management, waste management expenses covered by municipalities have been increasing. Due to tightening of regulations for waste treatment facilities and improvement of facilities to control dioxins, etc. conducted for a limited term until 2002, the expenditure temporarily increased and peaked in 2002.

Under this background local governments continue to take a proactive approach to the administration of waste management by securing necessary budgets as policies and laws are revised.

Figure 3-9 shows the changes in waste management expenses (expenditure) of the municipalities in Japan. In FY 2019, the total expenditure was JPY 2,319.4 billion, comprising waste management expenses of about JPY 2,088.5 billion and human waste management expenses of about JPY 230.8 billion.



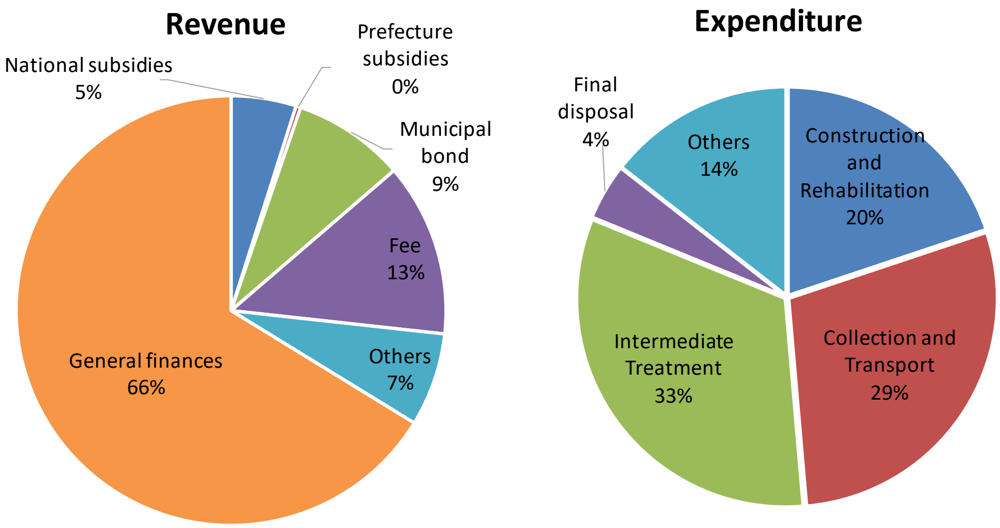
Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 3-9 Waste Management Expenses (Expenditure) of the Municipalities

3.2 Financial Conditions of Local Governments Concerning Waste Management

The expenses of waste management are mostly covered by general finances, on the basis that waste management is the responsibility of municipalities and is part of their administrative services. Many municipalities are starting to charge for waste collection (using municipality-designated waste bags with service fee added to the purchase price), not to cover the expenses for waste management but mainly to reduce waste by increasing people's awareness and to extend the life of final disposal sites.

Figure 3-10 shows the revenues and expenditures for waste management in the municipalities of Japan in FY 2019. The costs of waste management were covered by revenue of about JPY 1,383.3 billion (about 66% of the total revenue) which came from general finances, with other sources contributing 5-15% each including fee income contributing JPY 272.5 billion (13%). Concerning the expenditure breakdown, the operation and maintenance costs for intermediate treatment was about JPY 680 billion, taking up the largest share (33%), followed by the operation and maintenance cost for collection and transport of about JPY 600 billion (29%) and the facilities construction and improvement cost of JPY 415 billion (20%). In Japan, a large amount of financial resources are expended for intermediate treatment, mainly incineration, to ensure stable and appropriate intermediate treatment and to alleviate the shortage of final disposal sites.



Source: Ministry of the Environment "Results of the survey on municipal waste management (FY 2019)" (2021)

Figure 3-10 Revenue and Expenditure of Waste Management (FY 2019)

3.3 Central Government Financial Support Programs for Waste Management

The grant system for promoting the formation of a sound material-cycle society is no longer simply a system of spending subsidies on facilities; it now requires municipalities to prepare regional plans and to indicate the direction of the sound material-cycle society in the region, including the facilities to be developed. With the change in requirements from preservation of the living environment to the establishment of a sound material-cycle society, the government support system has also changed. In contrast to the government subsidy system established to achieve proper waste treatment and disposal, the grant system for promoting the formation of a sound material-cycle society is designed to realize the establishment of a sound material-cycle society.

The major portion of waste management costs, 66% is covered by general finances, and waste treatment facility improvement costs, which requires large funds, are financed by grants or subsidies and local government bonds.

(1) Changes in Subsidies and Grants for Facility Improvement

Under the *Act on Emergency Measures to Develop Facilities for Living Environments*, promulgated in 1963, it was decided to formulate a 5-year waste treatment improvement plan and establish a subsidy program to encourage municipalities to build modern incineration plants. The central government also started to provide support for landfill sites in 1977, about 15 years after the subsidy program for incineration plants was established.

The traditional subsidy program was abolished in 2004 and the Grant for Establishing a Sound Material-Cycle Society was created in 2005. While the old subsidy program provided subsidies to individual facility improvement projects to ensure proper waste treatment, the new grant program is a comprehensive support program for regional planning to form a sound material-cycle society that is supported by facility improvement projects. The grant program has the following characteristics.

a. Flexible planning and budget allocation according to the actual circumstances of the region

Grants can be moved to other projects or different years as long as the projects are included in the regional plan.

b. Focus on clear target setting and ex-post evaluation

Clear targets are set to control waste generation, promote recycling, control the amount of landfill waste, etc. Ex-post (actual results based) evaluation is conducted for target achievement and project progress, and the results are disclosed.

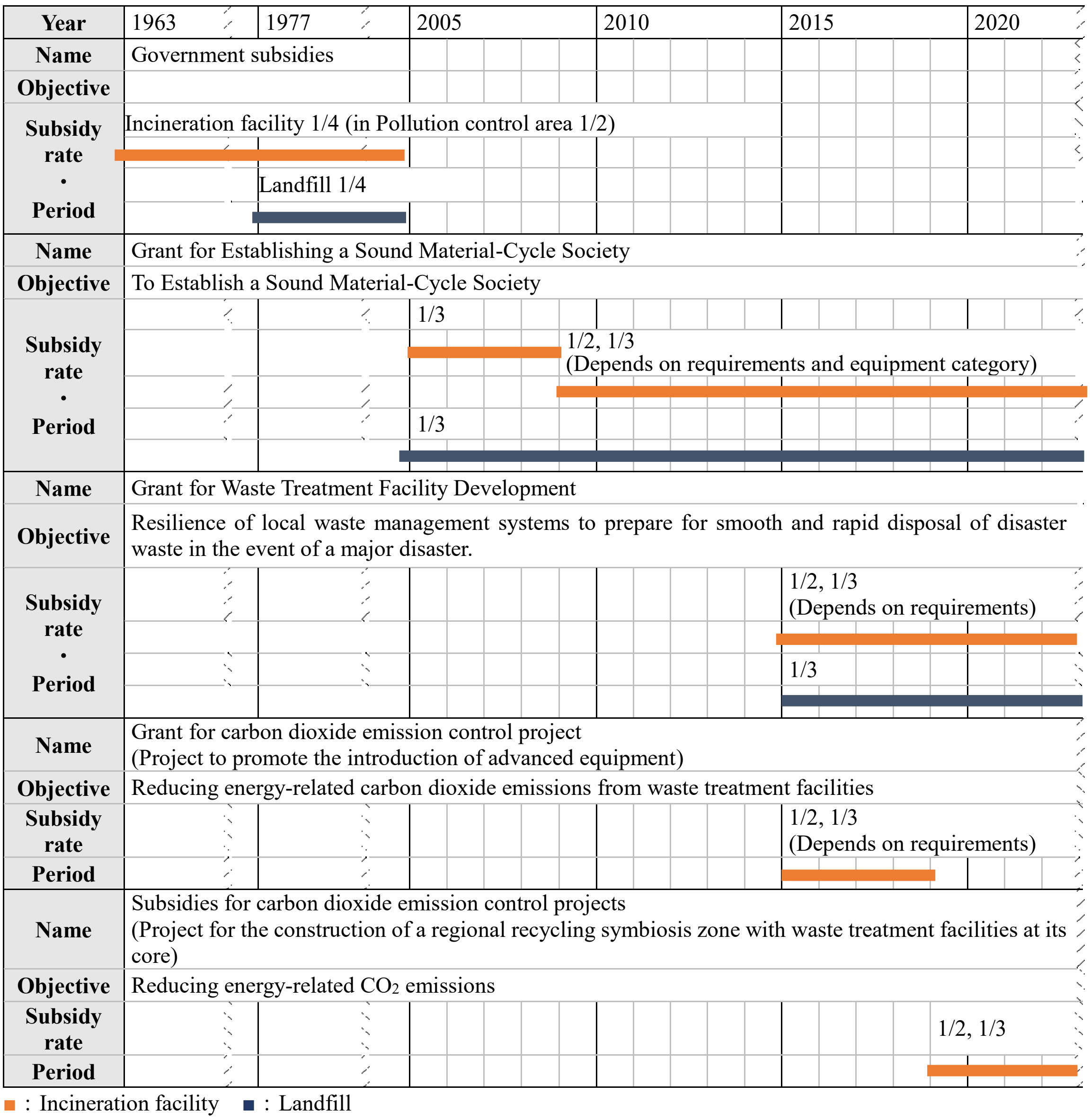
c. Cooperation between the central and local governments starting from the planning stage to promote the creation of a sound material-cycle society

For the development of a regional plan, an optimum 3R system is established through opinion exchange among the central, prefecture and municipal governments from the perspective of the whole country and with a view to international cooperation. At the same time, exercise of regional identity and autonomy is also ensured through the creation of a program with a high degree of freedom.

Source: Ministry of the Environment "Manual for the Development of a Regional Plan for Establishing a Sound Material-Cycle Society" (2005)

The transition of the government subsidy and grant system is shown in Figure 3-11, and the content of the grants has been updated to enable municipalities to implement stable and systematic improvement of waste treatment facilities in accordance with the emerging demands and needs of each era.

The central government is promoting the introduction of Stock Management for efficient renewal and maintenance of waste treatment facilities through efforts to extend the life of such facilities and reduce their lifecycle costs. Accordingly, the grant program is being expanded not only to cover the construction of new waste treatment facilities, but also for other types of construction works such as extending the life of facilities. (for more details on stock management, refer to "Topic 1 2.4 Column: What is stock management?"



Name of subsidy/grant	Objective
Government subsidies (1963～2004)	Development of facilities for the proper treatment and disposal of waste
Grant for Establishing a Sound Material-Cycle Society (2005)	Comprehensive support system for regional planning for the creation of a sound material-cycle society, including the development of facilities
	Promotion of measures to combat global warming (expansion of subsidies for high-efficiency waste power generation facilities)
Grant for Waste Treatment Facility Development (2015)	Development of a waste treatment facility to serve as a disaster response center in the event of a major disaster
Grant for carbon dioxide emission control project (2015)	Strengthening the fight against global warming
Subsidies for carbon dioxide emission control projects (2019)	Highly efficient use of waste heat through the introduction of equipment capable of significant energy savings Reducing energy-related CO_2 emissions

Figure 3-11 Changes in the System of Subsidy and Grant

(2) Grant Program for Establishing a Sound Material-Cycle Society

1) Overview of the Grant Program for Establishing a Sound Material-Cycle Society

The Grant Program for Establishing a Sound Material-Cycle Society is essential to municipalities improving waste treatment facilities in their districts. Improvement of waste treatment facilities are large projects that municipalities implement only every few decades and temporarily pose a huge financial burden on them. As such projects are important for the formation of a sound material-cycle society, the central government has created this grant program to provide not only technological support but also financial support necessary for such facility development.

The overview of this grant program is described below. It is a comprehensive support program for Regional Plans for Establishing a Sound Material-Cycle Society developed by municipalities, covering not only intermediate treatment facilities such as facilities for material recycling, waste-to-energy and organic waste recycling, but also projects to improve key equipment for landfill sites and existing waste treatment facilities. The funding share is determined depending on the type of facilities and contents of the project, but budget can be allocated in a flexible manner according to the conditions of the district.

[Overview of the Grant Program for Establishing a Sound Material-Cycle Society]

1. Purpose of the Grant Program

The purpose of the program is to form a sound material-cycle society through the comprehensive and regional promotion of improvement of waste treatment and recycling facilities under clearly defined goals related to 3Rs (Reduce, Reuse and Recycle) in order to comprehensively promote 3Rs through the municipalities use of their autonomy and ingenuity.

2. Overview of the Grant Program

Municipalities develop their Regional Plans for Establishing a Sound Material-Cycle Society (normally for 5 years) as a comprehensive regional plan to improve waste treatment and recycling facilities in order to promote 3Rs (Reduce, Reuse and Recycle) of waste management in a comprehensive manner. Grant is provided for the cost of projects carried out under the regional plan.

(1) Development of Regional Plan for Establishing a Sound Material-Cycle Society

Municipalities in the target region form a Council for Establishing a Sound Material-Cycle Society together with the participation of the central and prefecture governments. The Council commences discussions at the planning phase to develop a Regional Plan for Establishing a Sound Material-Cycle Society that describes 3R targets (to be achieved with the use of the grant) and projects to be carried out to achieve these targets.

(2) Provision of Grant

The central government provides grant each fiscal year if the Regional Plan for Establishing a Sound Material-Cycle Society complies with the basic principle of the *Waste Management Act*.

(3) Ex-post Evaluation

After the completion of the plan, municipalities are required to carry out ex-post evaluation of targets achievement and confirm and disclose the results. In the ex-post evaluation, municipalities evaluate achievements through the comprehensive efforts to promote 3Rs using the facilities improved with the grant.

3. Grant Eligibility

Eligible regions:	Eligible regions for the Regional Plan are municipalities with a population of 50,000 or more or with a total area of 400 km^2 (except for special regions including Okinawa and remote islands).
Eligible facilities:	• Material recycling facilities: Recycling facilities for incombustible waste and plastic, stockyards, etc. • Waste-to-energy facilities: Facilities for power generation by waste incineration, heat recovery facilities, bio gasification facilities, etc. • Organic waste recycling facilities: Recycling facilities for human waste, kitchen waste, etc. • Johkasou (Septic tanks) • Landfill sites • Improvement of key equipment in existing waste treatment facilities

4. Funding Rate

1/3rd of eligible expenses (1/2 for advanced facilities such as high-efficiency facilities for power generation by incineration)

Source: Ministry of the Environment "Reform toward the Sound Material-Cycle Society: Recipe Book - Guide for 3R Promotion Grant (Grant for Establishing a Sound Material-Cycle Society)" (2006)

Table 3-18 Eligible Projects and Facilities for Grants and Subsidies (Intermediate Treatment)

Eligible Project	Eligible Facilities
Material recycling facilities	Facilities for resource recycling processes such as separation and compression to reuse wastes as materials
	(1) Recycling Center Facilities for recycling through such processes as separating wastes (combustible and incombustible wastes), including functions to promote reuse of waste through repair of disused goods and display of recycled goods as well as raising awareness about 3Rs **(2) Stockyard** Facilities for temporary storage of recyclables such as glass bottles, cans and plastic bottles after they are collected separately, further sorted out and compressed for effective reuse as resources **(3) Ash Melting Facilities** Facilities to promote recycling of incinerated ash through processing incineration residue (such as incinerated ash) collected from heat recovery facilities into molten and solidified materials (so called molten slag) **(4) Containers and Packaging Recycling Facilities** Projects to establish a system for separate collection of containers and packaging as recyclable materials through the development of such facilities as separate collection centers, storage facilities and compression facilities for recyclables
Waste-to-energy facilities	Facilities to use remaining heat for power generation, etc. by collecting heat generated from waste incineration as steam energy or through gasification; facilities to use remaining heat for power generation, etc. by converting waste into biogas; and facilities to convert waste into such fuels as biodiesel fuel, refuse derived fuel and reformed gas
	(1) Heat Recovery Facilities (Incineration Including Gasification Melting) Facilities to transform waste into residue or molten and solid materials by reducing volume of waste through high temperature oxidation using a single or combination of unit processes such as thermal decomposition and melting. Specifically, waste incineration plants with stoker-type or other types of incinerators, or thermal decomposition and melting facilities with equipment to combust or collect (reform) gas generated from thermal decomposition of waste. **(2) Waste-to-fuel Facilities (RDF, BDF, Charcoal, Ethanol Fuel, Wood Chip, etc.)** Facilities to recover energy contained in waste through compression, chemical reaction, thermal decomposition, etc.
Organic waste recycling facilities	Facilities to treat kitchen waste and other types of organic waste (biomass waste) together with human waste, septic tank sludge, etc. and facilities for resource recycling through composting or feed production
	(1) Sludge Recycling Center Facilities to treat kitchen waste and other types of organic waste together with human waste and septic tank sludge and recover resources (methane, compost, etc.) **(2) Facilities to Produce Feed from Waste** Facilities to produce animal feeds by decomposing and drying kitchen waste, sorted out and separated to be free of foreign matter as well as other types of waste suitable for feed, through biological response using microorganisms, warming, etc. **(3) Waste Composting Facilities** Facilities to produce compost by mechanically stirring organic waste suitable for composting and exposing it to aerobic atmosphere to promote decomposition by microorganisms

Source: Ministry of the Environment "Guide for Application for Grant for Establishing a Sound Material-Cycle Society (Facility)" (2021)

2) Contents of the Regional Plan for Establishing a Sound Material-Cycle Society

Clear target setting is extremely important for the Regional Plan for Establishing a Sound Material-Cycle Society developed by municipalities, and facility improvement projects included in the plan are considered as measures to achieve such targets. Matters to be covered in the plan include facility improvement projects and the related support plans, waste generation control, promotion of reuse, establishment of a treatment system, and follow-up of the plan. Table 3-19 shows the contents of the Regional Plan for Establishing a Sound Material-Cycle Society.

Table 3-19 Contents of the Regional Plan for Establishing a Sound Material-Cycle Society

No.	Item	Overview
1	Basic matters to promote the establishment of a sound material-cycle society in the region	**(1) Target Region** Target region (name of target municipality, and area and population of municipal waste treatment target area), and target region map (as attachment for reference) **(2) Plan Period** Period for the plan (fiscal years): about 5 years **(3) Basic Direction** Goals for the region according to the purpose and schedule of the plan
2	Current state and targets for establishing a sound material-cycle society	**(1) Current State of Municipal Waste Treatment** Amounts of waste generated, recycled, and reduced through intermediate processing (incineration, crushing and sorting, etc.), amount of heat recovered, amount of waste landfilled, etc. (to be illustrated in a flowchart, etc. in an easy-to-understand way) **(2) Targets for Municipal Waste Treatment** Target waste amount for usage, amount reduced through intermediate treatment, amount of heat recovered, amount of waste disposed in landfills, etc. [Example of target setting for 3R promotion] (Target achievement to be evaluated after the plan period) Reduction of waste generation: Amount of waste generated per person per day (xx % reduction from year xxxx) Recycling: Recycling rate (xx% reduction from year xxxx) Thermal recovery: Amount of power generated with each ton of waste (xx kWh/t) Landfill: Amount of waste disposed in landfills (xx% reduction from year xxxx)
3	Contents of the measures	**(1) Reduction of Waste Generation and Promotion of Reuse** Current and future state of measures for reduction of waste generation and reuse: matters concerning measures that can be taken by the community such as switching to fee charging for the waste services, environmental education and awareness raising, promotion of reusable bags, elimination of disposable shopping bags and simplified packaging **(2) Waste Treatment System** Current and future conditions of the waste treatment system: Matters concerning waste categories, collection, transport and treatment methods, and response to various recycling laws **(3) Improvement of Treatment Facilities** Overview of facilities for improvement: Name and type of facilities,

No.	Item	Overview
		type of waste to be treated, treatment capacity, location, project period, year of completion, etc. **(4) Projects to Support Plan for Facility Improvement** Matters concerning facility improvement planning: Topographic and geological investigation, surveys, basic design, investigation of impact on living environment, etc. **(5) Other Measures** Matters concerning awareness raising, environmental education, discussion with residents, measures against illegal dumping and waste treatment during disaster
4	Follow-up and ex-post evaluation of the plan	Matters concerning assessment of progress, ex-post evaluation, review of the plan, amongst others

Source: Ministry of the Environment "Manual for the Development of a Regional Plan for Establishing a Sound Material-Cycle Society" (2005)

3) Procedure of the Regional Plan for Establishing a Sound Material-Cycle Society

The flow of the Regional Plan for Establishing a Sound Material-Cycle Society until the provision of the grant is as depicted in Figure 3-12.

The municipality applying for the grant prepares the Regional Plan for Establishing a Sound Material-Cycle Society (draft). The municipality organizes the Council for Establishing a Sound Material-Cycle Society together with the central and prefecture governments to exchange opinions about the draft.

The municipality develops the Regional Plan for Establishing a Sound Material-Cycle Society based on the discussion at the Council. The prefecture government sends the plan to the Minister of Environment after checking whether the opinions expressed in the Council are incorporated into the regional plan developed by the municipality.

Upon approval of the Minister of Environment, projects to support the plan and projects for facility improvement are carried out.

Figure 3-12 Grant Scheme Flow

4) Support for the Procedures Concerning the Grant Program

An important national policy in Japan is to develop necessary facilities for proper waste treatment in as many municipalities as possible. For large-scale waste treatment facility improvement projects that impose a large burden on municipalities, the central government provides support such as establishing guidelines for grant projects and holding explanatory meetings so that municipalities can carry out grant procedures smoothly.

3.4 Fee Collection Methods by Local Governments and Fee Bearing by Residents and Business Operators

In Japan, in building the sound material-cycle society, mechanisms have been created that incorporate ideas about extended producer responsibility and beneficiaries burden sharing.

Respective parties (i.e., residents, business operators and governments), by meeting their own responsibilities under appropriate role sharing, contribute to build mechanisms to help reduce burdens (especially, financial burdens) for municipalities, and to promote further recycling, reduce illegal dumping, and support proper waste treatment.

While water supply service adopts the independent accounting system of consumption as the principal financial revenue in the form of “water charges” collected from residents, in the case of municipal waste management service the expenses are covered by taxes (such as resident taxes) as principal financial revenues.

With the aim of promoting the reduction of waste generation and reuse, the government examined how waste should be managed by municipalities to create a sound material-cycle society. In 2010, The “Basic Policy for the Comprehensive and Systematic Promotion of Measures for the Reduction and Other Appropriate Disposal of Waste” was revised. This basic policy identified that the roles of municipalities should be to “promote charging fees for municipal waste management, in order to minimize waste and promote recycling by utilizing economic incentives, to advance fairness of burden sharing in proportion to generated-waste amounts, and to build residents’ awareness”. In response to this basic policy, each municipality is either already charging fees for waste management services, or considering to do so. Many municipalities have introduced a fee system for household waste because this encourages residents to change their lifestyles and behavior, in favor of reducing waste generation and promoting recycling of resources through recycling.

In line with the principle of “extended producer responsibility”, the *Containers and Packaging Recycling Law* has established a mechanism that obliges business operators to bear recycling-related expenses for waste containers and packaging. As it is difficult for municipalities to conduct proper treatment or to recycle large and heavy home appliances, the *Home Appliance Recycling Law* provides a mechanism by which waste-generators bear waste collection and transport fees as well as recycling fees when discharging their own home appliances. Regarding automobiles, the *End-of-Life Vehicle Recycling Law* provides a mechanism by which, in general, automobile owners should bear recycling fees when purchasing their own automobiles.

Table 3-20 shows laws and regulations providing for expense sharing mechanisms.

Table 3-20 Expense Sharing Mechanisms by Laws and Regulations and their Expected Impacts

Law and regulations / Targeted products	Financial revenues secured (Use of financial revenue)	Expense bearers	Expected impacts
Containers and Packaging Recycling Law / Containers and Packaging	Outsourcing Fees for collection, transport and recycling (recycling and merchandising) of containers and packaging	Designated business operators (retailers, manufacturers, etc.)	Reduction of waste, life extension of landfill site, promoting of recycling
Home Appliance Recycling Law / Four Items of Home appliances	Fees for collection, transport and recycling of Home Appliances	Waste-generators of used home appliances	Reduction of illegal dumping of used home appliances, reduction of waste, life extension of landfill site, promotion of recycling
End-of-Life Vehicle Recycling Law / End-of-life vehicles	Recycling fees for end-of-life vehicles	Vehicle owners	Reduction of illegal dumping of end-of-life vehicles, reduction of wastes, life extension of landfill site, promotion of recycling
Waste discharged from household	Forming part of financial revenue for waste management (used for public awareness building, etc.)	Residents	Reduction of wastes, life extension of landfill site, ensuring fairness of expense sharing, raising residents' awareness, building awareness and technology capacities of business operators, securing part of financial resource necessary for waste management

(1) Containers and Packaging Recycling Law

The *Containers and Packaging Recycling Law* covers waste containers and packaging included in municipal wastes, and provides for a system by which designated business operators (such as sellers and manufacturers) should bear expenses necessary for collection, transport and recycling process of containers and packaging.

One of the difficulties in introducing this law was to build consensus among interested parties. Employment is an extremely serious issue, and if there are stakeholders who are concerned about losing their jobs due to a decrease in the amount of waste, it is important to build consensus by holding repeated explanatory meetings.

In establishing recycling statutes, it is important to shift part of the responsibilities of municipalities to the manufacturers, and therefore, while limited, this law has shifted the waste treatment responsibility. It should be kept in mind that if the proposed share of responsibilities to be met by manufacturers becomes too large, it will be difficult to obtain their consent.

1) Background

Amid a rapid increase in the amount of waste discharged, cans, glass bottles, plastic bottles, and other container and packaging waste comprised roughly 60% of municipal waste in terms of volume, and roughly 30% in terms of weight. Very little container and packaging waste was being recycled despite the fact that it is technically relatively easy to recycle this waste type due to its homogeneity and the sheer amount. Given this background, and in an effort to reduce the overall amount of waste by promoting the recycling of container and packaging waste, a new system was created to assign the roles and responsibilities of municipalities, consumers, and producers.

Furthermore, the law aims to improve the administration of waste by municipalities confronting dioxin-related problems by reducing the amount of container and packaging waste incinerated along with municipal waste.

2) Overview of Containers and packaging Recycling Law

Up to the enactment of the *Containers and Packaging Recycling Law*, treatment and disposal of waste discharged from each household were wholly borne by municipalities as services under their own responsibility, and accordingly, municipalities incurred significant expenses for such services. When the *Containers and Packaging Recycling Law* was established, the concept of “extended producer responsibility” was introduced, and the law provided for obligations on business operators (such as manufacturers, sellers, importers) to implement recycling (recycling and merchandising) for these wastes.

For the cases where business operators themselves cannot implement recycling, the law set up another mechanism by which business operators shall pay “outsourcing fees” for recycling to the

Japan Containers and Packing Recycling Association (the corporation designated by the central government), so that the business operators can meet their respective recycling and merchandising obligations by such fee payment.

Name of law: Law for the Promotion of Sorted Collection and Recycling of Containers and Packaging (Containers and Packaging Recycling Law) Enacted: 1995 Amended: 2006, 2021 Purpose: To ensure the effective use of resources and proper treatment of waste through the reduction of municipal waste, and proper use of recycled resources by reducing the generation of containers and packaging waste discharged from households together with municipal waste and clarifying roles and responsibilities - specifically, sorted discharge by consumers, separate collection by municipalities, and recycling by business operators. Overview of law: The law sets out a recycling system based on the roles and responsibilities of three entities: sorted discharge by consumers, separate collection by municipalities, and recycling and merchandising by business operators (container manufacturers, and business operators that sell goods in containers and packaging). It marks the first incorporation of the concept of extended producer responsibility (EPR) in Japan, and imposes physical and financial responsibilities for recycling and merchandising on business operators. Targets: Steel cans, aluminum cans, glass bottles, cardboard, beverage cartons, paper containers and packaging, PET bottles, plastic containers and packaging Source: Law for the Promotion of Sorted Collection and Recycling of Containers and Packaging (1995)

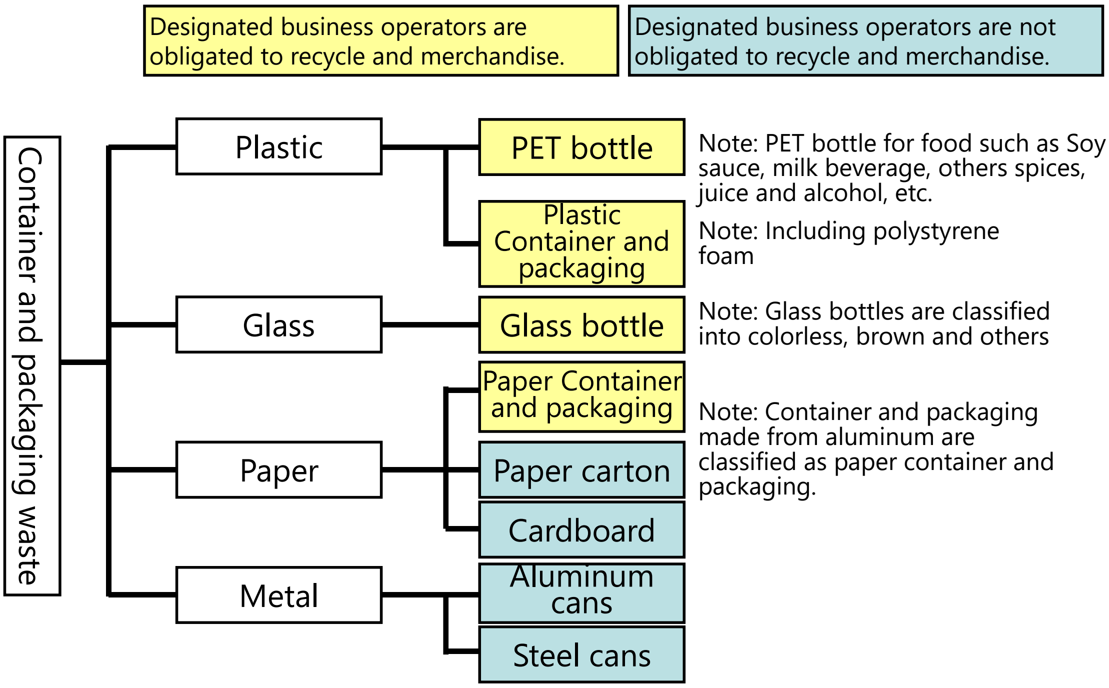
3) Recycling System under the Containers and Packaging Recycling Law

A) Containers and Packaging Covered by the Containers and Packaging Recycling Law

The *Containers and Packaging Recycling Law* defines containers and packaging as follows: “the term "containers and packaging" as used in this law means containers and packaging of goods (including the cases where containers and packaging of goods are paid for) which become unnecessary when the relevant goods have been consumed or when the goods have been removed from the relevant containers and packaging.” (Article 2, paragraph (1) of the Act)

Specifically, containers and packaging subject to separate collection can be divided into eight (8) categories: glass bottles, PET bottles, paper containers and packaging, plastic containers and packaging, aluminum cans, steel cans, paper packing, and cardboard.

Among these categories, the law specifies four (4) categories (glass bottles, PET bottles, paper containers and packaging, and plastic containers and packaging) as being subject to the recycling and merchandising obligations, because under the current circumstances the wastes under these categories cannot be recycled even after separate collection due to having less value for use as resources. On the other hand, the wastes under the other four (4) categories of aluminum cans, steel cans, paper packing and cardboard are not subject to the recycling and merchandising obligations, because under the current circumstances, they are already being recycled and traded in the market economy due to having a high value as resources.



Source: The Japan Containers and Packing Recycling Association "The Containers and Packaging Recycling System in Japan" (2020) https://www.jcpra.or.jp/Portals/0/resource/eng/JCPRAdocuments202012.pdf

Figure 3-13 Types of Containers and Packaging

Photo 3-6 PET Bottles

Photo 3-7 Plastic Containers (Polystyrene foam)

Photo 3-8 Glass Bottles

Photo 3-9 Paper (Cardboard, Paper Container)

Photo 3-10 Paper Carton

Photo 3-11 Cans

Source: Yachiyo Engineering Co., Ltd.

B) The Roles of each Party defined in Containers and Packaging Recycling Law

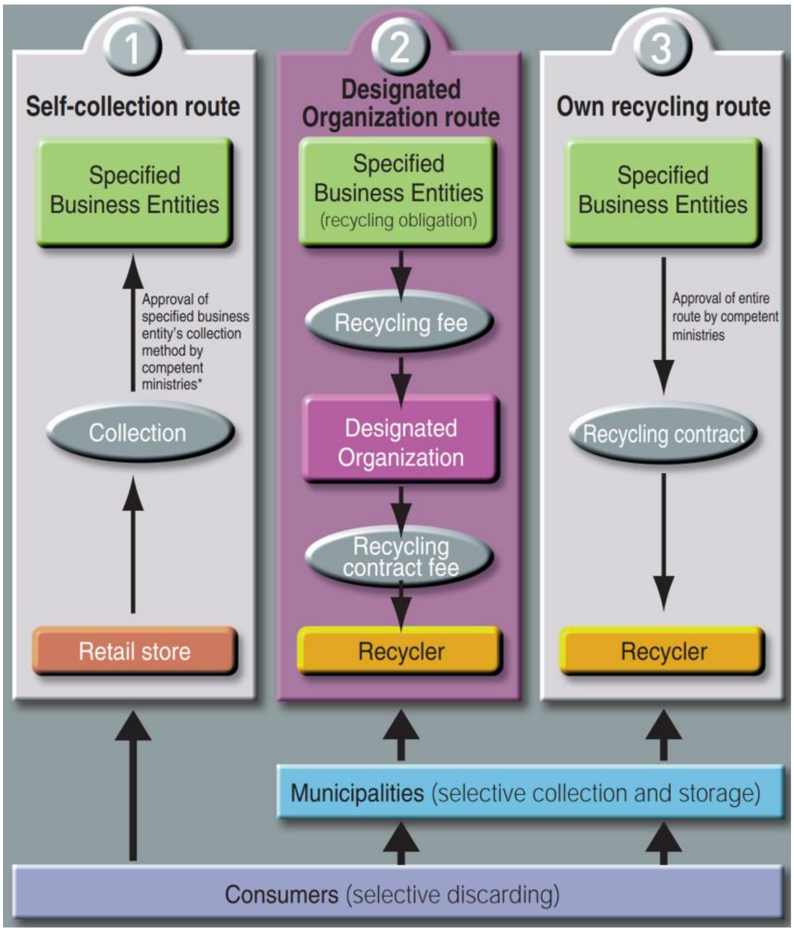
Table 3-21 shows the roles of each party under the *Containers and Packaging Recycling Law*.

Table 3-214 Roles of each Party under the Containers and Packing Recycling Law

Party	Overview of Roles
Designated business operators	Designated business operators ((1)business operators selling goods using "containers" or "packaging", (2)business operators manufacturing "containers", (3)business operators importing "containers" or goods with "containers" or "packaging") have recycling and merchandising obligations. Small business operators are exempted.
Consumers "Sorted discharge"	Recycling starts from each consumer's good manner and thoughtfulness, and accordingly consumers have to observe "discharge rules" established by the respective municipalities. Consumers will make efforts to minimize waste containers and packing, by carrying their own bags while shopping and not using plastic bags, selecting simply packaged goods, actively using returnable containers, etc.
Municipalities "Separate collection"	By separate collection, sorting and cleaning etc. of containers and packaging, municipalities will satisfy the "sorting standards" provided for in the Law. They will store the sorted wastes at appropriate storing facilities. Properly stored waste will become "waste containers and packaging that conform to the sorting standards", which will be collected by the designated corporation.
Recycling and merchandising operators "Recycling and merchandising"	These recycling operators will transport and reproduce "waste containers and packaging that conform to the sorting standards", and utilize them as new "resources".
Designated corporation	The Japan Containers and Packing Recycling Association is the designated corporation appointed by the five (5) principal ministries (Ministry of the Environment, Ministry of Economy Trade and Industry, Ministry of Finance, Ministry of Health, Labour and Employment, and Ministry of Agriculture, Forestry and Fisheries), and will smoothly and properly proceed with recycling (recycling and merchandising) of "waste containers and packaging that conform to the sorting standards".

Source: Ministry of Economy, Trade and Industry "*The Containers and Packing Recycling Law*" is responsible for most of our 'resources' (2006)

The *Containers and Packaging Recycling Law* indicates three (3) routes through which designated business operators having recycling obligations can perform their obligations (i.e., self-collection route, own-recycling route, and designated organization route). Self-collection route is the method in which designated business operators collect containers and packaging from consumers through their own distributors, and then re-use them. Own-recycling route is the method in which designated business operators directly outsource recycling and merchandising operators to process and recycle (i.e., recycling and merchandising) of containers and packaging collected by municipalities. Designated organization route is the mechanism introduced by the *Containers and Packaging Recycling Law*. This method of recycling (recycling and merchandising) through the Japan Containers and Packing Recycling Association (the designated corporation), in which the designated corporation executes outsourcing agreements with recycling and merchandising operators on behalf of the relevant designated business operators. By paying recycling expenses to the designated corporation, the designated business operators are deemed to meet their own recycling and merchandising obligations.



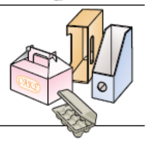
Source: Ministry of Economy, Trade and Industry "The Containers and Packing Recycling Law makes the most of our 'resources'" (2006)

Figure 3-14 Method of Implementation of Recycling Obligations of Designated Business Operators

C) Flow of Recycle Process for Containers and Packaging

Among containers and packaging sorted and collected in accordance with the separate collection plan established by the municipality, those collected, transported and stored in accordance with the standards established under laws and regulations are certified "waste containers and packaging that conform to the specified sorting standards". "Waste containers and packaging that conform to the specified sorting standards" are subject to material recycle for resource use by recycling and merchandising operators, and then are used for manufacturing of various products.

■ Recycling Methods

Type	Recycling methods	Examples of recycled products	
Glass containers	Making cullet, etc.	● Glass containers ● Construction and civil engineering materials, and others	
PET bottles	Pelletization, etc. Polyester materials, etc.	● Fibers ● Sheet plastic ● PET bottles and others	
Paper containers and wrapping	Selected pulp and waste paper + Refuse Derived Fuel Construction materials, recycled and shredded paper, textiles, etc. + Refuse Derived Fuel	● Paperboard ● Solid fuel ● Recycled and reused boards, etc.	
Plastic containers and wrapping Styrene foam trays	Materials for plastics Synthetic oil Coke substitute for pig iron production Synthetic gas Coal substitute for coke production	● Stationery supplies, household sundries and other plastic products ● Materials for industrial use	

Source: Ministry of Economy, Trade and Industry "The Containers and Packing Recycling Law" makes the most of our 'resources'" (2006)

Figure 3-15 Recycling Methods

4) Flow of Recycling Fees

The *Containers and Packaging Recycling Law* covers waste containers and packaging included in municipal wastes, and provides for a system by which a designated business operator (such as retailers and manufacturers) should bear expenses necessary for collection, transport and recycling process of containers and packaging.

When a designated business operator performs its recycling obligation through either of the self-collection route or own-recycling route, the designated business operator will have to implement recycling or execute an outsourcing agreement with recycling and merchandising operators by themselves.

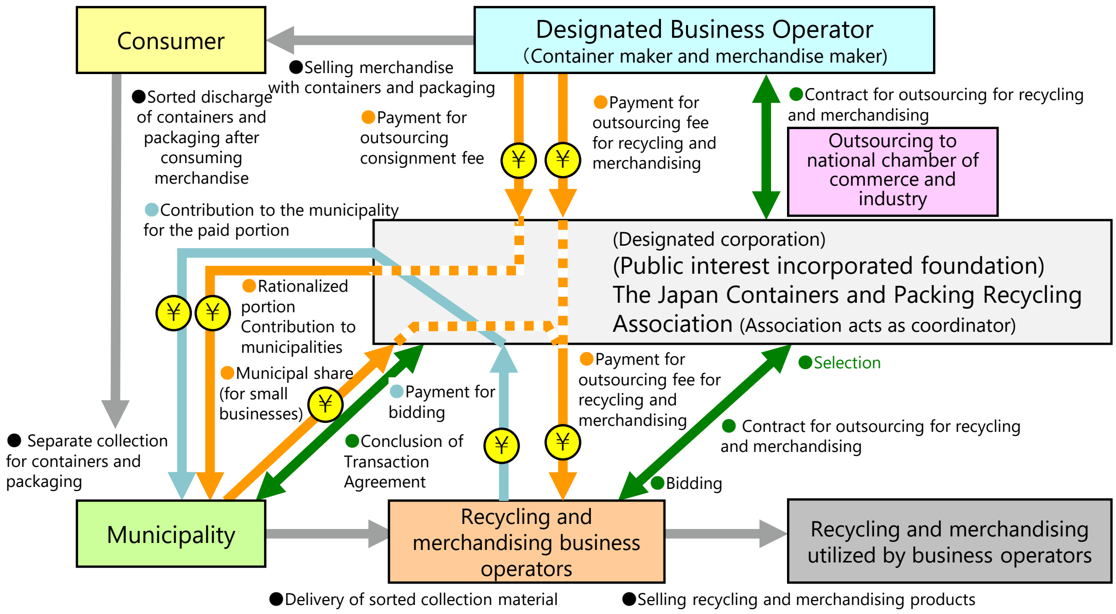
Figure 3-16 shows the flow in case where a designated business operator carries out its recycling obligations through the designated organization route.

Outsourcing fees are divided into two types: “recycling and merchandising outsourcing fees” and “municipality rationalization-contributing outsourcing fees”. By paying both fees to the designated corporation, the designated business operator will be deemed to have met its recycling and merchandising obligations.

“Recycling and merchandising outsourcing fees” are applied to cover recycling fees, and are paid from the designated corporation to the companies that actually carry out recycling (i.e., recycling and merchandising operators). “Municipality rationalization-contributing outsourcing fees” will become source for rationalization contribution paid to municipalities.

The system of contributing funds to municipalities is the mechanism adopted to distribute any benefits of reduced expenses to both business operators and municipalities when the efforts by business operators and municipalities are contributing to rationalize and streamlining the recycling of containers and packaging. Rationalization contributions to municipalities are paid as contribution to municipalities, of half amount of recycling expenses that had been reduced more than expected. Rationalization contributions are paid once a year, by the designated corporation to the municipalities in accordance with “quality” standard and depending upon extent of contribution to “reduced amounts”.

At the end of each fiscal year, the outsourcing fee is settled, and then, in proportion of any recycling expenses actually required, any excess will be returned to business operators, and on the other hand the business operators will be expected to pay for any deficit incurred in the recycling expenses.



Source: The Japan Containers and Packing Recycling Association “Business Report and Financial Statements in FY2018” (2019)

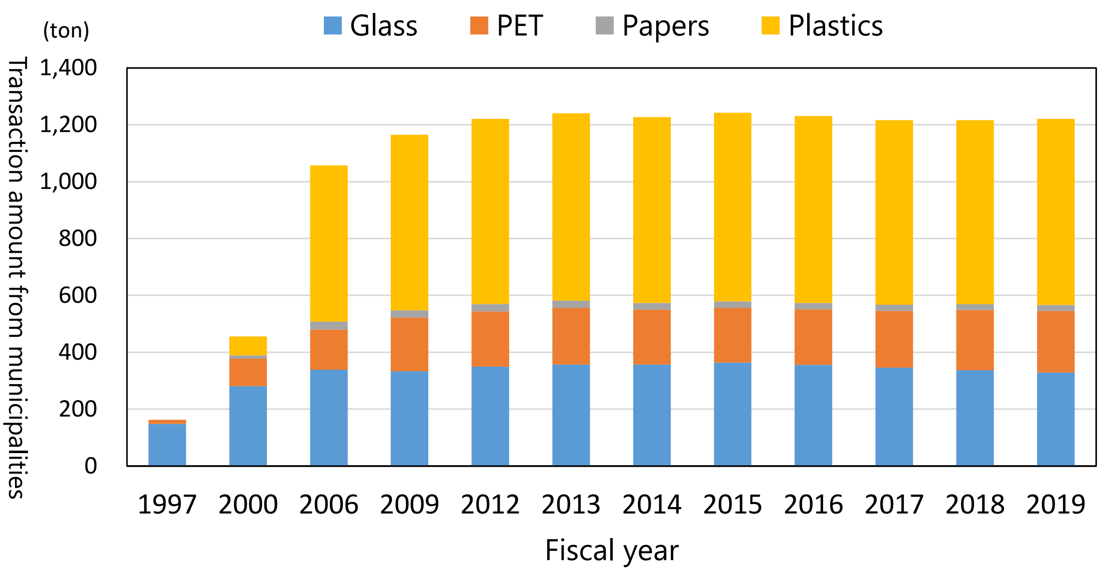
Figure 3-16 Scheme of Recycling and Merchandising

5) Actual Performance and Impacts of Containers and Packaging Recycling Law

The *Containers and Packaging Recycling Law* has positively impacted the reduction of final disposal amount. In addition, the law contributed to the thorough sorting for resource use, and reduction of excessive packaging, with improved resident awareness on containers and packaging.

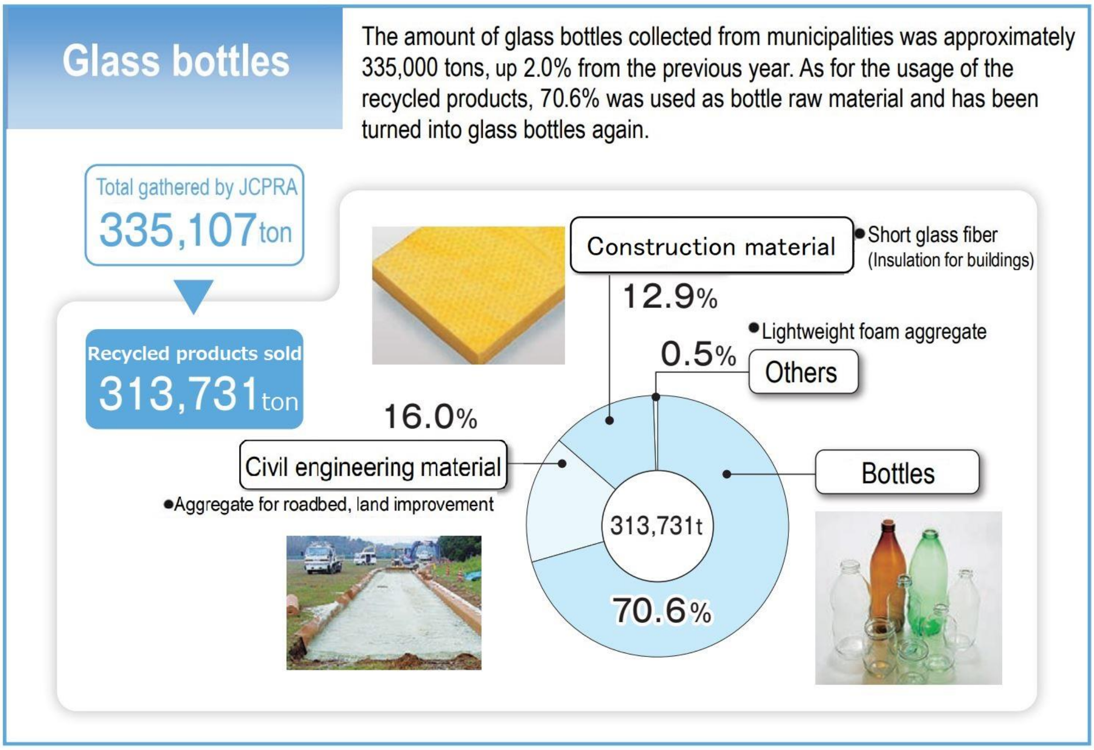
Figure 3-17 shows the actual performance of recycling of four (4) categories subject to recycling and merchandising obligations: glass bottles, PET bottles, paper containers and packaging, and plastic containers and packaging.

Containers and packaging amounted to about 60% in quantity of wastes discharged from household in 2019, but they are now re-used as resources through the enforcement of *Containers and Packaging Recycling Law*. In addition, progress in material recycling contributed to reduction of final disposal amount, and life extension of landfill sites. Furthermore, since containers and packaging are now subject to sorting and separate collection, consumers and business operators are increasing their awareness about 3R, and manufacturers have developed advanced technologies in the production of containers and packaging (weight saving of containers and packaging, and simplified structure to make sorting easier), contributing to the establishment of the sound material-cycle society.



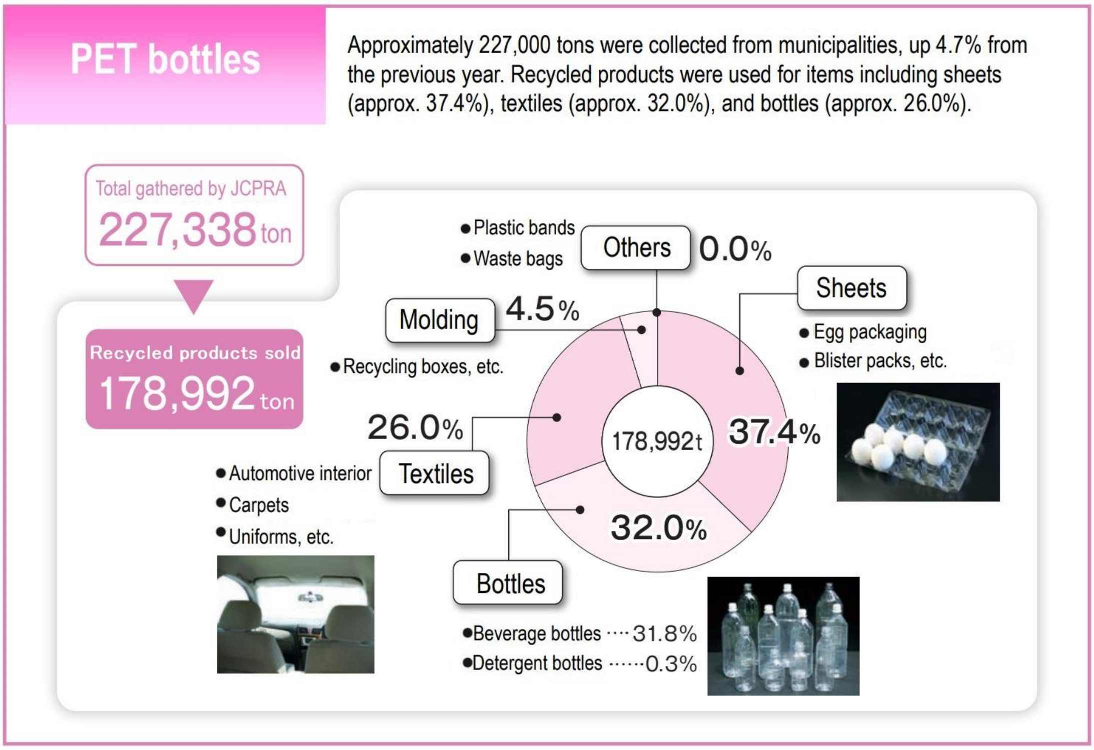
Source: The Japan Containers and Packing Recycling Association Website "Graph of actual collected amount over time" https://www.jcpra.or.jp/municipality/municipality_data/tabid/401/index.php#Tab401 (accessed February 16, 2022)

Figure 3-17 Municipalities Collected Amounts of Four Waste Categories Subject to Recycling and Merchandising Obligations



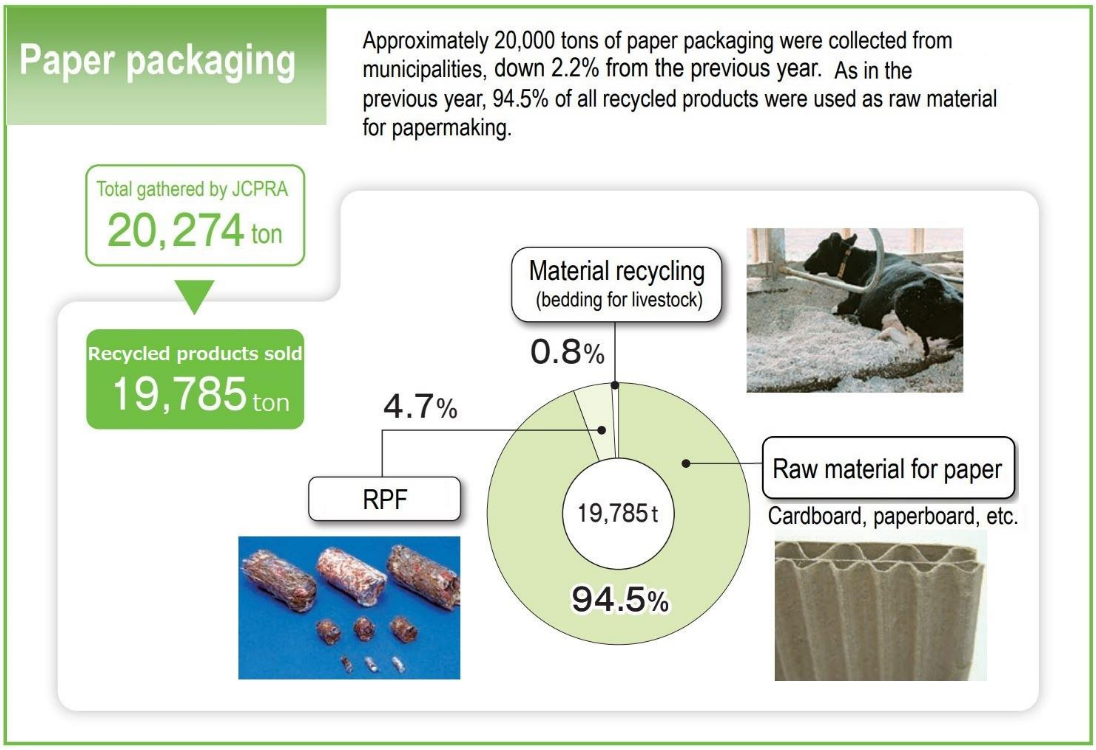
Source: The Japan Containers and Packing Recycling Association "Annual Report 2021" (2021)

Figure 3-18 Breakdown of Collected Glass Bottles Waste Amount from Municipalities



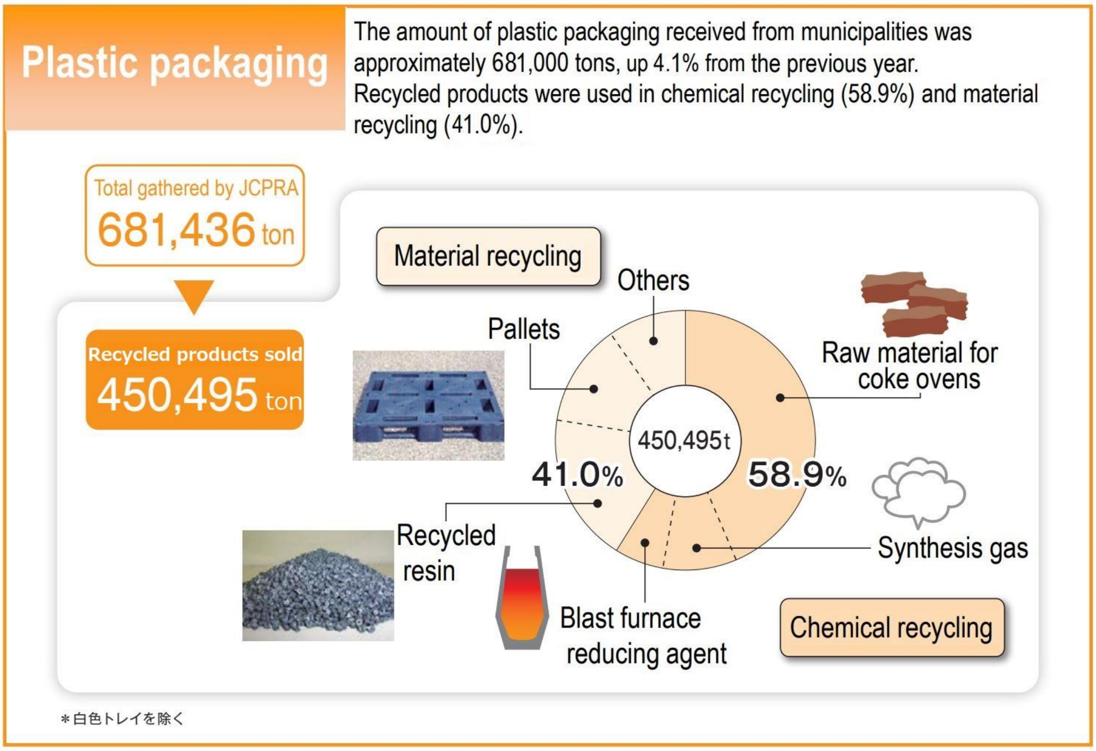
Source: The Japan Containers and Packing Recycling Association "Annual Report 2021" (2021)

Figure 3-19 Breakdown of Collected PET Bottles Waste Amount from Municipalities



Source: The Japan Containers and Packing Recycling Association "Annual Report 2021" (2021)

Figure 3-20 Breakdown of Collected Paper Packaging Waste Amount from Municipalities



Source: The Japan Containers and Packing Recycling Association "Annual Report 2021" (2021)

Figure 3-21 Breakdown of Collected Plastic Packaging Waste Amount from Municipalities

(2) Home Appliance Recycling Law

The *Home Appliance Recycling Law* established a new system for recycling by relevant entities to ensure the proper treatment of used home appliances and the effective recycling of resources found in the appliances. Under this scheme, retailers are obligated to take used home appliances from dischargers and deliver them to manufacturers, etc., and manufacturers are obligated to take the home appliances and recycle them. Additionally, given the problematic destruction of the ozone layer, it became necessary to properly treat the chlorofluorocarbons that are used in home appliances.

1) Background

TVs, air conditioners, refrigerators, washing machines, and other home appliances have been widely viewed as household essentials since Japan's period of high economic growth. Originally, used home appliances were discharged for municipal collection (roughly 600,000 tons as of 1997), and about half the collected used appliances were directly dumped into landfill sites because their size and weight made proper treatment difficult. Additionally, although home appliances contain iron, aluminum, glass, and many other useful resources, municipalities have difficulty recycling them. As a result, municipalities only collected some iron and other metals after shredding the used appliances. Consequently, the strain on remaining landfill capacity grew more severe, and highlighted the need for the reduction and recycling of waste as key issues. In light of these conditions, a new recycling system based on new obligations pertaining to home appliances for manufacturers and retailers, was created in an effort to effectively use resources and reduce waste by promoting the recycling of used home appliances.

Additionally, the proper treatment of used home appliances including the recovery of chlorofluorocarbons became an issue given the problematic destruction of the ozone layer by chlorofluorocarbons and environmental contamination by heavy metals and other harmful substances found in used home appliances.

2) Overview of Home Appliance Recycling Law

The *Home Appliance Recycling Law* defines four items of home appliance which are subject to the stipulations of this law, the role sharing by each party, the recycling and merchandising obligations, and expense claims, etc.

The four home appliances are air conditioners, TVs, refrigerators and freezers, and washing machines and dryers. All are large appliances that have their individual characteristics which make it difficult for municipalities to provide for their proper treatment after usage. Therefore, the proper treatment and disposal of the used appliances shall be implemented through allocation of roles to each of waste-generators, retailers and manufacturers (manufacturers and importers when relevant).

The waste-generators using home appliances will make efforts to use them for longer periods of time, and under the law will have to bear expenses necessary for recycling (i.e., collection, transport and recycling fees). The law further establishes the respective roles of the other parties: retailers selling home appliances will have to collect waste home appliances from waste-generators and deliver them to manufacturers, and manufacturers will then have to collect and recycle those wastes.

Name of law: Law for the Recycling of Specified Kinds of Home Appliances (Home Appliance Recycling Law)

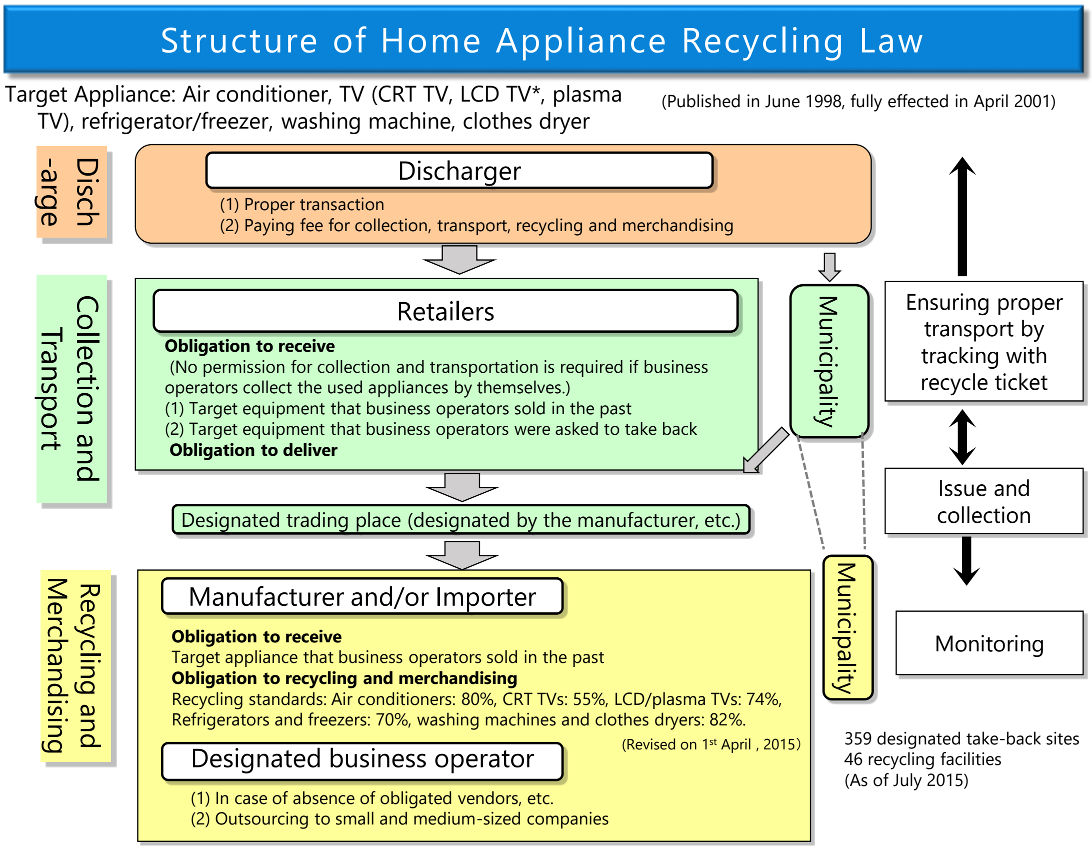
Enacted: 1998

Purpose: To ensure the effective use of resources and proper treatment of target home appliances that have become waste by sufficiently using recyclable resources, reducing waste, and the like through obligating retailers and manufacturers to implement certain measures in order to properly and smoothly collect, transport, and recycle waste.

Overview: The law sets out a new recycling system for four types of home appliances in which retailers are obliged to accept used home appliances from consumers (waste generators) and deliver them to manufacturers, and manufacturers are obliged to recycle them, among other things. The law sets out roles and responsibilities, for example obliging customers (waste generators) to pay fees for waste collection, transport, and recycling when they dispose of used home appliances.

Targets: Household air conditioners, TVs, electric refrigerators and freezers, and electric washing machines and dryers

Source: Law for the Recycling of Specified Kinds of Home Appliances (1998)



*: Excluding mobile TVs, car TVs and bathroom TVs, etc.

Source: Ministry of the Environment Website "Structure of Home Appliance Recycling Law"
https://www.env.go.jp/recycle/kaden/gaiyo.html (accessed February 16, 2022)

Figure 3-22 Overview of Home Appliance Recycling Law

3) Recycling System Stipulated in the Home Appliance Recycling Law

The *Home Appliance Recycling Law* covers waste units of four items of home appliances: TVs, air conditioners, refrigerators, and washing machines and dryers, and provides for a system by which consumers (waste-generators) of home appliances shall bear the expenses necessary for collection, transport and recycling process of their home appliances after they are discharged as waste.

A) Appliances Covered by Home Appliance Recycling Law

Air conditioners, TVs, refrigerators and freezers, and washing machines and dryers are covered by the *Home Appliance Recycling Law*. These items have been selected on the basis of the following requirements established in the law:

【Requirements for Waste Treatment of the Covered Appliances】

1 Considering the limitations of municipality's facilities and their technical capacities regarding waste treatment it is difficult for them to recycle and merchandise these waste home appliances.

2 It is especially important to recycle and merchandise these waste appliances in order to promote effective utilization of the many resources that are found in them, but for which there are significant economic constraints on recycling, etc.

3 The selection of design, parts etc. has significance on the implementation of recycling and merchandising.

4 As appliances retailers are engaged in the delivery of significant amounts of appliances, they have the capabilities and facilities to smoothly collect the used appliances.

Source： Ministry of Economy, Trade and Industry, "2019 Guidebook on *Home Appliance Recycling Law* for Use by Persons in Charge" (2019)

The four items of home appliances targeted in the law apply only to the appliances that were manufactured and sold for household use, and appliances that were manufactured and sold for business use are out of the scope of the law.

Table 3-22 shows the four items of home appliances covered in the law.

Table 3-22 Home Appliances Covered by the Home Appliance Recycling Law

Covered Home Appliances	Notes
Air conditioners for household use	—
TVs (cathode-ray tube type, LCD/plasma type)	Added LCD/plasma type TVs in April 2009
Refrigerators and freezers	Added freezers in April 2004
Washing machines and clothes dryers	Added clothes dryers in April 2009

B) The Roles of each Party related to Home Appliance Recycling

Table 3-23 shows the roles of each party as stipulated under the *Home Appliance Recycling Law*.

Table 3-23 Roles of each Party under the Home Appliance Recycling Law

Party	Roles	Overview of Roles
Waste-Generators (Consumers)	Proper delivery	To minimize wastes by using the four items of home appliances as long as possible. To be responsible to properly deliver the waste units to retailers, etc. at the time of discharging them in order to ensure recycling.
	Bearing of recycling fees	Consumers are obligated to pay collection, transport and recycling fees.
Retailers	Collection obligation	When waste-generators request retailers to collect any waste units of the four items of home appliances originally sold by the retailers, or waste-generators request retailers to collect any waste units when purchasing new items of the same types from them (i.e., replacement purchase), then in both cases retailers are obligated to collect the waste units at places designated by waste-generators (such as their homes)
	Delivery obligations	When retailers collect any of the waste units of the four items of home appliances from waste-generators, and except for cases where retailers re-use them by themselves, or retailers transfer these waste units with or without charge to other parties intending to reuse or sell them, the retailers are obligated to deliver the waste units to the manufacturer (if the manufacturer does not exist or is unknown, then to the designated corporation) at the designated collection place.
	Publication of collection/ transport fees	Retailers are obligated to set collection and transport fees in advance, and publicly display those fees in their stores, etc. The collection and transport fees shall be set taking into consideration costs of efficient collection and transport of the waste units of the four items of home appliances, and facilitating their proper discharge by waste-generators. In addition, retailers are obligated to respond to any inquiries concerning collection, transport or recycling fees.
	Issues and management of home recycle coupons	To issue manifests (home appliance recycling coupons) upon collecting any waste units of the four items of home appliances, and provide copies of the coupon to the waste-generators. Retailers have to retain, for three (3) years, home appliance recycle coupons delivered from manufacturers at designated collection places, and are obligated to respond to any requests for inspection by waste-generators.
Manufacturers (manufacturers and/ or importers)	Collection obligations	Manufacturers are obligated to collect, at designated collection places, any waste units of the four items of home appliances, etc., by themselves upon receiving a request for their collection.
	Recycling and merchandising obligations	Manufacturers are obligated, without delay, to recycle the waste units of the four items of home appliance that they collect by themselves. In addition, manufacturers are obligated to recover, reuse or destroy fluorocarbon refrigerants and fluorocarbon heat insulators found in the waste units. In this regard, manufacturers have to recycle them in accordance with the established standards of recycling and merchandising.

Party	Roles	Overview of Roles
Manufacturers (manufacturers and/ or importers)	Publication of recycling fees	Manufacturers are obligated to set recycling fees in advance, and publish them. Manufacturers have to set recycling fees that do not exceed the necessary costs for effective recycling, and do not prevent waste-generators from properly discharging their waste units.
	Suitable placement of designated collection places	Manufacturers are obligated to properly place the designated collection places, taking into consideration the geographical conditions, traffic circumstances, sales conditions for the four items of home appliances that they manufacture, and any other relevant conditions, in order that they can effectively recycle the waste units of the four items of home appliances, or can smoothly collect those waste units from retailers.
	Delivery and retaining of home appliance recycling coupons	Manufacturers are obligated to affix a receipt seal on home appliance recycling coupons submitted to them by retailers upon collecting the waste units of the four items of home appliances from retailers at designated collection places, and to deliver the sealed coupons to those retailers, and are further obligated to retain the copy of such coupons for three (3) years.
Central Government	Observance and guidance on enforcement status of *Home Appliance Recycling Law*	The central government is responsible to observe the performance status of obligations stipulated in the *Home Appliance Recycling Law* by retailers and manufacturers, etc. and to issue public notifications, perform guidance and impose sanctions as necessary.
	Information provision and public awareness building on home appliances recycling	The central government is responsible to provide information about home appliance recycling to consumers, etc. and make efforts to build public awareness.
Local Governments	Information provision and public awareness building for residents	Local governments are responsible to provide residents with information about proper waste-discharge and recycling of waste units of the four items of home appliances, and to better the understanding residents have through public relation activities, etc.
	Collection and recycling of waste of the four items of home appliances	Local governments are required to establish the collection system for waste units of home appliances of the four items that retailers are not obligated to collect. In this regard, under the *Waste Management Act*, local governments can recycle by themselves the waste units that they collect, or they can deliver those waste units to manufacturers for disposal.
	Efforts to prevent illegal collection or dumping	Local governments are required to police unlawful waste collection operators, and to make efforts to prevent illegal dumping.

Source: The Association for Electric Home Appliances Website "What is home appliances recycling system?"
https://www.aeha-kadenrecycle.com/system/?page=1#tab01 (accessed January 20, 2022)

4) Flow of Recycle Fees

The *Home Appliance Recycling Law* covers home appliances (such as TVs, air conditioners, refrigerators, and washing machines/dryers), and provides for a system by which consumers (waste-generators) shall bear expenses necessary for collection, transport and recycling process for home appliances they discharge as waste.

Expenses necessary for recycling (i.e., collection, transport and recycling fees) shall be borne by consumers (waste-generators), who are supposed to pay those fees to retailers upon discharge of any waste units of the four items of home appliances (no payment of fees will be made upon purchasing them). The recycling fees will be paid to manufacturers through retailers.

Collection and transport fees vary from region to region, and by retailer. Retailers are obligated to set collection and transport fees in advance and publicly display them in their stores, etc. Manufacturers (manufacturers and importers) are obligated to set recycling fees with detailed pricing tables depending upon respective appliances and types, and publish them in advance.

Table 3-24 shows examples of recycling fees.

Table 3-24 Examples of Recycling Fees

Item	Type	Size	Recycling Fees
Air Conditioners	—	—	JPY 900
TVs	Cathode-ray tube type	15 inch or smaller	JPY1,200
		16 inch or larger	JPY 2,200
	LCD / plasma type	15 inch or smaller	JPY 1,700
		16 inch or larger	JPY 2,700
Refrigerators / freezers	—	170 L or less	JPY 3.400
		170 L or more	JPY 4,300
Washing machines / dryers	—	—	JPY 2,300

*: 15 inch-size is 33.15cm wide, 16-inch size is 35.36cm wide.

Source: Ministry of Economy, Trade and Industry “2019 Guidebook on Home Appliance Recycling Law for Use by Persons in Charge” (2019)

5) Actual Performance and Impacts of the Home Appliance Recycling Law

The *Home Appliance Recycling Law* has diverted a large amount of waste units of home appliances from illegal dumping to the recycling process. In addition, securing the flow of proper recycling process, has contributed to the re-use of various valuable recyclables contained in the waste units of home appliances.

In 2020, approx. 16.02 million waste units of the four items of home appliances were collected at nation-wide designated collection places (approx. 8.4% increase from the previous year). The breakdown of these waste units comprised approx. values of 3.85 million air conditioners, 0.98

million cathode-ray tube type TVs, 3.00 million LCD/ plasma TVs, 3.71 million refrigerators/ freezers, and 4.48 million washing machines/ dryers. Table 3-25 shows the annual trend since 2016 for the number of waste units of the four items of home appliances discharged nation-wide.

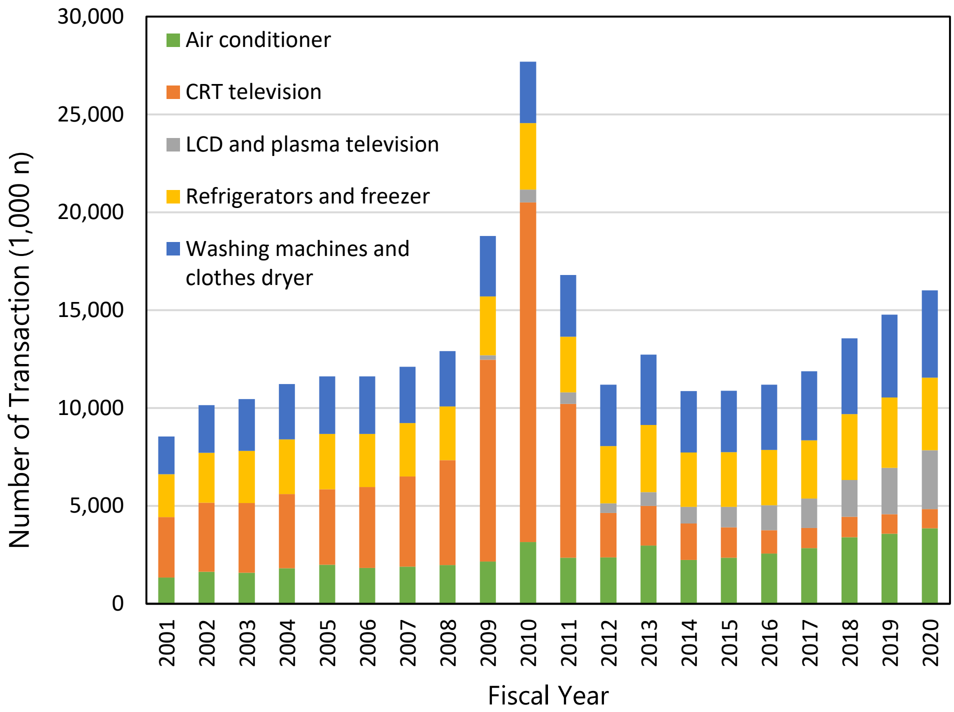
While the number of collected waste units of cathode-ray tube type TVs significantly increased from 2009 to 2011 due to the complete shift to digital terrestrial broadcasting in 2011, the total number of collected waste units of the four items of waste home appliances increased annually since 2014 (refer to Figure 3-23).

Table 3-25 Annual trend in Amounts of Collected Waste Units of the Four Items of Home Appliances

Unit: Million

Fiscal Year	Air conditioners	TVs		Refrigerators, Freezers	Washing machines, Dryers	Total
		Cathode-ray tube type	LCD / plasma type			
2016	2.567	1.184	1.278	2.829	3.339	11.197
2017	2.833	1.039	1.493	2.982	3.538	11.885
2018	3.398	1.035	1.894	3.354	3.880	13.561
2019	3.581	0.993	2.371	3.597	4.230	14.772
2020	3.854	0.983	2.998	3.709	4.476	16.020

*: Totals may differ due to rounding.
Source: Association for Electric Home Appliances “2020 Annual Report of Home Appliance Recycling” (2021)



Source: Association for Electric Home Appliances “2020 Annual Report of Home Appliance Recycling” (2021)
Figure 3-23 Annual Trend in of Amounts of Collected Waste Units of the Four Items of Home Appliances

From the waste units of the four items of home appliances delivered to recycling plants of home appliances manufacturers, iron, copper, aluminum, glass, plastic etc. are recovered as recyclable materials through recycling treatment (process for recycling and merchandising).

While the *Home Appliance Recycling Law* provides standards for each home appliance item to ensure recycling and merchandising (i.e., recycling and merchandising standards), all recycling plants have been achieving recycling and merchandising rates above the respective standards. Table 3-26 shows revisions of recycling and merchandising standards, while historical trends of recycling and merchandising rates for waste units of the four items of home appliances are shown in Table 3-27.

Table 3-26 Revision of Recycling and Merchandising Standards

Fiscal Year	Air conditioners	TVs		Refrigerators/ freezers	Washing machines, Dryers
		Cathode-ray tube type	LCD / plasma type		
Year Starting April 2001	60% or more	55% or more	Out of scope	50% or more	50% or more
Year Starting April 2009	70% or more	55% or more	50% or more	60% or more	65% or more
Year Starting April 2015	80% or more	55% or more	74% or more	70% or more	82% or more

*: "Recycling and merchandising" is defined as separating parts and materials, and re-using them as they are or after processing, as parts or raw materials in manufacture of new products, with or without charges."

Source: Association for Electric Home Appliances "2020 Annual Report of Home Appliance Recycling" (2021)

Table 3-27 Historical Trend of Recycling and Merchandising Rate for Waste Units of the Four Items of Home Appliances

Fiscal Year	Air conditioners	TVs		Refrigerators, Freezers	Washing machines, Dryers
		Cathode-ray tube type	LCD / plasma type		
2016	92%	73%	89%	81%	90%
2017	92%	73%	88%	80%	90%
2018	93%	71%	86%	79%	90%
2019	92%	71%	85%	80%	91%
2020	92%	72%	85%	81%	92%

Source: Association for Electric Home Appliances "2020 Annual Report of Home Appliance Recycling" (2021)

Table 3-28 shows the implementation status of recycling and merchandising of the waste units of the four items of home appliances in FS 2020.

Almost all of the waste units collected at the designated collection places in FY 2020 were processed for recycling and merchandising at recycling plants.

Considering the recycling and merchandising rates by waste units, the rate for air conditioners was 92% (above the recycling and merchandising standard of 80%), for cathode-ray tube type TVs 72% (above the 55% standard), for LCD / plasma type TVs 85% (above the 74% standard), for refrigerators/ freezers 81% (above the 70% standard), and for washing machines/dryers 92% (above the 82% standard). All items achieved recycling and merchandising rates above their respective recycling and merchandising standards.

Table 3-28 Implementation Status of Recycling and Merchandising of Waste Units of the Four Items of Home Appliances (FY 2020)

Items	Air Conditioners	TVs		Refrigerators, Freezers	Washing machines, dryers
		Cathode-ray tube type	LCD/plasma type		
Number of waste units collected at designated collection places	3.85million units	0.98 million unit	3,00 million units	3.71 million units	4.48million units
Numbers of waste units processed for recycling and merchandising	3.82 million units	1.00 million units	2.96 million units	3.64 million units	4.46 million units
Processing Weight for recycling and merchandising	154,908 tons	23,608 tons	51,707 tons	222,371 tons	178,168 tons
Weight of Recycling and merchandising	143,676 tons	17,006 tons	44,430 tons	180,148 tons	163,930 tons
Recycling and merchandising Rate	92%	72%	85%	81%	92%

Source: Association for Electric Home Appliances “2020 Annual Report of Home Appliance Recycling” (2021)

Table 3-29 show the breakdown of amounts of waste units processed for recycling and merchandising and reused as raw materials and parts, etc.

Regarding cathode-ray tube type TVs, 35% of processed waste amount, in terms of weight was recovered as cathode-ray tube glass, and a large quantity (27% to 44%) of iron was recovered from the other home appliance items. Copper and aluminum were recovered from waste units of all four items of home appliances, and then subjected to recycling and merchandising. Also, regarding other recyclables (such as plastics), large quantity (18% to 40%) was recovered and utilized as raw materials, etc.

Furthermore, the *Home Appliance Recycling Law* mandates the recovery of CFCs used as refrigerants and heat insulators in air conditioners and refrigerators, and the reuse and destruction of recovered CFCs. Non-recycled CFCs are destroyed in accordance with the “CFC Destruction Treatment Guidelines”.

Since *Home Appliance Recycling Law* subjected almost all waste units of home appliances to treatment at recycling plants and prohibited illegal dumping, the law significantly contributed to reducing the amount of illegal dumping for waste units of home appliances. In addition, proper treatment of waste units of home appliances was secured, significantly contributing to promotion of material recycling.

Table 3-29 Implementation Status for Material Recycling（FY 2020）

Unit: ton

Item	Air Conditioners	TVs		Refrigerators, freezers	Washing machines, dryers
		Cathode-ray tube type	LCD/plasma type		
Iron	41,228 (27%)	2,419 (10%)	20,262 (39%)	85,346 (38%)	78,107 (44%)
Copper	10,146 (7%)	969 (4%)	465 (1%)	4,104 (2%)	3,047 (2%)
Aluminum	11,792 (8%)	22 (0%)	1,948 (4%)	1,906 (1%)	3,551 (2%)
Mixed ferrous and non-ferrous materials	53,224 (34%)	54 (0%)	967 (2%)	27,749 (12%)	19,358 (11%)
Cathode-ray tube glass	—	8,372 (35%)	—	—	—
Other recyclables	27,286 (18%)	5,170 (22%)	20,788 (40%)	61,043 (27%)	59,867 (34%)
Total weight	143,676 (92%)	17,006 (72%)	44,430 (86%)	180,148 (81%)	163,930 (92%)

*1: “Other recyclables” means plastic, etc.

*2: % (percent) within brackets indicates the ratio to recycling and merchandising treatment by weight.

Source: Association for Electric Home Appliances “2020 Annual Report of Home Appliance Recycling” (2021)

(3) End-of-Life Vehicle Recycling Law

The *End-of-Life Vehicle Recycling Law* focuses on automobiles, which are manufactured using a large amount of useful resources, and promotes the recycling of useful resources contained in automobiles by defining the roles of each related entity in the recycling process. It also stipulates the proper treatment of chlorofluorocarbons against the background of the problem of ozone layer depletion.

1) Background

Roughly 3 million used vehicles are disposed annually, which are highly valuable in terms of recyclable resources, since they are consisted of great amount of metals (e.g. iron, which comprises approximately 70% in terms of weight). Roughly 80% of their gross weight was recycled, with the remaining 20% turned to shredder dust (plastic bits and other materials left over after dismantling and shredding) which are mainly disposed of in landfills.

However, factors such as the shortage of landfill sites and the associated increase in the cost of disposal gave rise to concerns over illegal dumping and improper treatment of used vehicles. Additionally, cars' air conditioners were full of fluorocarbon refrigerants, a factor that caused problems such as the destruction of the ozone layer and global warming; thus, proper collection and treatment became essential. Furthermore, Japan had confronted many new issues in the years leading up to the enactment of the law, including the need to use special techniques when demolishing the many used vehicles equipped with airbags which contain explosives.

2) Overview

End-of-life vehicles contain useful metals and parts which are of high value as resources, so they have traditionally been distributed, recycled, and processed through trades by dismantlers and shredders, and have been subject to recycling and treatment. However, due to the shortage of industrial waste final disposal sites, the need to reduce the amount of shredder dust generated from recycling processes of end-of-life vehicles has increased, and with the competing factors of high increases in costs of final disposal, and decline in iron scrap market prices, the threats of increased illegal dumping and improper treatment became serious issues. To mitigate all these concerns the *End-of-Life Vehicle Recycling Law* was enacted.

Name of law: Law for the Recycling of End-of Life Vehicles
(End-of-Life Vehicle Recycling Law)
Enacted: 2002
Purpose: To establish a new recycling system for promoting the recycling and proper treatment of used vehicles by obliging entities - namely manufacturers and importers of motor vehicles - to fulfill appropriate roles and responsibilities.
Overview of law: The law sets out roles and responsibilities pertaining to motor vehicle recycling for the owners of the vehicles, relevant business operators, and manufacturers and importers of motor vehicles. The law also requires motor vehicle manufacturers to accept and recycle shredder dust and airbags, and to accept and destroy chlorofluorocarbons, as these three articles in motor vehicles are difficult to treat and lead to illegal dumping. Additionally, the law requires the owners of used motor vehicles to pay fees for treatment and recycling of their vehicles.
Targets: Nearly all four-wheeled vehicles, excluding some vehicles (including trucks, buses, and other large vehicles, special-purpose vehicles, and commercial vehicles)

Source: Law for the Recycling of End-of Life Vehicles (2002)

3) Recycling System Defined in the End-of-Life Vehicle Recycling Law

The *End-of-Life Vehicle Recycling Law* covers end-of-life automobiles, and provides for a system by which automobile owners shall bear expenses necessary for the recycling process of their end-of-life automobiles.

A) Responsibilities of Relevant Entities

a. Owners of Vehicles (last owners)

Pay recycling fees. Deliver used vehicles to used vehicle collectors registered with the local government.

b. Used Vehicle Collectors

Accept used vehicles from their final owners, and deliver them to chlorofluorocarbon collectors or scrapping operators.

c. Chlorofluorocarbon Collectors

Properly collect chlorofluorocarbons in line with standards, and deliver the chlorofluorocarbons to the manufacturers or importers of the vehicles. After collecting chlorofluorocarbons, deliver car chassis to scrapping operators.

d. Scrapping Operators

Properly dismantle used vehicles in line with standards, collect the airbags, and deliver them to the manufacturers or importers of the vehicles. After scrapping the vehicles, deliver the chassis to shredding operators.

e. Shredding Operators

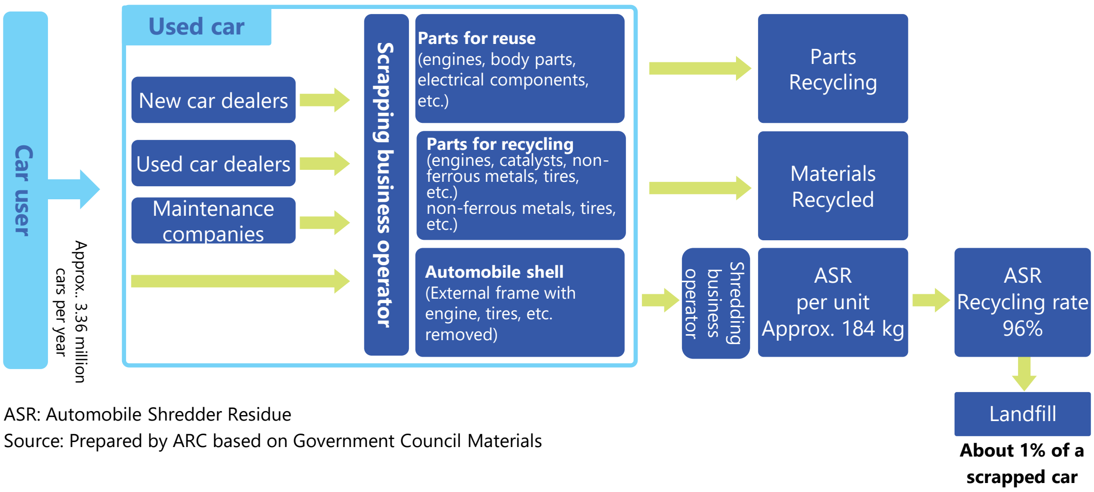
Properly shred (pressing, shearing treatment, shredding) dismantled vehicles (vehicle frame) in line with standards, and deliver the shredder dust (the waste that remains after scrapping/shredding the vehicles) to the manufacturers or importers of the vehicles.

f. Manufacturers and Importers

Accept and recycle the automobile shredder dust, airbags, and chlorofluorocarbons generated from the automobiles when automobiles manufactured or imported by the company are no longer in use..

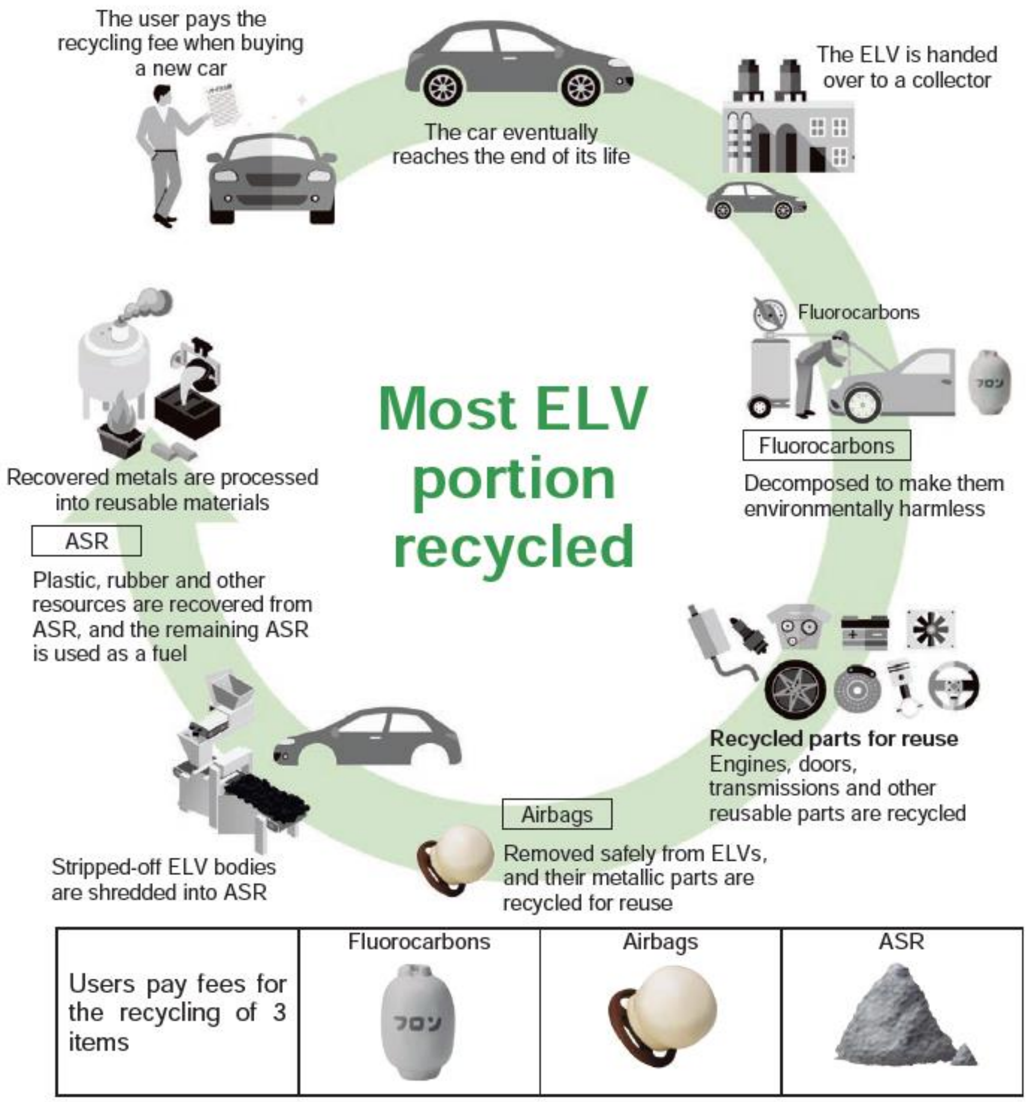
B) Flow of Recycling Process for End-of-life Automobiles

In recycling end-of-life automobiles, many stakeholders (such as automobile users, automobile sales operators, and treatment operators) are implementing recycling in cooperation with each other, under appropriate role sharing. Figure 3-24 and Figure 3-25 show the recycling process stipulated under the *End-of-Life Vehicle Recycling Law*, and the recycling flow.



Source：Japan Automobile Recycling Promotion Center "Go! Recycle Your Vehicle" (2021)

Figure 3-24 Recycling Process stipulated by End-of-life Vehicle Recycling Law



[1]. Automobile users pay recycling fees upon purchasing their automobiles.

[2]. Automobile users deliver their end-of-life automobiles to collection operators (such as automobile sales operators or automobile repair operators) who are registered or have permits issued by local governments.

[3]. Collection operators deliver the end-of-life automobiles to fluorocarbons recovery operators.

[4]. Fluorocarbons recovery operators collect fluorocarbons used in their end-of-life automobiles air conditioners, and then deliver the same to automobile maker or importers. Thereafter, fluorocarbons recovery operators deliver the end-of-life automobiles to dismantlers.

[5]. Dismantlers (scrapping operators) recover air bags from the end-of-life automobiles, and deliver the same to automobile manufacturers or importers. Dismantlers then remove useful parts or elements (such as engines or doors), and deliver the automobiles to shredder operators.

[6]. Shredder operators shred the end-of-life automobiles by using shredding machines, and recover useful materials (such as iron). Shredder operators deliver the sorted and collected shredder dust (ASR), to automobile manufacturers or importers.

[7]. Automobile manufacturers or importers properly treat the recovered shredder dust, air bags and fluorocarbons.

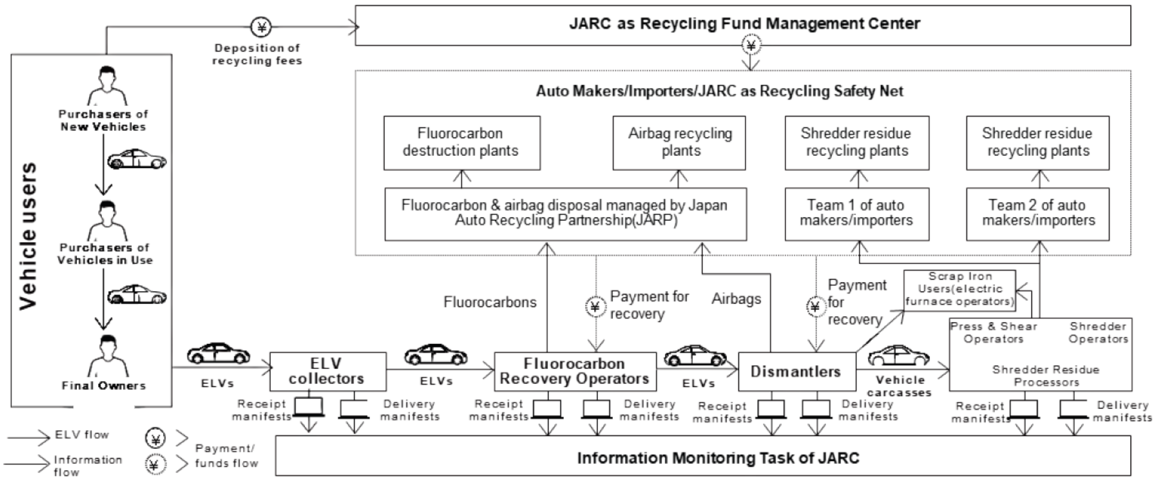
Source: Japan Automobile Recycling Promotion Center "10 questions to find out what people are doing to recycle automobiles for a sound material-cycle society" (2019)

Figure 3-25 Recycling Process of End-of-life Vehicles

4) Flow of Recycling Expenses

The *End-of-Life Vehicle Recycling Law* establishes a system under which vehicle owners bear the costs necessary to recycle end-of-life vehicles they dispose of.

Under the *End-of-Life Vehicle Recycling Law*, automobile owners are in principle supposed to bear recycling fees of their own automobiles upon purchasing the automobile. Recycling fees paid by automobile owners are managed by the fund management corporation which has been designated by the central government, in order to prevent any losses due to bankruptcy or dissolution of automobile manufacturers, etc. When recycling shredder dust, air bags and others, automobile manufacturers, dismantlers etc. will request payout of those fees from the fund management corporation. Figure 3-26 shows the flow of recycling fees.



Source: Japan Automobile Recycling Promotion Center "10 questions to find out what people are doing to recycle automobiles for a sound material-cycle society" (2019)

Figure 3-26 Recycling Fee Flow under the End-of-Life Vehicle Recycling Law

Expenses included in recycling fees paid by automobile owners are shown in Table 3-30.

Table 3-30 Breakdown of Expenses of Recycling Fees

Setting Party	Composition	Use of Fees
Automobile manufacturer, importers	Shredder dust	Expenses to recover shredder dust, and properly treat them.
	Air Bags	Expenses to recover air bags, and properly treat them. Remaining metal parts will be used as raw materials.
	Fluorocarbons	Expenses to recover fluorocarbons, and then to thermally decompose them and make them harmless.
Japan Automobile Recycling Promotion Center	Information management fees	Expenses necessary to electronically manage the status of proper treatment of end-of-life automobiles.
	Fund management fees	Expenses necessary for receipt, administration and management of recycling fees

Source: Japan Automobile Recycling Promotion Center Website "Recycling Fee" https://www.jarc.or.jp/automobile/fee/feeindex/ (accessed February 2, 2022)

Expenses related to shredder dust, air bags, and fluorocarbons included in the recycling fees are not uniform rates, but should be set and published by automobile manufacturers or importers. On the other hand, information management fees and fund management fees (which are expenses for management of recycling expenses by the fund management corporation) are fixed amounts (approx. JPY 500 per automobile; approx. US$ 5.00 per automobile).

Table 3-31 Ranges of Recycling Fee Rates

Type of Automobiles	Recycling Fee Rate
Standard passenger cars (with A/C and four (4) air bags)	In the range of JPY10,000 to JPY18,000 （US$91.00～US$164.00）
Light and small passenger cars (with A/C and four (4) air bags)	In the range of JPY 7,000 to JPY16,000 （US$64.00～US$145.00）
Middle and large-size trucks (with A/C and two (2) air bags)	In the range of JPY10,000 to JPY16,000 （US$91.00～US$145.00）
Large-size fixed-route buses / sightseeing buses (with A/C and two (2) air bags)	In the range of JPY10,000 to JPY65,000 （US$364.00～US$591.00）

*: US$1.00=JPY110

Source: Ministry of Land, Infrastructure, Transport and Tourism Website "Ministry of Land, Infrastructure, Transport and Tourism and *End-of-Life Vehicle Recycling Law*"
https://www.mlit.go.jp/jidosha/sesaku/environment/recycle/recycle/charge02.html (accessed February 15, 2022)

5) Actual Performance and Impacts of Recycling of End-of-Life Automobiles

The *End-of-Life Vehicle Recycling Law* significantly reduced the number of end-of-life automobiles illegally dumped or improperly stored. In addition, the law promoted recovery of fluorocarbons and recycling of shredder dust, leading to substantial impacts upon recycling end-of-life automobiles.

Almost all end-of-life automobiles are being recycled. The recycling rate of air bags is 95%, as iron, copper, aluminum, etc. that are found in airbags are recycled for use as resources. Shredder dust are processed by material recycling or thermal recycling, and 0.56 million tons (about 3 million automobiles) were recycled in FY 2020, at a rate of 96% of the generated end-of-life vehicles generated as waste.

Since January 2005 when the *End-of-Life Vehicle Recycling Law* was enacted, the number of end-of-life automobiles subject to illegal dumping or improper storing was significantly reduced. Compared with the situation in September 2004 (i.e., before the enforcement of the law), the number of illegally dumped end-of-life automobiles as of March 2021 was 560 (a decrease of 21,939), and the number of improperly stored automobiles was 5,194 (190,666 decrease), leading to a reduction achievement of 5,754 automobiles in total, i.e., a reduction rate of more than 97%.

Table 3-32 Trend in Recycling of Specified Automobile Parts

＜Air bags＞

Items	Standard (Target)	Actual in FY 2019	Actual in FY 2020
Air bags	85%	94~95%	95~96%

＜Shredder Dust＞

Items	Actual in FS 2005	Actual in FY 2019	Actual in FY 2020
Weight of Shredder Dust Collected ①	480,463 tons	601,055 tons	564,895 tons
Weight of Shredder Dust Recycled ②	297,130 tons	576,787 tons	542,718 tons
Recycling Rate （②／①）	61.8%	96.0%	96.1%

Source: Japan Automobile Recycling Promotion Center Website “Achievements to date”
https://www.jarc.or.jp/automobile/effort/ (accessed March 1, 2022)

Table 3-33 Trend in Illegal Dumping and Improper Storing of End-of-life Automobiles

Items	As of End of September 2004	As of End of March 2021
Illegal dumping ①	22,499 vehicles	560 vehicles
Improper Storing ②	195,860 vehicles	5,194 vehicles
Total （①＋②）	218,359 vehicles	5,754 vehicles

Source: Japan Automobile Recycling Promotion Center Website “Achievements to date”
https://www.jarc.or.jp/automobile/effort/ (accessed March 1, 2022)

(4) Charging Fees for Waste Management

Municipalities are responsible for management of municipal wastes. Municipalities procure budgets necessary for waste collection and transport, and provide residents with collection and transport services as part of government services, either directly by themselves, or outsourcing those services to other entities. Many municipalities have introduced waste management fees due financial constraints, as well as for the purposes of raising the awareness of residents about reducing the generated waste amounts and extending the life of landfill sites.

1) History of Charging Fees

In the past, some areas had already introduced waste management fees, but the number of municipalities introducing the fees has since changed in response to the legal system and economic conditions.

During the era of the *Waste Cleaning Act* (1900 to 1954) municipalities could not legally charge fees for waste collection. Municipalities imposing waste management fees increased during the post-war era when the waste services were governed by the *Public Cleansing Act* (1954 to 1970), but thereafter in the period spanning the late 1960's to early 1970's, the number of municipalities imposing fees decreased. Thereafter from the late 1970's to the 1980's, the number of municipalities imposing fees remained almost unchanged. From 1970 to 2000, during the era of the *Waste Management Act* (1970 to 2000), the introduction of management fees was postponed due to various reasons, including the issue of maintaining public services for residents and the anticipated workload of collecting fees.

After the 1990s, and in order to address issues such as an increase in the amount of waste and a shortage of landfill sites, charging management fees for the purpose of reducing the amount of waste generated has been promoted, and the number of municipalities charging fees increased once more.

2) Purpose of Charging Fees and Expected Impacts

The municipalities are responsible for management of municipal wastes. The costs thereof are principally covered by municipal taxes. Since 2005, an increasing number of municipalities have started charging fees with the purpose of reducing the generated waste amounts.

In 2015, the Central Environment Council issued "Opinion about Desirable Processing of Municipal Wastes by Municipalities towards Building Sound Material-Cycle Society (2015)", recommending the desirable management of municipal wastes the municipalities should implement, as well as encouraging the involvement of the central government, in pursuit of establishing a sound material-cycle society. In response, the Ministry of the Environment revised the "Basic Guidelines for the Comprehensive and Systematic Promotion of Waste Reduction Measures and Other Appropriate Treatments", which is established by the Minister of Environment as stipulated under Article 5-2, paragraph (1) of the *Waste Management Act*. With this revision, the Ministry clarified that the policy on nation-wide measures is to promote charging fees for municipal waste management.

In response to this revision, the "Guidance for Charging Fees on Municipal Waste Treatment (Established June 2007, revised April 2013)", was prepared by the Ministry of the Environment for municipalities, and explains the purpose of charging fees, and their expected impacts, as follows.

【Purpose of Charging Waste Treatment Fees and Expected Impacts】

(1) Promotion of Waste Minimization and Recycling

Charging fees for municipal waste treatment will incentivize reducing of expenses bearing, leading to expectation to minimize generated-municipal waste amount.

The amount of waste generated has a major impact on the scale and construction timing of treatment facilities such as incineration facilities and final disposal sites. Reduction of generated waste amounts will make it possible to develop or improve smaller treatment facilities, as well as to extend the lifetime of landfill sites. In addition, reducing of incineration treatment amounts will contribute to minimization of greenhouse gas emission.

In this regard, comparing with fees for combustible wastes and incombustible wastes, the fees for recyclables can be set at lesser levels or even without charge, and thereby differentiated fee levels, promotion of sorting, as well as an increase of resource recovery amounts will be expected.

(2) Ensuring Fairness

Municipal waste treatment service implemented solely by tax revenues, will not provide differences in cost sharing depending upon extent of services provided, with more service necessary for residents generating more waste compared to residents generating less waste. There is also further concern that some people are receiving waste treatment services in their municipality of residence, while they are registered in another municipality where they pay their residence taxes, and therefore are unfairly receiving the services free of charge. By introducing service charging fee that is proportional to the generated waste amount, more fairness of cost sharing can be ensured.

Furthermore, for small business operators, or business operators generating smaller waste amounts, some municipalities collect their generated waste as household wastes, and do not collect treatment expenses. However, if these municipalities charge fees directly to households, it will be necessary to charge fees to those business operators as well, in order to maintain fairness.

(3) Raising Awareness of Residents and Business Operators

If fees are not charged on discharge of municipal wastes, economic incentives for waste minimization will be smaller, because there is no match between waste discharge and timing of cost sharing, and discharged-waste amount and amount of shared costs.

Introduction of fees will lead to cost sharing in proportion to the discharged municipal waste frequencies and amounts of municipal waste, and will increase the necessity for municipalities to explain to residents and business operators about municipal waste treatment expenses, etc. Introduction of fee charging will therefore raise the awareness of residents and business operators about waste treatment expenses, and improve their overall understanding on the consequences of generating waste. As a result, waste minimization may finally take root as residents select less-waste generating products (such as simply packaged products and refilling products), minimize purchase of unneeded or non-urgent products, and promote the reuse of products, and on the other hand, business operators will thoroughly sort waste and promote reuse.

(4) Other Impacts

It is anticipated that environmental burden, as well as expenses for waste collection, transport and treatment will be reduced, because minimization of municipal waste, and promotion of recycling will reduce the waste amounts carried into incineration treatment facilities and final disposal sites. In addition, revenues obtained from charging fees may be allocated to implement measures for the purpose of building sound material-cycle society, such as separate collection and recycling, as well as providing support for group collection.

Source：Ministry of the Environment, "Guidance for Charging Fees on Municipal Waste Management" (2013)

3) Methods of Charging Fees

Most of the waste fees are collected through the designated waste bag method or seal method. Regarding household waste (excluding bulky wastes), many municipalities have adopted the method of selling waste bags designated by the relevant municipality with the fees added to the sale cost.

Regarding business wastes, methods differ by municipality. Some municipalities that collect business waste employ the designated waste bags or seals methods. However, most municipalities do not collect business wastes, and business operators must either arrange for approved collection operators to collect their waste, or deliver the waste directly to the treatment facilities. In the latter case, the waste receiving fees are set depending on the wastes delivered by the operators.

Furthermore, regarding fee structures, depending upon the characteristics of regions, etc. various methods are adopted, such as the simple proportion formula, multi-step proportion formula, and quantitative formula),.

Table 3-34 Advantages and Disadvantages of Designated Waste Bag Method and Seal Method

Item	Designated Waste Bag Method	Seal Method
Advantages	・Possible to collect fees in proportion to the bag size ・Does not decrease work efficiency because bags can be more easily identified as designated bags during collection.	・Other bags, such as plastic shopping bags can be used. ・In cases where municipalities manage the service, seals have less weight and are compact in size, and as a result storing expense and working burdens are reduced.
Disadvantages	・Bags other than the designated ones cannot be used. ・In cases where municipalities manage the service, designated bags are heavy and large in size, leading to increased storing expense and working burdens.	・It is difficult to collect fees responding to size (there is an issue of not using the proper seals) ・It is likely that seals will be removed and used for other wastes. ・It is less easier to identify specific seals, leading to reduced working efficiency.
Actual Introduction	Many municipalities have introduced this method.	Not many municipalities have introduced this method.

Source: Yachiyo Engineering Co., Ltd.

Photo 3-12 Designated Waste Bag (Kyoto City)

Source: Ota City "How to separate and dispose of resources and waste" (2021)

Photo 3-13 Seals for Bulky Waste (Ota City in Tokyo)

(Left : For plastics, Right : For Combustible waste)

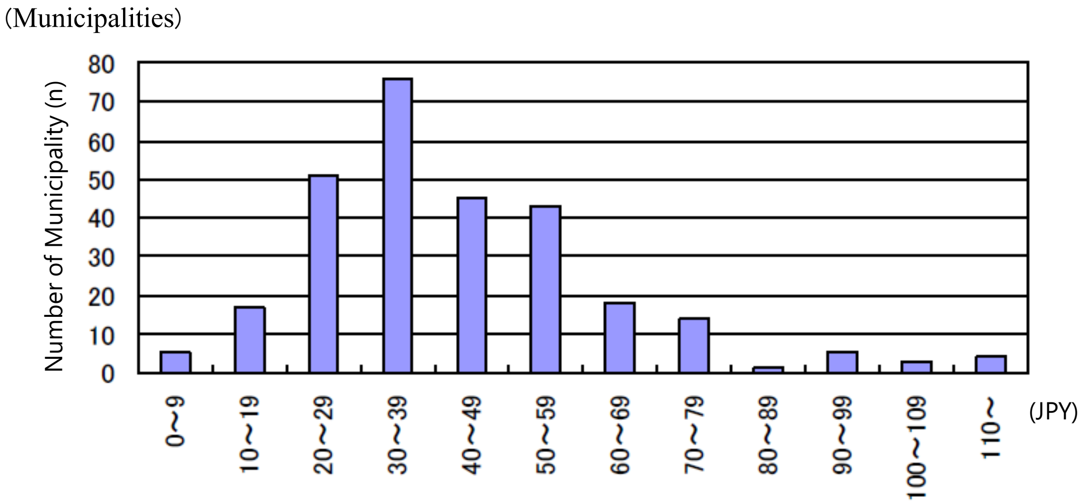
*: Kyoto City's designated 30 liters waste bags for plastics are sold at JPY 75 per pack of 5 bags and JPY 300 per pack of 10 bags for combustible waste.

4) Setting of Fees

According to the "Guidance for Charging Fees on Municipal Waste Management", fees should be set for waste treatment "in consideration of the effects of municipal waste minimization and recycling promotion, public acceptability, fee levels in surrounding municipalities and other factors." The guide shows that for recycling promotion, it is appropriate to set a difference in fee levels among different types of waste by either waiving the charge or setting a low fee for recyclables treatment.

As waste-generating business operators are obliged to properly treat business waste at their own responsibilities, it is desirable to collect a fee equivalent to the cost of waste management. On the other hand, the relevant fee is sometimes waived or set at a low fee level as a support for small and medium-sized firms and local industries, or other purposes. In this case, efforts are made as much as possible to reduce financial burdens of municipalities, such as obliging the waste-generating business operator benefiting from this support to submit a plan for reduction of waste generation.

The ratio of the charged fee to household waste management costs varies from about 10% to over 30%, as each municipality sets the fee in consideration of its own actual situation. Figure 3-27 shows the distribution of fee levels adopted by the municipalities and set by simple proportion to waste discharge (price per one large garbage bag, of 40 to 45 liters). For household waste, the collection fee of JPY 30 per large bag is the most common amongst the municipalities, after which the number of municipalities tends to decrease as the fee increases.

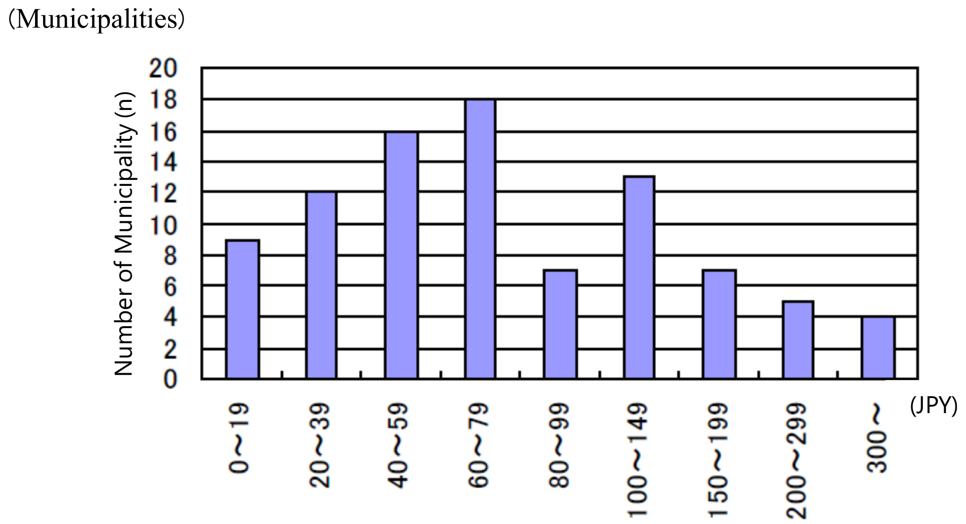


【Price per large garbage bag (40 to 45 liters)】

Source: Ministry of the Environment "Questionnaire survey for the promotion of 3R and reduced carbon emissions in waste and recycling fields" (2011)

Figure 3-27 Distribution of Fee Levels set by the Simple Proportion Formula to Household Waste Discharge

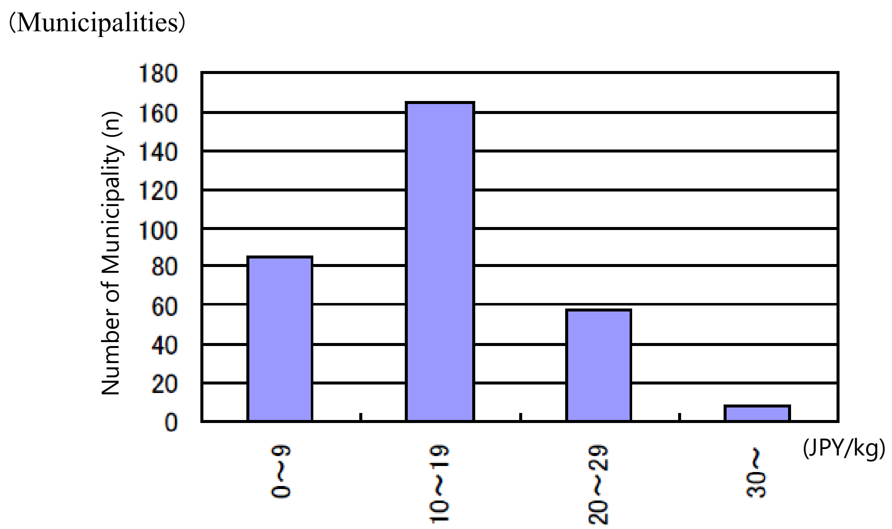
The price of each large waste bag for business waste, which peaks at 60 to 79 JPY, is set higher than that for household waste. On the other hand, the collection fee for 1 kg of business waste directly delivered to the waste treatment facility peaks at the 10 JPY level and accounts for 50% of the total.



【Price per large garbage bag (40 to 50 liters)】

Source: Ministry of the Environment "Questionnaire survey for the promotion of 3R and reduced carbon emissions in waste and recycling fields" (2011)

Figure 3-28 Distribution of Fee Levels Set by the Simple Proportion Formula to Business Waste Discharge



【Price per kilogram of directly incoming business waste】

Source: Ministry of the Environment "Questionnaire survey for the promotion of 3R and reduced carbon emissions in waste and recycling fields" (2011)

Figure 3-29 Distribution of Fee Levels Set by the Simple Proportion Formula to Business Waste Directly Delivered to Facilities

5) Achievements of Charging for Waste Collection

Of the total 1,741 municipalities, 1,140 municipalities (65.5% of total municipalities) introduced fee charging for collection of household waste (excluding bulky waste) in 2019. In addition, 1,501 municipalities (86.2%) introduced fee charging for collection of business waste (excluding bulky waste).

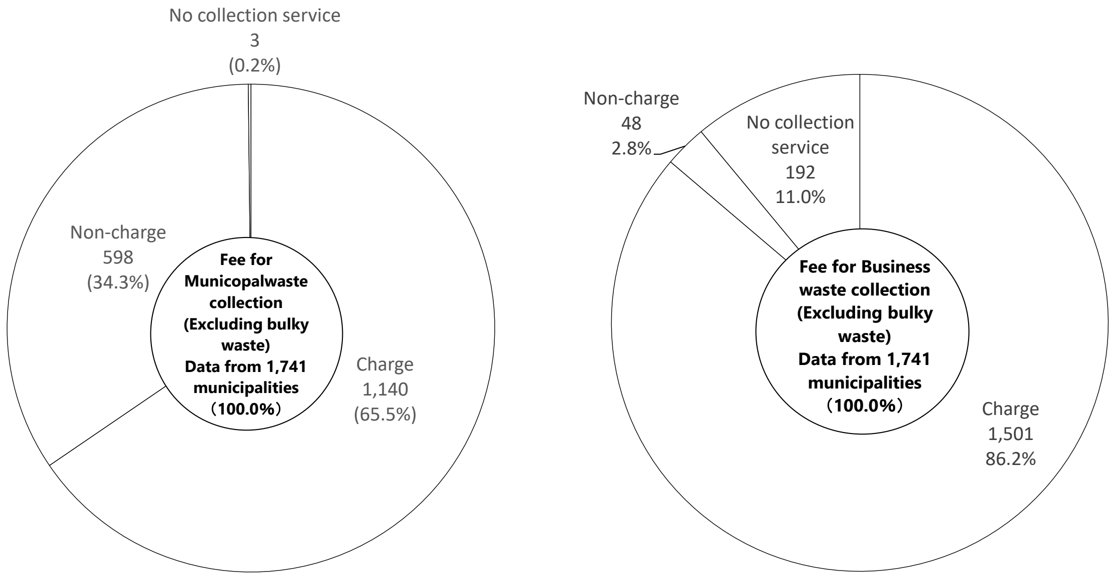
Table 3-35 Number of Municipalities by Status of Fee Charges Introduction for each Type of Waste Collection in 2019

Unit: Number of municipalities

Discharge pattern \ Waste types		Mixed waste	Combustible waste	Incombustible waste	Recyclables							
					Paper items	Paper packaging	Paper containers/ packaging	Metals	Glass items	Plastic bottles	White plastic trays	Plastic containers/
Household waste (Waste for collection)	Charge	40	1,086	838	103	83	103	357	345	336	251	296
	No-charge	20	607	786	1,389	1,337	1,119	1,280	1,325	1,375	1,008	856
	No collection	1,681	48	117	246	321	519	104	71	30	182	589
Business Waste (Waste for collection)	Charge	54	1,459	1,090	518	427	397	694	710	638	420	352
	No-charge	4	45	70	303	278	233	234	239	264	157	137
	No collection	1,683	237	581	920	1,036	1,111	813	792	839	1,164	1,222

Discharge pattern \ Waste types		Recyclables							Other waste for collection	Any one of the preceding items, charged	Bulky waste	Any one of the preceding items including bulky waste, charged
		Plastic items	Clothes	Kitchen waste	Edible oil waste	Pruned branches	Compact home appliances	Other				
Household waste (Waste for collection)	Charge	98	96	96	10	32	104	60	118	1,140	1,118	1,409
	No-charge	229	868	129	532	153	833	499	646	598	361	329
	No collection	1,414	749	1,516	1,199	1,556	804	1,182	977	3	262	3
Business Waste (Waste for collection)	Charge	140	252	181	62	120	121	151	228	1,501	820	1,509
	No-charge	48	103	45	72	15	63	64	90	48	43	40
	No collection	1,553	1,386	1,515	1,607	1,606	1,557	1,526	1,423	192	878	192

Source: Ministry of the Environment "Waste Disposal in Japan (FY2019)" (2021)



Source: Ministry of the Environment "Waste Disposal in Japan (FY2019)" (2021)

Figure 3-30 Number of Municipalities by Status of Fee Charges Introduction for each Type of Waste Collection in 2019

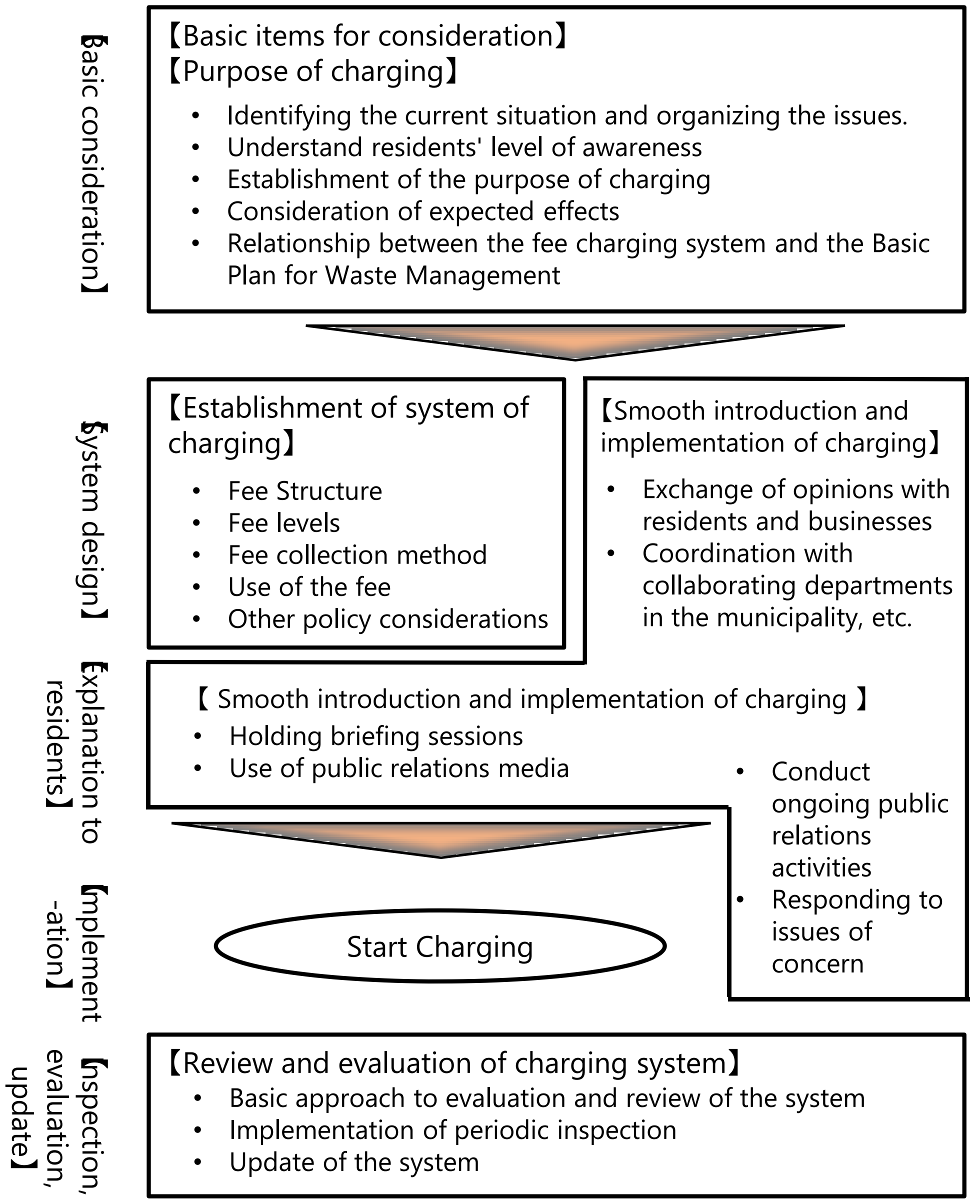
6) Processes for Introduction of Charging for Waste Collection and Items of Review

The "Guidance for Charging Fees on Municipal Waste Treatment" (April 2013) prepared by the Ministry of the Environment provides a road map for municipalities to examine the introduction of charging for waste collection and start charging.

The processes for introduction of charging for waste collection, and the items of review are shown in the guidance.

A) Whole Process for Introducing Fee Charging for Waste Treatment

The basic process for municipalities to introduce fee charging is shown in Figure 3-31.

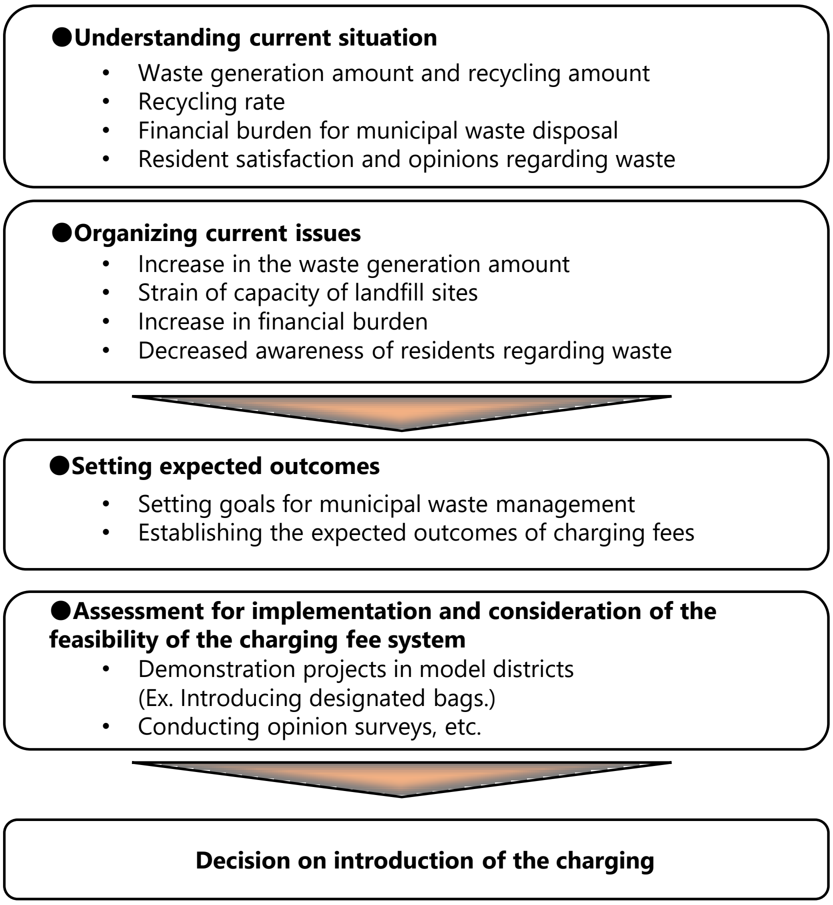


Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Figure 3-31 Basic Process for Introducing Charging fees for Municipal Waste Management

B) Assessment on Whether to Introduce Charging for Waste Management

It is important to clarify the relationship between charging for waste collection and basic policies or strategies/measures for waste management, the issues to be solved due to charging and the target effect of charging before assessing whether to introduce charging or not. Many municipalities have introduced charging systems, with the goal of reducing waste generation and extending the life of landfills through raising residents’ awareness. An example of an effective assessment flow for introduction of charging is shown in Figure 3-32. The interested municipality collects and organizes information on waste collection in its region, to form an understanding of the “current situation” of waste management and organizes the “current issues” to be solved. After that, the municipality proceeds to “setting expected outcomes” from introducing charging and to implementing “Demonstration projects in model districts” in order to assess the feasibility of charging fees, and thereby have sufficient information to reach a “Decision on introduction of charging fee” in the municipality.



Source: Ministry of the Environment “Guidance for Charging Fees on Municipal Waste Management” (2013)

Figure 3-32 Example of Assessment Process for Introduction of Charging Fees

C) Items of Review at each Stage in Introduction of Charging Fees on Waste Management

When the introduction of charging is decided, items required to start charging are reviewed in line with the steps defined in the basic process flow (shown earlier in Figure 3-32) and after completion of the "Basic items for consideration", namely; "Establishment of system of charging fees" → "Smooth introduction and implementation of fee charging" → "Review and evaluation of fee charging system". Also, after the start of charging fees, it is important to assess and review the charging system on a regular basis with the aim to attain a sustainable charging system. The review items at each stage are shown in Table 3-36 to Table 3-38.

Table 3-36 Review of "Establishment of System of Charging fees"(1)

Review item	Overview
1. Fee schedule	The method to set a fee schedule based on the "type of simple proportion to waste discharge (in which fees charged to waste generators depend on the municipal waste amount they discharge)" is the simplest way that the public can easily understand. With a focus on this method, as needed, other ideas can be considered, such as multistep fees, non-charging for collection of partial waste, and greater fee burden on business operators with a large amount of waste discharge.
2. Fee level	The fee level is set considering the effect on the control of municipal waste discharge, promotion of recycling, acceptability of residents and fee levels in surrounding municipalities
3. Method for fee collection	In the case of household municipal waste, the standard methods for collecting fees is to sell designated municipal garbage bags with the fees added on the selling price, and stickers which are attached to garbage bags. On the other hand, in the case of business-related municipal waste, the standard method is to measure the weight of the waste when bringing it in to the waste treatment facilities and collect the fees accordingly. The fee collection method should be determined in consideration of the fee structure and advantages, amongst others.
4. Use of fee revenues	It is necessary to determine the appropriate use of the fees collected under the charging system for municipal waste treatment, in addition to the expenses necessary for the operation of charging fees, and to make this usage transparent. In addition, it is expected that by specifying the usage that contributes to the control of municipal waste discharge and the promotion of recycling, it will be possible to deepen residents' and businesses' understanding of the fee charging system and raise their awareness on waste discharge control.
5. Combination with other measures	In order to control the discharge of municipal waste and promote recycling, in addition to fee charging for municipal waste disposal, it is required to reassess the separate waste collection categories, provide public funds for group collection of recyclables, and support retailers that are working on waste generation control and recycling. In addition other measures should also be considered, such as certification and support of eco-shops, and promotion of reuse.

Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Table 3-37 Review of "Smooth Introduction and Implementation of Fee Charging"

Review item	Overview
1. Collaboration with concerned parties towards smooth introduction	In order to smoothly introduce and implement fee charging of municipal waste treatment, it is necessary to exchange opinions with residents at the stage of "Review and evaluation of fee charging system" and incorporate their ideas into the charging mechanism.
2. Collaboration with concerned parties towards smooth implementation	In order to smoothly implement fee charging of municipal waste treatment, relevant information shall be provided to residents and business operators through convening of explanatory meetings, using the PR system of the municipality and other means. It can be expected from these efforts that residents and business operators will deepen their understanding of fee charging and waste management and pay the waste treatment fees.
3. Response to concerned issues	In order to smoothly implement fee charging for municipal waste treatment, it is required to consider in advance the issues that may surface during implementation, such as improper discharge of waste, illegal dumping and low achievement in waste discharge control, and prepare the necessary countermeasures to confront such issues should they occur.

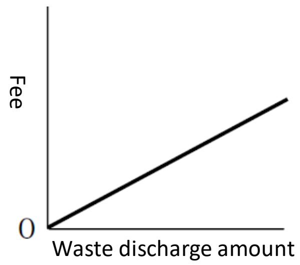
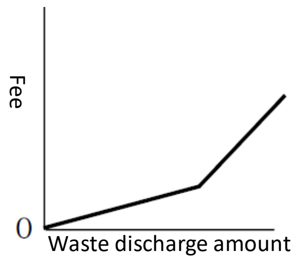
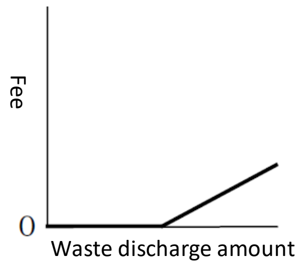
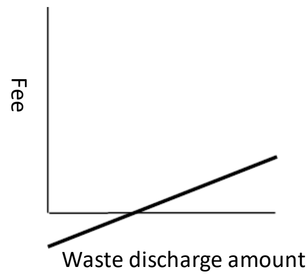
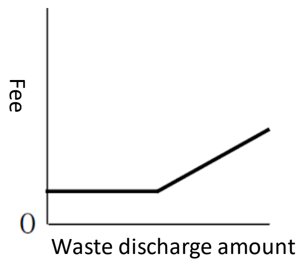
Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Table 3-38 Review of "Review and Evaluation of Fee Charging System"

Review item	Overview
1. Basic concept of assessment and review of fee charging system	In order to implement an effective charging system, the implementation conditions and their effects shall be inspected annually, while the evaluation of the system shall be carried out once every 5 years, based on the annual inspection results, and shall be reassessed together with the reassessment of the waste disposal master plan. In addition, the results of annual inspections and evaluation shall be made public to residents and business operators.
2. Implementation of inspection	After introducing the fee charging system for municipal waste treatment, the status and effects of charging shall be inspected every year. Based on the inspection results it is required to consider and implement measures to maintain and improve the system as necessary. Information on the implementation status and results shall be made public to the residents and business operators.
3. Evaluation of the system	The fee charging system shall be evaluated once every 5 years together with the reassessment of the waste management plan, the merger of municipalities or any other occurrence that has a significant effect on waste management in the municipality.

Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Table 3-39 Fee Structure and Mechanism by Type (1)

Type	Fee structure chart*	Fee mechanism
(1) Simple proportion to waste discharges		Under this method a waste generator is charged fees according to the municipal waste amount discharged. A fee level per unit waste amount is fixed regardless of waste amount discharged. For instance, if a unit price is charged for the collection of each garbage bag as the fixed collection fee, the total fee charged to a waste generator will equal the product of the unit price of collection charge per garbage bag and the number of garbage bags used. (Flat fee).
(2) Multistage proportion to waste discharges		Under this method a waste generator is charged a fee according to the waste amount discharged, and when the amount of waste exceeds a certain amount, the fee level per unit amount of waste is raised. (Progressive fee)
(3) Non-charging for collection of a fixed amount of waste		Under this method no fee is charged until the waste discharged reaches a fixed waste amount, after which a waste generator is charged a fee according to the waste amount discharged. For instance, municipalities distribute a certain number of garbage bags and stickers required for discharging waste free of charge, and if a waste generator needs more garbage bags and stickers, the waste generator purchases the additional garbage bags and stickers for a fee.
(4) Combination of burden and subsidy for waste collection		Under this method the fee is free up to a fixed discharged waste amount, after which waste generators are charged fees according to waste amounts discharged up to a second fixed waste discharge amount. Should the discharged waste amount be less than the second fixed waste amount, then discharge savings are passed on to waste generators according to the reduced discharged amounts. For instance, municipalities distribute to waste generators at no charge, a fixed number of garbage bags or seals required for waste discharge. Generators pay for additional bags or seals they may need. On the other hand, generators can sell back to municipalities unused garbage bags or seals.
(5) Combination of fixed-fee and pay-for-use systems		Under this method a fee is charged regardless of the waste amount discharged up to a fixed waste amount. When the discharged waste amount exceeds this fixed amount, waste generators are charged according to their discharged waste amounts at a fixed fee.

*: (Source) Yukiko OCHIAI (1996) "Approach to Waste Reduction by Charging of Household Waste - Questionnaire Survey for 533 Cities in Japan and Introduction of Municipality Cases- " Life Design Laboratory

Table 3-40 Fee Structure and Mechanism by Type (2)

	Advantages	Disadvantages
(1) Simple proportion to waste discharges	・The system is simple and easy-to-understand. ・It is unnecessary to manage each waste generator's waste discharges, and the system is operated at a lower cost than other fee systems.	・The case of a low fee level may not lead to control of waste discharge.
(2) Multistage proportion to waste discharges	・A higher fee level in the case of a large amount of discharged waste can be expected to motivate large waste generators to control waste discharge.	・The cost for operating this fee system will increase as it is necessary to identify the waste amount discharged by each generator which will require additional operating resources.
(3) Non-charging for collection of a fixed amount of waste	・The employment of the pay-for-use system only for the amount of waste discharged above the fixed discharged waste amount can be expected to control discharge amounts below the fixed amount.	・There is less incentive to motivate control of discharge within a range in which there is no charge. ・In order to identify the waste amount discharged by each generator costs will be incurred (e.g. cost for distribution of garbage bags used up to a fixed amount of discharged waste), which will increase the cost for operation of the system.
(4) Combination of burden and subsidy for waste collection	・The employment of the pay-for-use system only for the amount of waste discharged above the fixed discharged waste amount can be expected to control discharge amounts below the fixed amount. ・As discharge savings are passed on to waste generators according to their reduced discharge amounts, this fee type can be expected to be more effective in controlling waste discharge than the preceding Type 3 fee system.	・In order to identify the waste amount discharged by each generator costs will be incurred (e.g. cost for distribution of garbage bags used up to a fixed amount of discharged waste), which will increase the cost for operation of the system.
(5) Combination of fixed-fee and pay-for-use systems	・The employment of the pay-for-use system only for the amount of waste discharged above the fixed discharged waste amount can be expected to control discharge amounts below the fixed amount. ・The employment of the fixed-fee system to a fixed amount of discharged waste enables municipalities to collect a stable amount of money.	・There is less incentive to motivate control of discharge within a range in which there is no charge. ・In order to identify the waste amount discharged by each generator costs will be incurred (e.g. cost for distribution of garbage bags used up to a fixed amount of discharged waste, costs for fee collection), which will increase the cost for operation of the system.

Source: Ministry of the Environment "Guide for Charging for Municipal Waste Management" (2013)

Table 3-41 Comparison of Characteristics of Methods Used for Fee Collection

Items	Designated garbage bag	Seal
Ease of handling	・It is easy to check the amount of discharged waste. ・Over filling garbage bags makes them too heavy and bulky.	・In cases where waste items of certain sizes or shapes cannot be contained in a garbage bag, these items may be discharged using seals. ・It is relatively difficult to check the amount of discharged waste. ・The seal is easily handled due to its small size. ・The seal is easy to lose.
Necessary measures	・It is necessary to place on the bag, a mark or color that makes it prominent. ・It is important to prepare garbage bags that have different sizes, and provide incentives to use a smaller garbage bag.	・It is necessary to place on the seal, a mark or color that makes it prominent. ・It is important to prepare seals that have different sizes, and provide incentives to use a smaller garbage bag.
Market impact	・It is necessary to consider the impact of the designated bags on the existing waste bag market.	・The seal has a lesser impact on the existing market.
Treatment of plastic bag	・A plastic shopping bag cannot be utilized as a garbage bag.	・In some cases, the plastic shopping bag cannot be utilized as a garbage bag.

Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Table 3-42 Example of Use of Advertising Media

<Advertising Media/Publicity Method>

- Provision of information through TVs, newspapers, radios and other media
- Periodical publication in municipal PR magazine
- Use of advertisements on trains, buses and other vehicles
- Street speech/explanation
- Presentation on waste-collection point
- Use of circular boards
- Distribution of booklets and/or flyers to all homes
- Holding of festivals and events

<Content of Information>

- Details of charging system
- Dates of fee collection
- Sorting waste categories
- Amount of discharged municipal waste

Source: Ministry of the Environment "Guidance for Charging Fees on Municipal Waste Management" (2013)

Topic 4. Waste Management Technologies

Contents

1. Waste Discharge, Collection and Transport

1.1 Transition of Waste Collection and Transport Methods

Since the 1950's, when Japan entered a period of rapid economic growth after postwar reconstruction, the increase in generated waste and related sanitation issues made it necessary to collect the growing waste amounts discharged from each household. To ensure reliable waste collection and transport systems the related technologies continued to progress. At the initial stage of waste collection, hand carts were used. Due to the requirements for more efficient and sanitary collection, the transport method shifted from manual collection to the introduction of mechanical collection by compactors - vehicles for waste collection with the function of compressing waste, often referred to as packers in Japan. With changes in the social conditions including economic growth and urbanization, issues such as waste collection in large amounts, sanitary collection, and efficiency arose and these issues have been handled with technological innovations for waste collection and transport vehicles as well as collection forms and methods.

Waste collection had been in place prior to the enactment of the *Public Cleansing Act*. In the 1950's when the *Public Cleansing Act* was established, waste collection was introduced to address the problems of the increase in waste amount and related sanitation issues. At the initial stage, waste was collected from each household by using a hand cart. The waste collected in the hand cart was then transferred to a vehicle and transported to a landfill site or an incineration plant.

Due to the subsequent continuous increase in the amount of waste combined with population concentration in urban areas due to urbanization, the collection of waste in urban areas became a serious issue. To resolve this issue, collection vehicles were introduced to ensure more efficient and sanitary waste collection.

With the introduction of waste collection compactor vehicles (packers) and shifting from manual collection by hand carts, there were improvements in the safety of collection operations (e.g., accidents involving workers), sanitary conditions during transportation (e.g., countermeasures of odor and waste liquid leakage), and collection efficiency (e.g., collection route planning). At the same time, in order to operate an efficient waste collection and transport system various types of vehicles were developed for waste collection and transport, low-pollution emissions, and transport of recyclable materials.

Photo 4-1 Collection of Kitchen Waste from Households by Handcart - circa 1957

Photo 4-2 Transfer of Household Waste from Handcart to Transport Vehicle - circa 1961

Photo 4-3 Transport Vehicle that were Often Used- circa 1961

Photo 4-4 Pilot Project for Introducing Mechanized Waste Collection by Compactor - circa 1957

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 4-5 Waste Collection by Compactor

Photo 4-6 Example of Low Pollution Type of Waste Collection Compactor

Source: Ministry of the Environment “Solid Waste Management and Recycling Technology of Japan” (2013)

1.2 Collection Methods

Waste discharge methods are classified into two major methods, door-to-door collection and station collection. In Japan, both methods have been adopted for a long time and the selected method in a certain region is determined by the actual conditions of that region or the preference of the residents. For upgrading, it is important to introduce a practical and effective collection method suitable for the actual conditions of the region - for example if it is a built-up area or a suburb, the population density, and land utilization status, etc. - after examining the advantages and disadvantages of each method.

(1) Storage and Discharge of Waste

Waste is generated every day from each household and it is important to collect the waste generated effectively and efficiently to secure the sanitary condition of each household and its surrounding area. For this reason, in principle, it is important for residents to collect the waste that is generated in each household, and store the waste inside the house until it is time to discharge it to the designated location at the specified time according to the predetermined collection plan.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 4-7 Fixed Waste Box in Front of each Household

In most cases, plastic bags are used to discharge waste at designated locations. For recyclables, paper is tied up with string, or special containers are used.

Photo 4-8 Waste Discharged to Collection Points Using plastic Bags

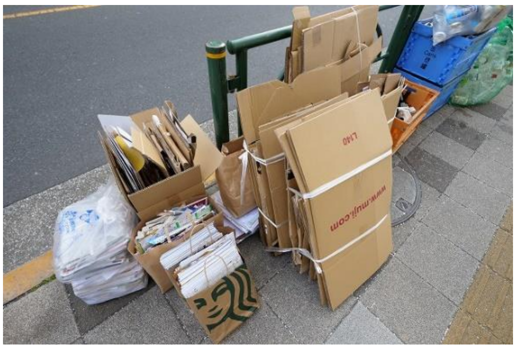


Photo 4-9 Corrugated Cardboard Discharged Tied with String

Source: Yachiyo Engineering Co., Ltd.

(2) Door-to-door Collection and Station Collection

Waste collection services that are provided by the municipality (not only directly managed services but also by subcontracted collection services operators,) are mainly carried out by door-to-door collection or station collection methods. Depending on the type of waste being discharged, there may be a direct delivery system whereby a resident of the household directly delivers the waste to the specified waste management facility (transfer station, intermediate treatment facility, or landfill site).

In the door-to-door collection method, waste is discharged in front of each household which is then collected. In Japan, not many municipalities adopt door-to-door collection as the standard collection method. However, this method is partially used in many municipalities for certain circumstances such as collection of bulky waste and to support elderly residents in their waste discharge. Since each household discharges its own waste in front of the residence under its responsibility, this method has certain features such as clarity of the responsibility for the waste discharged and some degree of freedom for each household. Door-to-door collection is effective for districts with low population densities - districts containing large residences of high-income earners and districts in local areas where residences are scattered over a large area. On the other hand, since waste discharged needs to be collected from many collection points, the workload of the collection operators increases, which becomes a disadvantage for the municipality.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 4-10 Station Collection (1964)

In the station collection method, a specific location is set as a waste discharge station and a number of households discharge their wastes there for collection. In Japan, many municipalities adopt station collection. In station collection, since a station is shared by a number of households, the unique features of this method are that the station location needs to be determined by all the residents who share the station and the stations needs to be managed. Therefore, in long-established districts where there usually are residents associations, it is possible to examine the introduction of station collection method there since it is comparatively easier for the residents to cooperate together. Furthermore, since less waste collection points are required than those of door-to-door collection, waste can be collected more efficiently, reducing the workload of operators, which is an advantage for the municipality. Station collection is efficient in districts where many households are concentrated such as apartments and terrace houses. Table 4-1 shows the features of door-to-door collection and station collection.

Another effective collection method is the container collection method, although this method is not widely adopted in Japan. Container collection is a method in which containers of 4 to 10 m^3 are set up to collect waste from surrounding households. Residents can discharge their waste at any time, and a large amount of waste can be collected at one time. On the other hand, if container is not emptied at an appropriate frequency, the waste may overflow from the container and deteriorate the sanitary environment in the area where the container is set up.

Photo 4-11 Station Collection - 1

Photo 4-12 Station Collection - 2

Photo 4-13 Door-to-door Collection - 1

Photo 4-14 Door-to-door Collection - 2

Source: Yachiyo Engineering Co., Ltd.

Table 4-1 Advantages and Disadvantages of Door-to-door Collection and Station Collection

Item	Door-to-door collection	Station collection
Advantages	✓ The responsibility of the location of discharge and the waste discharged is clearly defined (the owner of the waste discharged is identifiable). ✓ Highly convenient for residents as the waste discharge point is nearby, and there is a certain degree of freedom in how and when to dispose of the waste. ✓ Awareness of the residents is raised. They have better waste discharge manners. There is less waste scattering caused by dogs and crows. ✓ Sorting of waste is improved.	✓ Collection operation can be implemented efficiently since there are less collection points (number of stations). ✓ Collection cost is reduced. ✓ Collection time is shorter and operator burden is reduced. ✓ Awareness on waste discharge can be shared within the regional community. ✓ Less impact on the traffic conditions.
Disadvantages	✓ A longer collection time is required due to the large number of collection points involved. ✓ Increase in collection cost due to the large number of collection points involved. ✓ Lower operation efficiency due to the large number of collection points involved, thereby causing an increase of the operator's work burden. ✓ Consideration is necessary for privacy since the waste can be easily traced to the discharging household	✓ Selection of collection stations may be difficult. ✓ The responsibility for the waste discharged is unclear. Awareness of individual households on their own discharged waste is lowered. ✓ The handling of inappropriate discharge by any of the households sharing the station is difficult. ✓ The collection station needs to be managed. Inappropriate management creates a situation similar to open dumping at the station.
Remarks (Examples of countermeasures against disadvantages)	✓ Efficiency of waste collection is improved by examining collection plans in detail such as establishing the most efficient routes. ✓ Sufficient collection vehicles and workers are secured to reduce the burden on workers. ✓ The discharged waste is promptly collected.	✓ In selecting collection stations, it is important to consult in advance with the residents who will be using the stations. ✓ If a new residential district is to be developed, it is desirable to decide on the location of the collection station at the stage of development. ✓ If there is an understanding among residents, and considering privacy concerns, it is possible to reduce the decline in resident’s awareness by having them write their names on the waste bags they discharge. ✓ A manager or assistant should be assigned to each collection station to provide regular monitoring and advice.

Column: Measures for Handling Birds and Animals

Birds, particularly, crows are natural enemies of waste collection as they scavenge waste collected for food. In some regions, damage is caused by animals such as monkeys and boars. In particular, in developing countries, it is necessary to prevent waste scavenging by stray dogs.

In Japan, each region takes some measures to prevent birds from tearing waste bags such as covering the waste at the station with nets. In some cases, waste is covered by simple nets and in other cases, waste is placed inside of a meshwork cage. Where waste is to be placed on the roadside, residents are asked to discharge their waste on the scheduled collection day, instead of the previous day to reduce the time the waste is susceptible to damage caused by birds and animals.

Prevention of waste scavenging by birds and animals contributes to smooth and improved collection operations as well as prevention of deterioration of the sanitary environment and maintenance of local beauty of the region.

Photo 4-15 A Crow Rummaging through the Waste

Photo 4-16 Waste Collection Bag Torn by Crows

Photo 4-17 Countermeasure Using Net at Collection Station

Photo 4-18 Countermeasure Using Wire Frame Box for Door-to-door Collection

Source: Yachiyo Engineering Co., Ltd.

(3) Source Separation and Separate Collection

It is extremely important to separate waste at the source of generation (commonly referred to as source separation) in order to promote recycling. Through source separation, positive effects such as waste amount reduction, collection efficiency improvement, and improvement of recyclables quality (cans, bottles, plastic, paper, kitchen waste, etc.) can be expected. The cooperation of residents is essential to realize source separation. In addition, it is necessary to secure collection equipment and personnel required for collection as well as recyclables businesses. While source separation is an effective measure, it is important to establish and implement a feasible plan, giving some consideration to the degree of cooperation from the residents and the funds available in the municipality.

Source separation and separate collection is expected to contribute to the promotion of recycling, as waste generated is separated at an early stage. In addition, many municipalities are implementing this as an effective measure at the waste discharge stage, since it leads to raising public awareness on waste management among residents and to reduction of waste. On the other hand, since an increase of the number of categories for waste materials separation requires development of a system for sorting and increases the burden on the residents, further cooperation of residents becomes necessary. In each municipality, the categories for separation are determined according to the characteristics and actual condition of the region.

Effects of source separation and separate collection:

- More types of waste to separate and recycle reduces the waste amount.
- Recycling is facilitated, leading to a reduction of the recycling cost and improvement of the quality of recyclables.
- Awareness of residents towards waste discharge improves through the work for separating waste, which in turn has an effect on the reduction of waste generation.

Considerations on source separation and separate collection:

- It is essential for the municipality to be able to develop a collection system through securement of personnel and equipment and the funds required.
- Set the number of categories for separation and the separation items such as plastic bottles so that waste can be separated easily to gain the understanding of the residents.
- In order to secure receivers (takers) for the separated items, the growth of the venous industry for recycling is important.

Photo 4-19 PET Bottle Separated and Discharged by Residents in Tokyo

Photo 4-20 Bins and Cans Separated and Discharged by Residents in Tokyo

Source: Yachiyo Engineering Co., Ltd.

Separate collection is actively implemented to promote both prolonging the life of landfill sites and recycling. Table 4-2 shows the waste separation status in Japan. All the municipalities have adopted waste separation and in 32 municipalities (2% of total municipalities) waste is separated into over 26 categories. There are 646 municipalities where waste is separated into 11 to 15 categories (38% of total), accounting for the highest proportion, followed by 418 municipalities where waste is separated into 16 to 20 categories (24% of total). The waste in more than half of all the municipalities is separated into 11 to 20 categories.

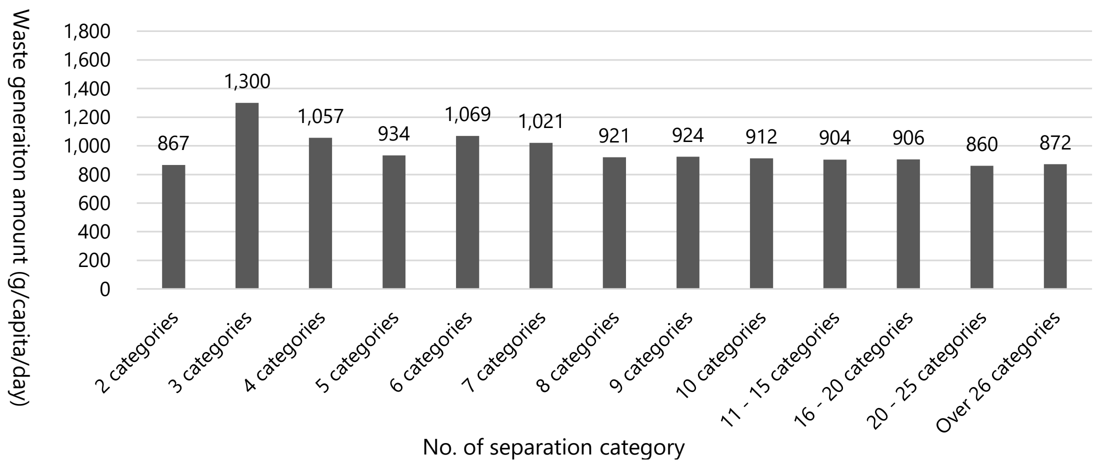
Table 4-2 Waste Separation in Japan

<table>
<tr><td>No. of separation</td><td>No separation</td><td>2 categories</td><td>3 categories</td><td>4 categories</td><td>5 categories</td><td>6 categories</td><td>7 categories</td><td>8 categories</td><td>9 categories</td></tr>
<tr><td rowspan="2">No. of municipalities</td><td rowspan="2">0</td><td>7</td><td>8</td><td>11</td><td>33</td><td>67</td><td>58</td><td>92</td><td>97</td></tr>
<tr><td colspan="8">373</td></tr>
<tr><td>(%)</td><td>0</td><td colspan="8">22%</td></tr>
<tr><td>Waste amount (g/capita/day)</td><td>0</td><td>867</td><td>1,300</td><td>1,057</td><td>934</td><td>1,069</td><td>1,021</td><td>921</td><td>924</td></tr>
</table>

No. of separation	10 categories	11 - 15 categories	16 - 20 categories	20 - 25 categories	Over 26 categories	Total
No. of municipalities	113	646	418	137	32	1,719
(%)	7%	38%	24%	8%	2%	100%
Waste amount (g/capita/day)	912	904	906	860	872	-

Source: Ministry of the Environment “Waste Management in Japan (FY2019)” (2021)

Figure 4-1 shows the numbers of categories of waste separation and the amount of waste discharged per day per person in grams. Separation of waste into 3 categories falls into the category of the highest amount of waste discharged, which is 1,300 grams/person/day. Starting from the separation of waste into 3 categories with the highest amount discharged, as the number of categories for separation increased, the amount of waste discharged per person per day decreased. This indicates that the number of categories applied for separation of waste contributes to the reduction of the amount of waste.



Source: Ministry of the Environment “Waste Management in Japan (FY2019)” (2021)

Figure 4-1 Relation between Number of Separation Categories and Unit Generation Rate

(4) Establishment of Collection Form

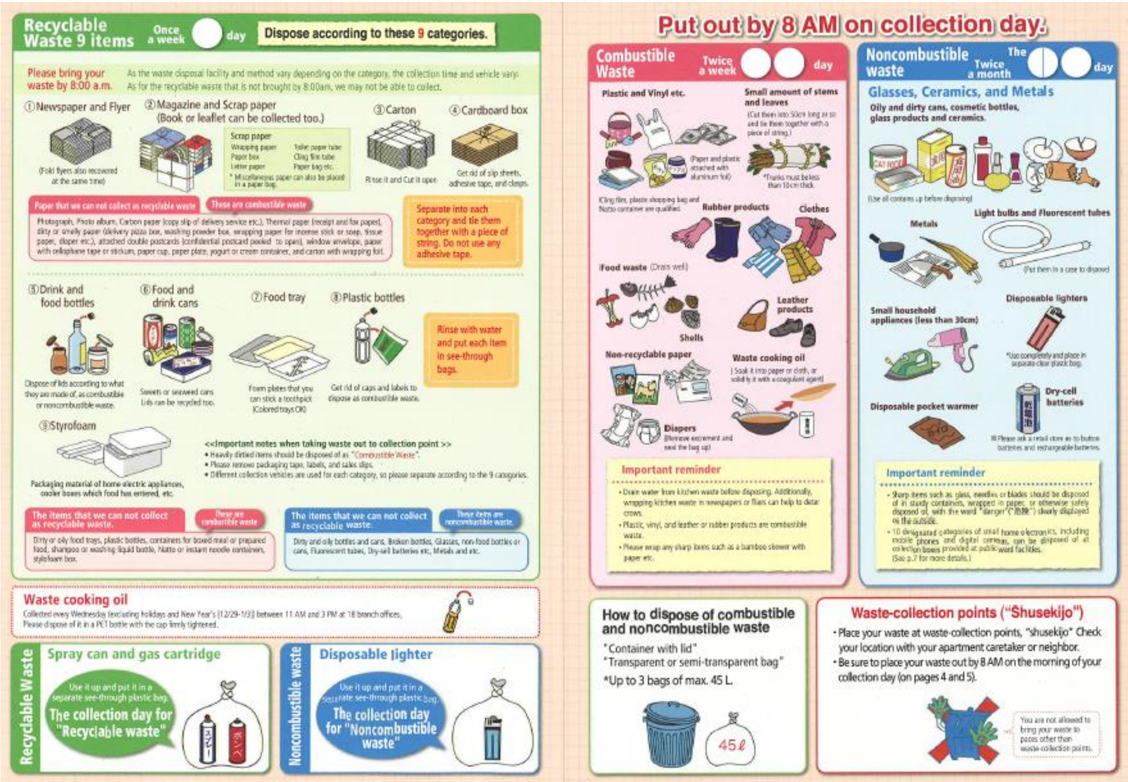
Local governments have always positioned gaining the understanding and cooperation of local residents as an important issue in the implementation of waste management in each region, and are actively disclosing and disseminating information such as plans and data related to waste management.

In particular, the collection and transport stage is the best opportunity to make contact with local residents, and it is extremely important for municipalities to build relationships of trust with them. Therefore, in order to ensure the smooth implementation of collection and transport, the local governments need to continuously disseminate information on how to discharge waste and collection services provided to local residents.

Each municipality actively discloses information on waste management projects and activities planned and implemented by the municipality through the municipality website and other means in order to gain local residents’ understanding of waste management. In addition, each municipality continuously conducts various activities such as environmental education and facility tours related to waste management in order to promote the residents’ proactive participation in waste management.

Each municipality is responsible for providing services related to waste collection and transport, and the proactive participation and cooperation of residents are indispensable for the smooth operation of these services. For this reason, many municipalities provide information on how to dispose of waste and the collection schedule through pamphlets and municipal websites.

The pamphlets and other information include not only the types of waste to be separated and the collection days, but also the size of waste, procedures to discharge waste (putting it in bags, tying it up with string, etc.), draining food scraps, and other points to keep in mind as a reference for residents when disposing of waste.



*: Pamphlet is available in Japanese, English, Chinese, Korean, Tagalog, Nepali and Vietnamese.
http://www.city.ota.tokyo.jp/honnyaku/index.html

Source: Ota City "How to dispose and separate your waste and recyclables" (2021)

Figure 4-2 Leaflet on How to Discharge and Separate Household Waste in Ota City, Tokyo

(5) Resource Recovery

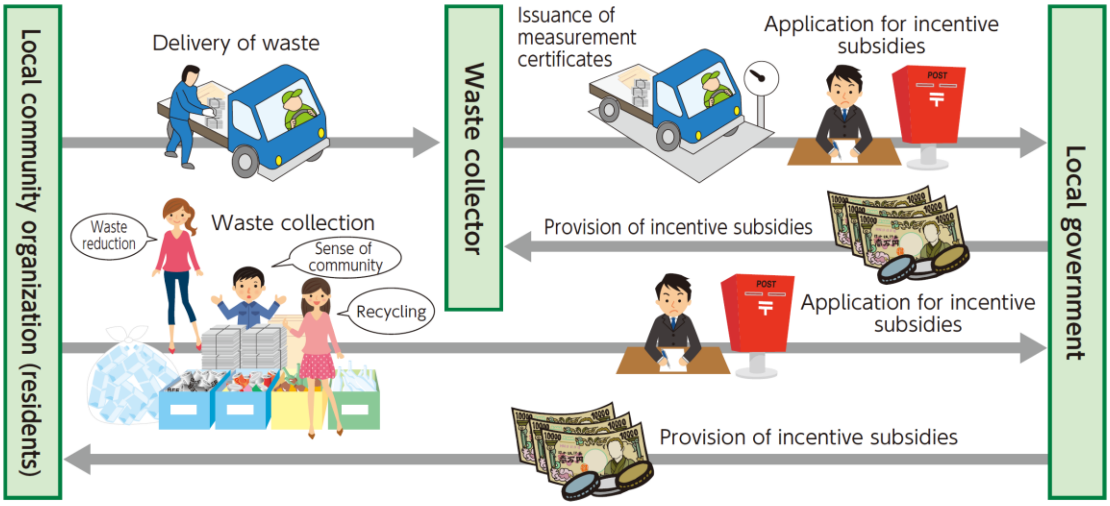
In Japan, group collection has been adopted since a long time ago, where a voluntary association of community residents voluntarily collects recyclables and delivers it to recycle business operators. The adoption of group collection contributes to the effects of not only an increase in the amount of recyclables, but also enhancement of awareness of community residents towards waste management and the environment, as well as creation of opportunities for children to learn about the environment and for residents to communicate with the administration.

In addition to source separation and separate collection that are implemented by municipalities, community group collection is exercised as a recycling activity, where a voluntary association of community residents such as a neighborhood association and a children's group voluntarily collects recyclables and delivers it to a recycle business operator. Many municipalities support voluntary associations that implement community recycling activities through group collection, by providing subsidies to cover expenses for the activities and introducing them to recycle business operators. Group collection can directly contribute to the improvement of the recycling rates. More significant effects that can be expected are improvement of awareness of community residents towards recycling and the reduction of the amount of waste and improvement of their understanding on waste management.

Source: Yachiyo Engineering Co., Ltd.

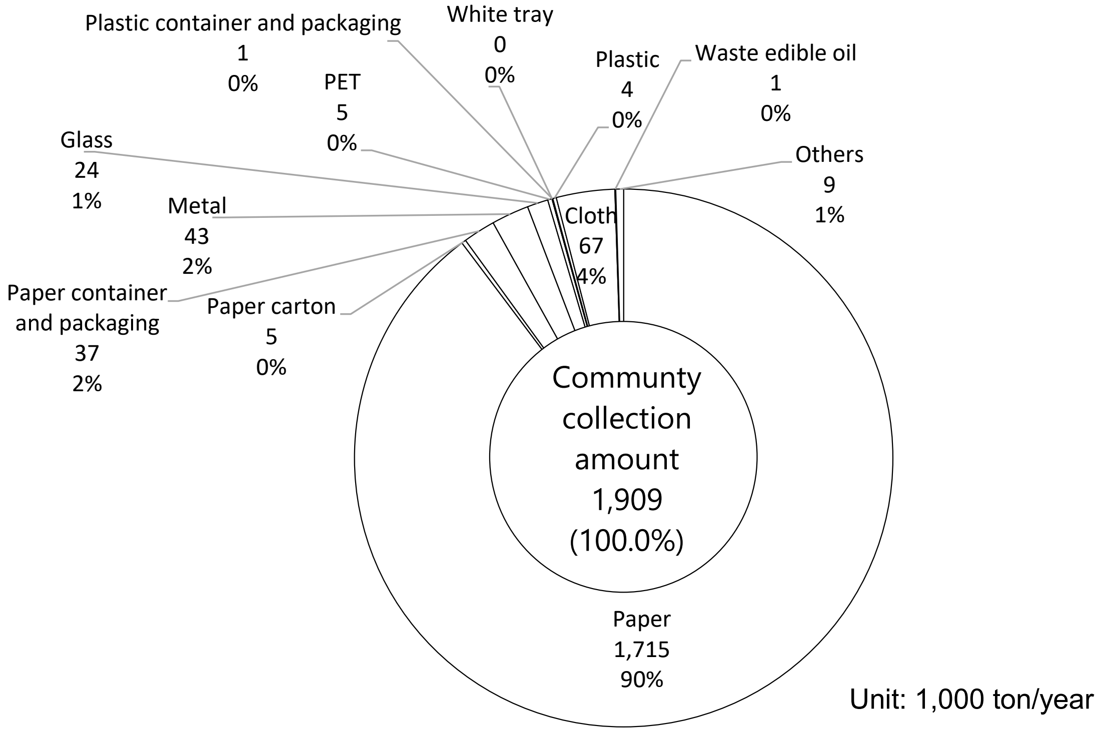
Photo 4-21 Group Collection (in Tokyo)

The main recyclables categories targeted for group collection include paper, bottles/cans, and fabrics. The performance records of 2019 show that paper category accounts for the majority at the overwhelmingly high amount of 1,715,000 tons (89.8%).



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 4-3 Group Collection System



Source: Ministry of the Environment "Waste Management in Japan (FY2019)" (2021)

Figure 4-4 Status of Residential Community Collection (FY 2019)

1.3 Features of Vehicles and Equipment for Waste Collection and Transport

Various types of vehicles have been developed for waste collection and transport to improve the collection efficiency. In Japan, compaction vehicles (often referred to as packers in Japan) that compress the waste during collection are widely used as they can collect and transport a large amount of waste in one trip. However, suitable vehicles need to be assigned according to the characteristics of the vehicles and the usage method, including normal dump trucks.

Various types of vehicles are used for waste collection and transport to cater for various purposes, collection plans, and collection modes. Table 4-3 lists the collection vehicles.

Recently, introduction of low gas exhaust vehicles and low fuel consumption vehicles is becoming widespread and in the future, electric vehicles are expected to be widely used for waste collection and transport. The battery power required for electric vehicles for waste collection and transport can be charged at waste treatment facilities and this power can also be shared with the households during times of disaster. Such usage methods are also examined.

Examples of considerations on selecting waste collection and transport vehicles

- In principle, select waste collection and transport vehicles that can be repaired and maintained. In particular, vehicles with readily available spare parts are preferable.
- Select the type and size of a vehicle considering the amount of waste to be collected and transported, road conditions in the collection route (width of the road and pavement conditions), and the topography (slopes).
- A compactor vehicle is suitable when a large amount of waste is to be collected and collection efficiency is the priority.
- For a residential area that generates a comparatively low amount of waste and does not require frequent collection, a container is effective for collection. For a market that also discharges a sizable amount of waste regularly, a container is also effective for collection.

Table 4-3 List of Vehicles Used for Waste Collection and Transport

Vehicle type	Feature
Dump Truck  Source: Yachiyo Engineering Co., Ltd	✓ It is an ordinary dump truck. ✓ Because it is not a special vehicle, maintenance is comparatively easy. ✓ Since it does not have the ability to compact waste, it is not highly efficient in transportation. ✓ In the case of high vehicle height, it is not easy for workers to load waste into the truck.
Compaction Vehicles (Packers)  Source: Sapporo City ”Waste Disposal Administration/ 3R Policy in Sapporo City (JICA training text)” (2019)	✓ This vehicle is designed for efficient collection of waste and collects waste while compressing it with a compactor (press type, turntable plate type, or rotary type) that is installed in the container compartment. ✓ Since the waste can be collected while compressing the loaded waste, a packer can transport more waste than a normal truck. ✓ As this is a special vehicle, routine maintenance is important for the vehicle’s stable and long-term use. ✓ As this is a special vehicle, it is not easy to maintain and repair (including parts replacement).
Container vehicle with arm type removable unit  Source: Yachiyo Engineering Co., Ltd.	✓ Vehicle equipped with a steel arm and hock that can mount or dismount a transport container on or off the vehicle. ✓ The whole process such as storage, collection, transport, and discharge of waste to facility can be operated as a system flow. ✓ As this is a special vehicle, routine maintenance management is important for the vehicle’s stable and long-term use. ✓ As this is a special vehicle, it is not easy to maintain and repair (including parts replacement).

Vehicle type	Feature
Container vehicle  Source: Yachiyo Engineering Co., Ltd.	✓ With one dedicated vehicle and multiple containers, it is possible to place containers at appropriate locations to collect waste at multiple locations, thus increasing collection efficiency. There is no need for loading work, reduced waiting time due to loading, etc. ✓ As this is a special vehicle, routine maintenance management is important for the vehicle's stable and long-term use. ✓ As this is a special vehicle, it is not easy to maintain and repair (including parts replacement).

1.4 Maintenance Management of Waste Collection and Transport Vehicles

To carry out waste collection and transport stably and continuously, regular inspection and maintenance of collection vehicles are essential. In Japan, annual inspection, monthly inspection, and regular voluntary inspection before starting operation are regulated by technical standards such as Safety Management Guideline. Implementing such periodic inspections and taking preventive maintenance measures not only contributes to the stable and continuous use of the vehicle, but also contributes to its long-term use.

Collection vehicles must be constantly kept in good condition to operate them stably and continuously according to the collection plan. For this reason, regular and appropriate vehicle inspection and maintenance is very important.

To maintain vehicles in good condition, it is desirable to apply the concept of preventive maintenance and inspection that prevents faults occurring during operation, and that not simply takes measures swiftly to rectify the faults that are detected as a result of inspection or occur during collection operation. In developing countries, it has been observed that mechanized parts, especially hydraulic and loading equipment, often become defective and result in the related vehicles to be out of service for long periods due to the large amount of time required to purchase the necessary replacement parts and make repairs.

In Japan, for general vehicles daily routine inspection is required by the *Road Vehicles Act* and also implementation of regular inspection and maintenance are regulated. It is required to keep a record book containing the details of the inspection and maintenance - including information on the date, method, section inspected, result, executer, and contents of measures taken for the inspection result. Waste collection vehicles need to be inspected and maintained based on the “Safety Management Guidelines for Mechanical Garbage Trucks” (1987). These management guidelines specify the implementation of annual inspection, monthly inspection, and regular voluntary inspection at the start of operation. The outline of each inspection is provided in Table 4-4 and Table 4-5. Thus, proper implementation of the voluntary periodic inspections will enable the vehicles to be used for longer periods, as well as ensure the safety of workers and prevent accidents.

Table 4-4 Annual Inspection Items for Collection Vehicles

No.	Inspection items
1	Motor, motor transmission device, running gear, controlling gear, and braking system
2	Rotating plate, push-in plate, compression board, and other loading equipment
3	Hydraulic pump, hydraulic motor, cylinder, hydraulic piping, hydraulic hose, safety valve, and other hydraulic devices
4	Electric system
5	Emergency stop switch, emergency stop unit, interlock unit to prevent tailgate power dive, safety rod, and other safety devices
6	Loading operation switch
7	Discharger
8	Tailgate, body, alarm unit, direction indicator, lighting system and gauge
9	Power unit for the waste collection vehicle that has a dedicated power unit for lifting a tailgate
10	Other accessories

Source: Ministry of Labor "Safety Management Guidelines for Mechanical Garbage Trucks" (1987)

Table 4-5 Monthly Inspection Items for Collection Vehicles

No.	Inspection items
1	Controlling gear, braking system, and wheels
2	Loading unit and hydraulic device*
3	Safety device
4	Loading operation switch
5	Alarm unit
6	Power unit for the waste collection vehicle that has a dedicated power unit for lifting a tailgate
7	Device for automatically mounting a safety rod for the waste collection vehicle that has such a device

*: Refer to following Figure 4-5 for the location of each equipment.
Source: Ministry of Labour "Safety Management Guidelines for Mechanical Garbage Trucks" (1987)

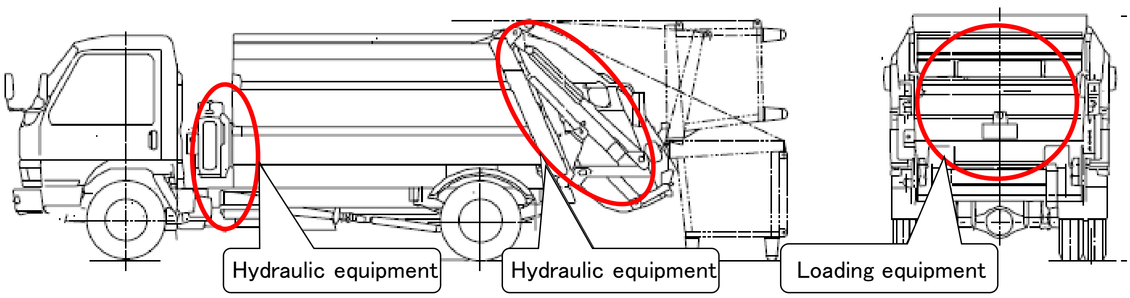


Figure 4-5 Equipment of Waste Collection Vehicles

Table 4-6 Check List for Periodic Inspection of Waste Collection Vehicle - example 1

Inspection items		Inspection points	Span of inspection		
Part	Items		Before starting operation	Monthly	Yearly
Vehicle	Engine	Noise, rattle, looseness, heat generation, oil leakage, etc.	✓	✓	✓
	Power transmission	Noise, rattle, looseness, heat generation, oil leakage, etc.		✓	✓
	Driving unit	Noise, rattle, looseness, heat generation, oil leakage, etc.	✓	✓	✓
	Steering unit	Noise, rattle, looseness, heat generation, oil leakage, etc.	✓	✓	✓
	Braking system	Noise, rattle, looseness, heat generation, oil leakage, etc.	✓	✓	✓
Hydraulic system	Hydraulic pump	Noise		✓	✓
		Oil leakage		✓	✓
		Loosening of mounting bolts			✓
	Hydraulic Cylinders	Rod damage			✓
		Oil leak		✓	✓
		Presence of abnormalities in the mounting part			✓
	Hydraulic motor	Noise		✓	✓
		Oil leak		✓	✓
		Loosening of mounting bolts, sprockets, etc.			✓
	Hydraulic oil	Oil content in the tank	✓		✓
		Stains (color)			✓
		Clean the strainer in the tank			✓
		Replace filter			✓
	Rubber Hose	External damage due to contact, impact, etc.		✓	✓
		Oil leakage, surface deterioration and cracking, etc.		✓	✓
		Loose tightening			✓
	Hydraulic pipe fittings	Oil leakage, loosening of tightening		✓	✓
		Loose pipe clamps, contact with other parts, etc.			✓
	Hydraulic pressure	Confirmation of predetermined pressure			✓
	Hydraulic valve	Oil leak		✓	✓
		Loose mounting bolts			✓
		Operation			✓
Electrical and control equipment	Switches for Loading	Check the operation of the rear switch.	✓		
		Damaged or loosely attached waterproof rubber cover		✓	✓
	Loading Control	Loose cam mounting bolt		✓	✓
		Loose limit switch mounting bolt		✓	✓
		Loose relay timer			✓
	Discharge Control	Loose tailgate lock, limit switch, etc.			✓
		Loose lift control limit switch			✓
		Loose damper limit switch			✓
	Wiring	Contact damage, connector ground corrosion, etc.			✓
	Rotary solenoid (Engine constant speed device)	Loose arm wire			✓
Safety devices and functions	Emergency stop switch	Checking operation, looseness of switch attachment, etc.	✓	✓	✓
	Emergency stop device	Check operation, damage, etc.	✓	✓	✓
	Garbage input device prevention device	Checking operation	✓		✓
		Adjustment		✓	✓
	Interlock when tailgate is lowered	Checking operation	✓	✓	✓

Source: The Waste Management Society of Japan “Waste Handbook” Ohmsha (1996)

Table 4-7 Check List for Periodic Inspection of Waste Collection Vehicle - example 2

Safety devices and functions	Safety bar	Check for abnormalities and normal operation. Confirmation of alarm buzzer.	✓	✓	✓
	Confirmation of loading cycle time	Confirmation of predetermined cycle time	✓		✓
		Confirmation of sealing		✓	
	Back buzzer	Back buzzer emit an alarm sound when the vehicle is backing up	✓		✓
	Tailgate up, down Alarm buzzer in operation	Tailgate emits an alarm sound when it is operating up or down	✓		✓
	Contact buzzer	Proper operation	✓		
	Dump drop protection device	Inspection check	✓	✓	
	Tailgate lock	Engagement condition	✓		✓
Conduction control	PTO and control	Smooth and reliable switching of disconnection, and good feeling of operation	✓		✓
		Are there any abnormalities such as abnormal noise	✓	✓	✓
		Oil leakage, looseness of mounting bolts		✓	✓
		Adjust the wire.			✓
	Drive shaft and UJ	Abnormal noise, runout, oil supply, etc.		✓	✓
		Looseness of mounting bolt		✓	✓
Loading and discharging	Loading operation	Operation of the loading plate		✓	✓
		Bending or cracking of plate links, etc.			✓
		Rattling of the bearing, loosening of the pin stopper			✓
		Tension of chain, abnormal noise, etc.		✓	✓
		Wear of the reverse rotation prevention pin.			✓
		Can the reversing prevention pin be easily removed?		✓	
	Tailgate open/close operation	Tailgate up/down operation			✓
		Bending, cracking, looseness, etc., of cylinder mounting part *			✓
		Bending or cracking of the tailgate lift stopper *	✓		
		Does the tailgate not rise when it is not in the normal position, such as when it is caught in debris?			✓
		Tailgate lock rattles in pin, adjust often.			✓
		Tailgate lock. Are the nuts on the U-bolts unloose and are they tightened evenly on both sides?			✓
Direction indicators	Direction indicators	Confirmation of normal operation	✓		
	Lighting devices	Confirmation of normal operation	✓		
	Gauges	Confirmation of normal operation	✓		
Other equipment	Tailgate	Bend, crack, rust			✓
	Bodies	Bending, cracking, rusting			✓
	Subframes and bracing	Looseness of tightening bolts to chassis			✓
	Spare tire carriers	Looseness of mounting nut, looseness of fixing	✓		
	Wastewater leak prevention	Damage to the wastewater packing			✓

*: For loading and lifting cylinder car

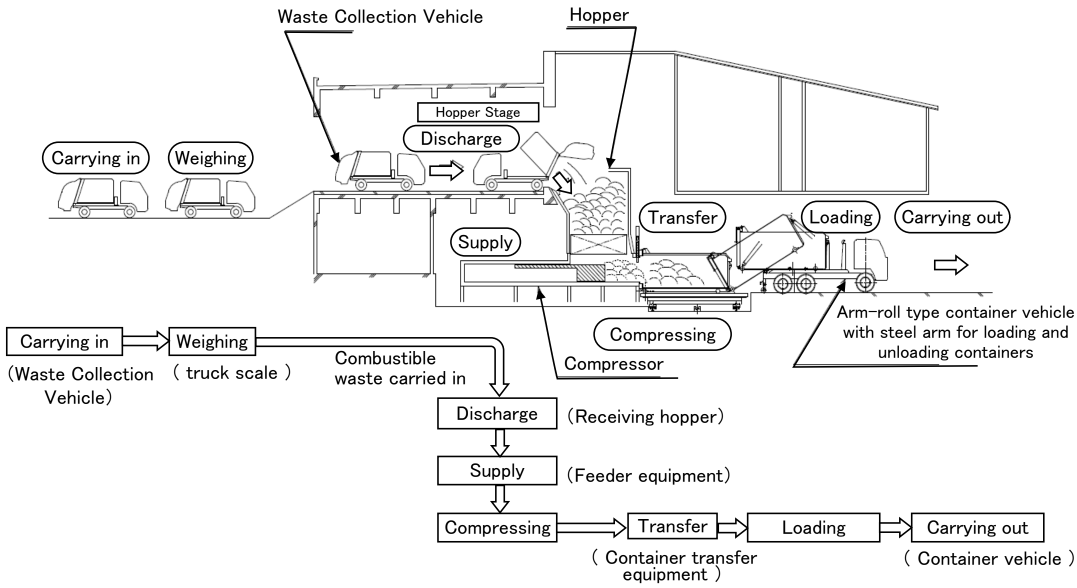
Source: The Waste Management Society of Japan "Waste Handbook" Ohmsha (1996)

1.5 Transfer Station

A transfer station is useful for efficient waste collection when waste is to be collected from a wide area or the distance to the treatment plant or final landfill site is far. In Japan, there are not many transfer stations in operation because many municipalities have their own necessary facilities and the targeted collection areas are not large.

At a transfer station, waste is transferred from the collection truck to a larger transport vehicle, referred to as a secondary transport vehicle, with or without compression depending on the transfer station. This allows the collection truck to speedily return to the waste collection area and thereby improves the collection truck operation efficiency. A transfer station may have shredding equipment and provide a function of a recycling facility, depending on the waste that is received.

A transfer station is a facility where waste is transferred from a small or a medium-size collection vehicle to a large transport vehicle, either with or without compression of the waste, in order to allow the collection truck to speedily return to its collection activities. The transfer station operation thereby enhances the efficiency of waste collection and transport for urban areas where waste is to be collected across wide areas. Figure 4-6 shows an example of a transfer station processing flow (compactor/container type). In the compactor/container type, waste fed from collection vehicles into the loading facility is compacted by a compressor and transferred into a large container. The container is then mounted on a container vehicle for transport to the next destination, either treatment facility or landfill site.



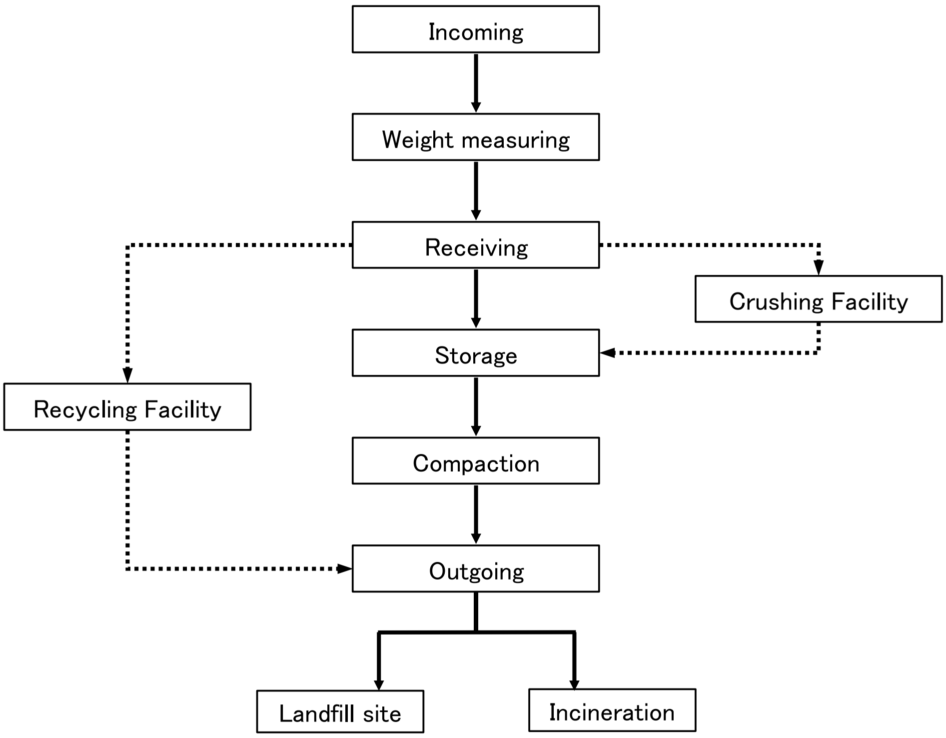
Source: Ministry of the Environment "Guidance for application for subsidy for establishing a Sound Material-Cycle Society (For Facility)" (2021)

Figure 4-6 Example of Process at Compactor/Container Type Transfer Station

Source: Yachiyo Engineering Co., Ltd.

Photo 4-22 Transfer Station in Kuala Lumpur, Malaysia

Figure 4-7 and Table 4-8 respectively show the structure and outline of the main facilities of a transfer station. After the incoming waste is weighed, it is reduced in volume by compression and crushing, etc. and then carried out.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 4-7 Structure of Transfer Station Facility

Table 4-8 Main Facilities of a Transfer Station

Main facility	Outline of the facility
Unloading/ loading facility	This facility comprises a weighing machine for managing receiving and transporting waste, entry/exit roads for collection/transport vehicles, a platform for unloading waste in a storage pit/storage site, an unloading hopper for temporarily storing the incoming waste, and loading equipment for loading the waste that is stored in the incoming hopper on to a compression facility.
Shredding facility	This facility shreds combustible bulk waste that is received at the station.
Compression facility	In a compactor/container type transfer station, this facility is used for loading the waste that is supplied on to a container by compressing it. The facility comprises a compactor and a hydraulic system. Other devices include a storage discharger that cuts out waste into a fixed amount continuously and loads it in a large transport vehicle, and a packing machine that compresses waste that was delivered to the hopper and packs it by strapping or baling.
Recycling facility	This facility processes recyclables as required to facilitate transportation and recycling. The facility must be suitable for processing the targeted recyclables. Recyclables include iron, aluminum, refillable bottles, glass cullet, plastic bottles, paper, fabric, and plastics. The equipment units of the facility include metal press, plastic bottle compressing and packaging machine, plastic container compressing and packaging machine, plastic material compressing and compacting machine, paper binding machine, bottle shredder, and styrene foam compactor.
Transport facility	In a compactor/container type transfer station, this facility is used for transporting containers between a compactor connection position and a position for loading/unloading containers on to a container vehicle. This facility comprises standalone equipment or a combination of a trolley, a conveyer, and so on. A container storage facility temporarily stores containers inside the facility. Containers and arm-roll type container transport vehicles equipped with steel arm device to load and unload containers on to the vehicle bed, are used in this facility.
Dust collection/ deodorization facility	This facility is used to maintain the integrity of the surrounding environment and the work environment of the facility. It comprises hoods, ducts, a dust collector, ventilators, and a deodorizer.
Water supply facility	This facility is used to supply cooling water and washing water, spray water for dust prevention, and water for extinguishing fires.
Wastewater treatment facility	This facility is available for treating wastewater or for transporting it with a vacuum vehicle when various types of water are assumed to be generated. The handling varies depending on the plan. If the condition allows, such as that the peripheral sewage treatment facility has an extra capacity, collected wastewater may be discharged to sewage after being diluted and stirred.
Electrical facility	This facility receives power required for all these facilities and distributes power to the required sections (motor, and so on) of each equipment.
Instrumentation facility	The instrumentation facility is necessary for operation and control of the facilities.

Source: Created based on Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

1.6 Waste Collection and Transport Technical System necessary for Efficient Collection

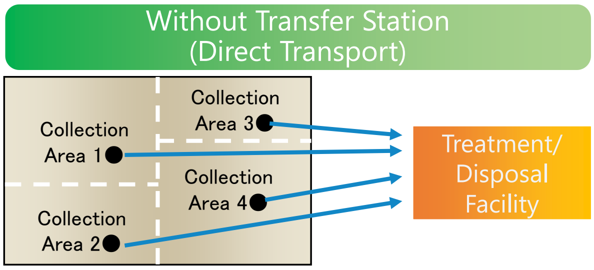
At the waste collection and transport stage of the waste management many persons are engaged in collection and transport and maintenance of vehicles and facilities and accordingly a large amount of labor costs is incurred. Therefore, implementation of efficient collection is extremely important not only to ensure a good collection service, but also in order to reduce the associated costs.

To achieve efficient waste collection and transport, it is necessary to consider the use of collection stations and transfer stations, by examining the time and cost associated with waste collection and transport according to the characteristics and actual conditions of the region.

In order to provide efficient waste collection and transport it is necessary to exert efforts in preparing collection and transport plans that carefully consider the current conditions of the region and any advantages of using transfer stations. In particular, for developing countries, the plans should carefully determine suitable vehicle specifications for large-size trucks and trailers considering the local traffic conditions (traffic congestion, accidents, etc.) and road conditions (unpaved roads, sloping roads, etc.). In addition to comparing transport times and costs, it is important to develop and implement collection and transport plans that take safety into consideration.

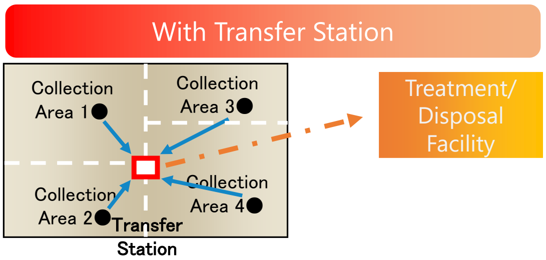
Table 4-9 Considerations for Achieving Efficient Waste Collection and Transport

Item	Description
Use of collection stations	Use waste collection stations as appropriate considering the characteristics and actual conditions of the region (population, land use, location, etc.).
Preparation and implementation of a detail collection plan	Develop a collection plan and a detailed operation plan for collection (collection route, collection schedule, etc.) to gain the residents' cooperation and increase collection efficiency
Use of a transfer station	In cases when the target collection area is widespread or when large vehicles can be easily utilized, the introduction of transfer stations should be considered. When checking cost effectiveness, compare the cost of collection and transport of the waste to the treatment/disposal facility with and without a transfer station, as shown in Figure 4-8. If the distance of collection and transport from the collection area to the treatment/disposal facility is far, although the construction costs for introducing a transfer station are required at the initial stage, over the long term the costs of collection and transport may be reduced. However, with regard to the use of large-size transport vehicles from transfer stations to treatment/disposal facility, it is necessary to avoid subjecting roads and bridges to excessive loads, etc. Appropriate vehicles should be selected based on local traffic and road conditions.



Total Collection Cost (case ①)

Costs	Contents
Cost 1	Collection from Collection Area 1 to Transfer Station
Cost 2	Collection from Collection Area 2 to Transfer Station
Cost 3	Collection from Collection Area 3 to Transfer Station
Cost 4	Collection from Collection Area 4 to Transfer Station
Total Collection Cost (=Cost 1+Cost 2+Cost 3+Cost 4)	Collection from Collection Areas 1~4 to Treatment/disposal facility



Total Collection Cost (case ②)

Costs	Contents
Cost 1	Collection from Collection Area 1 to Transfer Station
Cost 2	Collection from Collection Area 2 to Transfer Station
Cost 3	Collection from Collection Area 3 to Transfer Station
Cost 4	Collection from Collection Area 4 to Transfer Station
Cost 5	Collection from Transfer Station to Treatment/disposal facility
Cost 6	Cost for transfer station (Construction cost, operation and maintenance cost)
Total Collection Cost (=Cost 1+Cost 2+Cost 3+Cost 4+Cost 5+Cost 6)	Collection from Collection Areas 1~4 to Transfer Station Collection from Transfer Station to Treatment/disposal facility Cost for transfer station

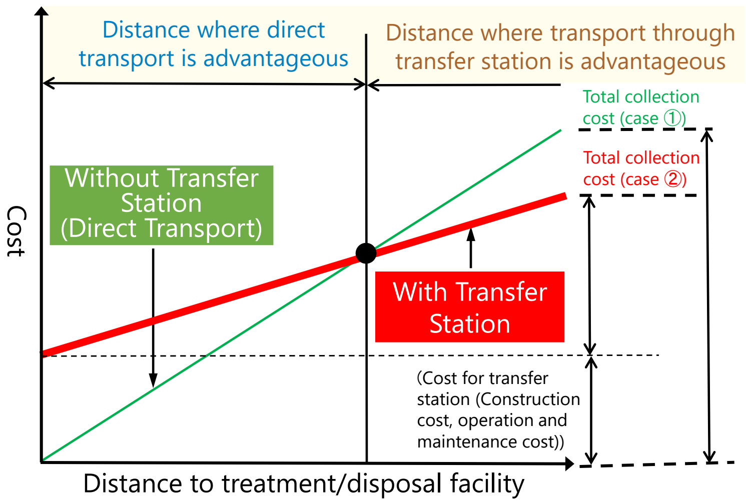


Figure 4-8 Comparison between with and without Transfer Station Options

Colum: Formulation of Efficient Collection and Transport Plan

Establishing efficient waste collection and transport routes will result in increased work efficiency, reduced costs, and reduced accident rates. To improve the efficiency of collection routes, the routes need to be studied by collection workers and staff members responsible to formulate routes based on actual data. A summary is presented here of the elements necessary to study efficient refuse collection based on the example of Yokohama City.

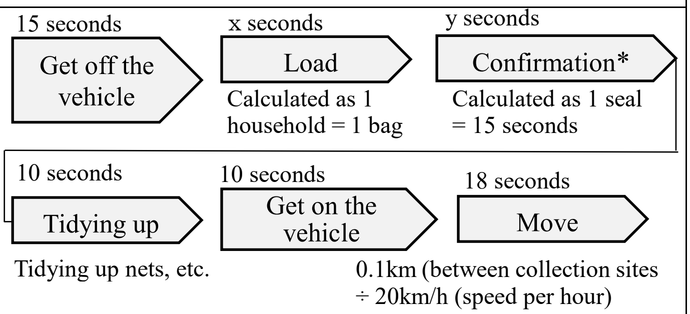
Table 4-10 Benefits from Formulating an Efficient Collection Plan

Benefit	Contents
Work efficiency improvement	Analyzing traveling routes, minimizing travel distance
Decrease in cost	Minimizing costs of personnel, vehicles, fuel consumption, etc.
Reduction of accident rate	Identify dangerous areas in advance so that collection crews can take sufficient care when working in those areas
Work environment improvement	Set clear working hours and reduce staff burden

Data Collection

The data needed for route formulation are shown in Table 4-11. Data on collection areas, waste amounts, and working hours are used to establish routes.

Table 4-11 Examples of Data Collection

<table>
<tr><th>Items</th><th>Data to be collected</th><th>Example</th></tr>
<tr><td>Collection sites</td><td>・Number of households
・Estimated discharge amount for each collection site
・Coordinates on the map</td><td>1. Collect data from citizens on collection sites
Station area: 2.03 m^2
Waste storage method: Net is used
Date to start using: 30th March 2022 etc.
2. Calculate the number of households per collection site
<table>
<tr><th>Items</th><th>Area A</th><th>Area B</th></tr>
<tr><td>Number of households</td><td>128,328</td><td>117,957</td></tr>
<tr><td>Number of collection site</td><td>6,473 sites</td><td>4,252 sites</td></tr>
<tr><td>Household/collection site</td><td>19.9</td><td>27.6</td></tr>
<tr><td>Time required to collect at each location</td><td>Short</td><td>Long</td></tr>
</table></td></tr>
<tr><td>Waste amount</td><td>・Collection results for each vehicle/each trip
・Seasonal changes in the waste amount
・Facility treatment amount results</td><td>IC cards are installed in each collection vehicle to control the amount and time of waste collection. (See Table 4-12)
By recording detailed work conditions, it will be easier to predict the waste amount and working hours when formulating routes.</td></tr>
<tr><td>Working hours</td><td>・Breakdown of each work activity</td><td>
</td></tr>
</table>

*: Confirmation is the process of placing a sticker on the discharged waste if it is found not to be eligible for collection as per the collection schedule and to notify the correct discharge date based on the waste category

Table 4-12 Examples of Data Records Related to Waste Collection

No.	Vehicle Size	1st Trip	2nd Trip	3rd Trip	4th Trip	Waste Amount	Work Start	Work End	Mileage
1	Medium	9:36 2.25 t A area	11:46 2.28 t A area	14:20 2.02 t A area		6.55 t	8:15	15:05	32 km
2	Small	9:18 1.62 t B area	10:23 1.47 t B area	11:42 1.78 t B area	13:40 1.44 B area	4.87 t	8:20	14:35	46 km
				:					
Total						205.20 t			1,529km

Preparation of Collection Maps

The procedure shown in Table 4-13 is used to divide the district into blocks, which are further subdivided according to the number of collection vehicles. In each of these areas, waste discharge points are plotted on a map and collection routes are developed.

Table 4-13 Process of Creating Collection Maps

No.	Process
1	In order to designate the collection days, consider the waste amount generated and divide it into blocks with roughly equal waste amounts
2	Divide each block further by the number of vehicles allocated. The size of the area varies depending on the topography, road conditions, distribution of housing, and the capacity of the fleet.
3	Based on the divided area, create a route considering the collection amount and work time

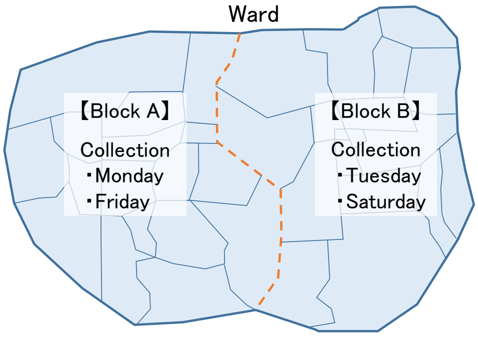
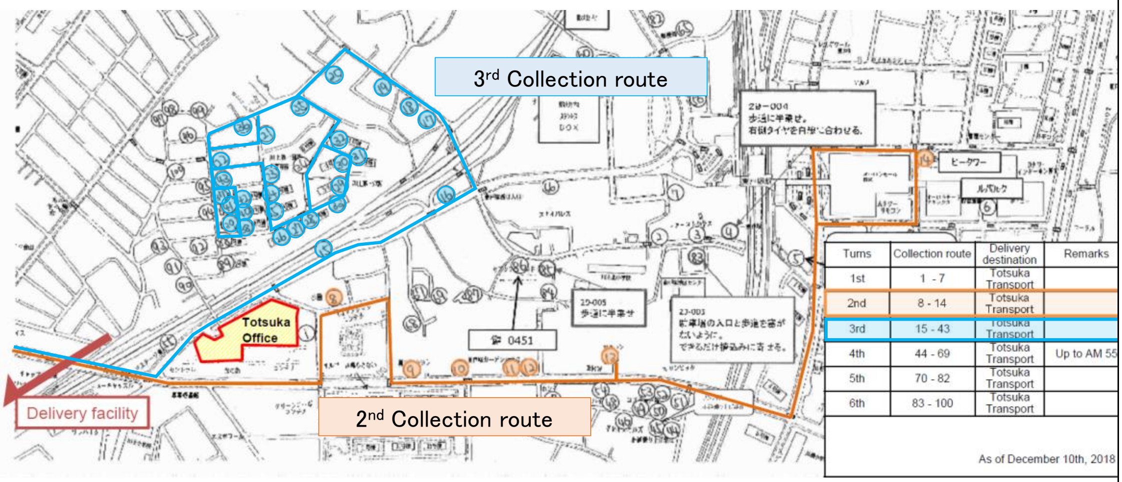


Figure 4-9 Conceptual Figure of Dividing Blocks



*: ○number is waste collection site

Figure 4-10 Example of Actual Collection Map for Totsuka Ward in Yokohama City

Source: Yokohama City "JICA Training Materials Formulation of Efficient Collection Plan" (2019)

2 Intermediate Treatment

2.1 Transition of the Intermediate Treatment Technologies

For Japan, which has a small land area, effective use of the limited land area has been an extremely important issue. Since deterioration of the living environment caused by waste has become a serious problem, incineration treatment has been widely adopted from the hygienic viewpoint.

In addition, since incineration is a well-versed waste treatment method in terms of sanitary treatment and amount reduction, waste treatment systems based on incineration treatment are being built in many local communities.

At the same time, due to the realization of a sound material-cycle and the pressure on final disposal sites, intermediate treatment technologies have been developed and reformed to suit the types of waste and the Japanese technologies are playing a part for setting targets and taking measures to solve the issues associated with recycling and amount reduction.

Since Japan has a small land and the usable land area is limited, reduction of waste amount is extremely important. Therefore, incineration has historically been considered an effective treatment method and was mandated under the amendment of the *Waste Cleaning Act*, in 1930. However, even with this mandate the burning of waste in open fields and the dumping of waste into rivers continued to be frequent occurrences, and in reality incineration technologies were not introduced as centralized intermediate treatment.

From the period of the 1960s’, the treatment of the increased waste amount that was associated with the rapid economic growth, the improvement of the living environment, and enhancement of public sanitation became serious issues. In order to resolve these issues and from the perspective that incineration of waste is very effective in sanitary treatment of waste and reduction of the waste amount, the development of intermediate treatment facilities using incineration technology was promoted.

Under this development policy, the introduction of a waste incineration facility was promoted in all urban areas through the provision of technical and financial support based on the laws and plans established by the central government, and promising results were achieved for sanitary treatment and amount reduction of waste. At the same time, in response to the pollution issues caused by waste incineration, the central government established the Facility Technical Standards Including Exhaust Gas Treatment (1971) for proper waste treatment by intermediate treatment facilities. Since then, the incineration technology has significantly progressed to become a highly reliable waste treatment method, through the process of responding to new and updated standards, regulations, and structural guidelines (1979) and performance guidelines (1998) which ensured the necessary countermeasures against dust, dioxins, organic pollutant, and mercury.

In conjunction with the progress of the incineration technology, new technologies including RDF, gasification melting, and ash melting were developed and introduced. Since then the development and introduction of recycling technologies including organic waste recycling and the technology for generating power by using waste for thermal recovery (also referred to as thermal recycling) have been actively promoted in order to bolster the national policy of establishing a sound material-cycle society.

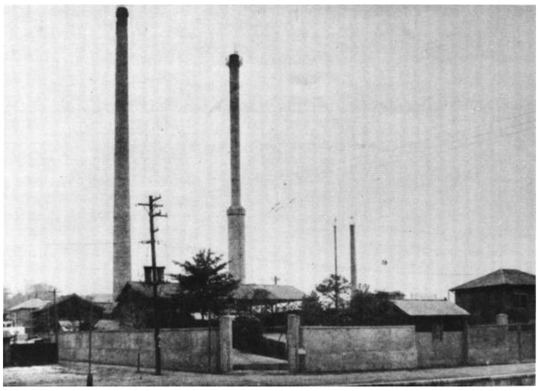


Photo 4-23 Osaki Incineration Plant - First Incineration Plant in Tokyo (Completed in 1924)

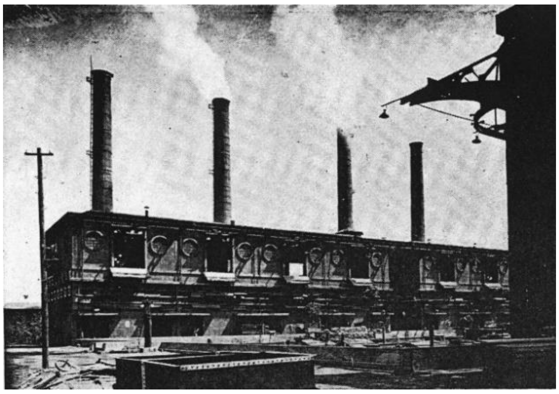


Photo 4-24 Fukagawa Incineration Plant – Technology of the Time did not Provide Adequate Exhaust Gas Treatment (Completed in 1933)

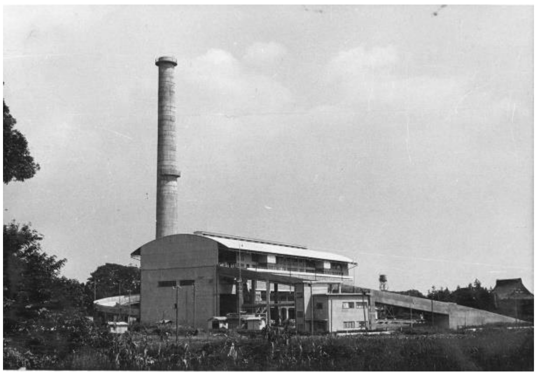


Photo 4-25 Waste Incineration Plant (Completed in 1958)

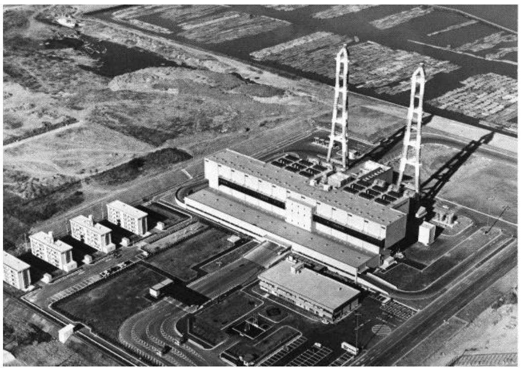


Photo 4-26 Koto Incineration Plant (Completed in 1974)

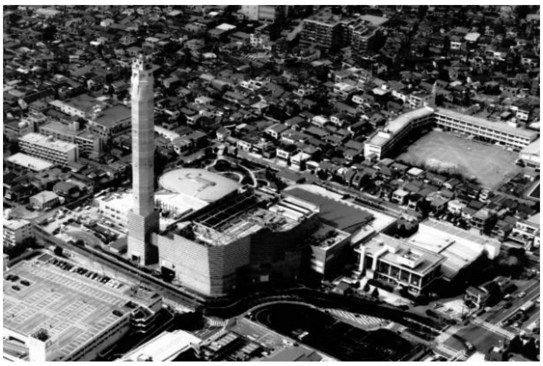


Photo 4-27 Kita Incineration Plant (Completed in 1988)

Photo 4-28 Shin-Koto Incineration Plant (Completed in 1998)

Source: Tokyo Metropolitan Archives (Photo 4-23, Photo 4-24)
Source: Tokyo Metropolitan Government Bureau of Environment (Photo 4-25, Photo 4-26, Photo 4-27, Photo 4-28)

Column: Waste Incineration Facility in Shibuya City, Tokyo

Source: Ministry of the Environment "Japanese Waste Treatment and Recycling Technology" (2013)

Photo 4-29 Shibuya Incineration Plant

Central Government Agencies are located in the 23 special cities of Tokyo, the capital of Japan. These special cities are the center of politics and the economy and have about ten million residents (about 15,000 persons/km^2).

Within these 23 special cities, commercial and residential zones coexist, generating a large amount of waste. Under these conditions, a waste incineration facility (treatment capacity: 200 ton/day) was constructed in July 2001 at the center of a highly dense populated city area near Shibuya railway station.

Even for Tokyo, under the principle of treating the waste within the special city it is generated in, it was necessary to construct this facility in such an urban district. In Tokyo, waste facilities are constructed and operated even in heavily populated urban areas by obtaining the understanding of the residents through discussions with them from the planning stage and by developing a facility that sufficiently satisfies the environmental regulations such as exhaust gas.

Source: Ministry of the Environment "Japanese Waste Treatment and Recycling Technology" (2013)

Photo 4-30 Outer View of Incineration Plant

Photo 4-31 Green Exterior Walls

Photo 4-32 Facility Entrance for Waste Collection Vehicles

Photo 4-33 Green Buffer zone between Incinerator Plant and Residential Area

Source: Yachiyo Engineering Co., Ltd.

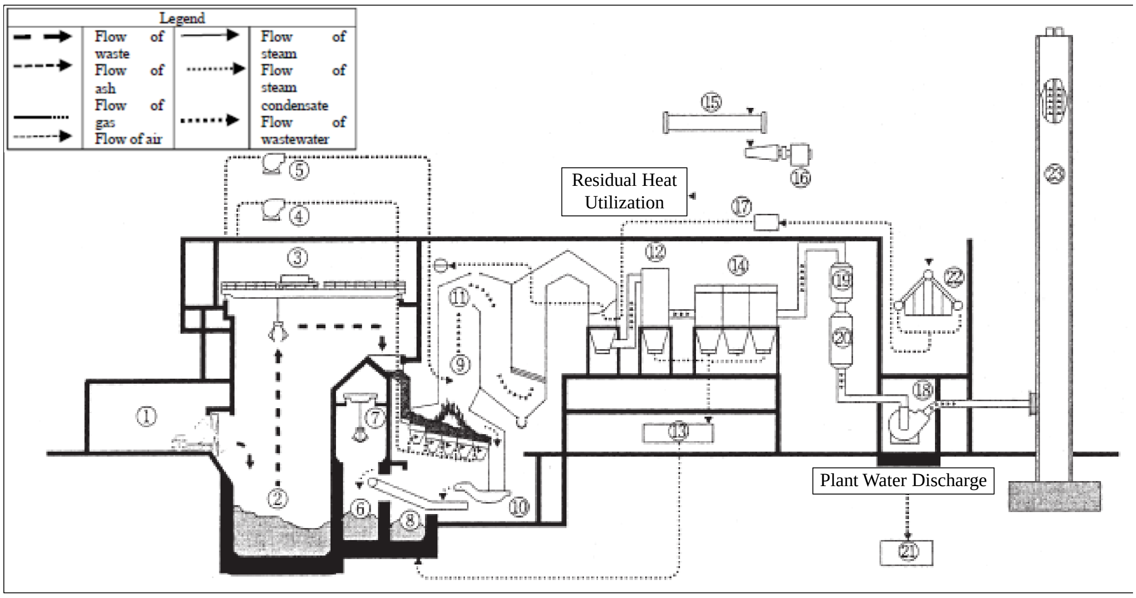
2.2 Incineration Technologies

(1) Overview and Types of Technologies Associated with Incineration

An incineration facility is a special facility comprising various facilities including an incinerator for treating waste in a sanitary manner by burning the waste as the main unit, a facility for receiving waste, a facility for properly treating exhaust gas after burning, and a facility for collecting and transporting ashes. Therefore, incineration facilities are required to satisfy many standards including the exhaust gas standards and the wastewater quality standards.

In Japan, the stoker type technology is most widely applied and when an incineration facility is installed in a municipality, the type to be installed is determined through comparison and examination of each type.

Figure 4-11 shows an example of the structure of an intermediate treatment facility that utilizes stoker-type incineration technology. Waste that is unloaded into a waste pit is transferred to the loading/unloading facility, stably placed into an incinerator, and burnt. Exhaust gas that is generated as a result of burning waste is discharged from a stack after harmful substances such as dioxins are removed by treatment facilities such as a dust collector and a catalytic reaction. Ashes generated by combustion are collected and transported after being sorted into incinerated ash and fly ash, and a facility for treating wastewater is also provided.



(1) Platform	(9) Incinerator	(17) Steam condensate Tank
(2) Waste pit	(10) Ash extruder	(18) Induced draft fan (IDF)
(3) Waste crane	(11) Boiler	(19) Steam type gas re-heater
(4) Forced draft fan (FDF)	(12) Cooling tower	(20) Catalytic reaction tower
(5) Secondary positive blower	(13) Fly ash treatment device	(21) Wastewater treatment facility
(6) Ash pit	(14) Filter type dust collector	(22) Steam Condensers
(7) Ash crane	(15) Steam receiver	(23) Stack
(8) Induced fan at ash pit	(16) Turbine generator	

Source: JICA "Guideline for Promoting Waste to Energy Facility Projects" (2017)

Figure 4-11 Example of Waste Incineration Plant with a Stoker Furnace

Photo 4-34 (1) Platform

Photo 4-35 (1) Platform (Waste Pit)

Photo 4-36 (2) Inside the Waste Pit

Photo4-37 (2) Inside the Waste Pit

Photo 4-38 (3) Waste Crane

Photo 4-39 (9) Waste Incineration inside Stoker Furnace

*1: Numbers (1), (2), (3) and (9) match the respective number in Figure 4-11

*2: The Photos were taken in Suginami Incineration Plant

Source: Yachiyo Engineering Co., Ltd.

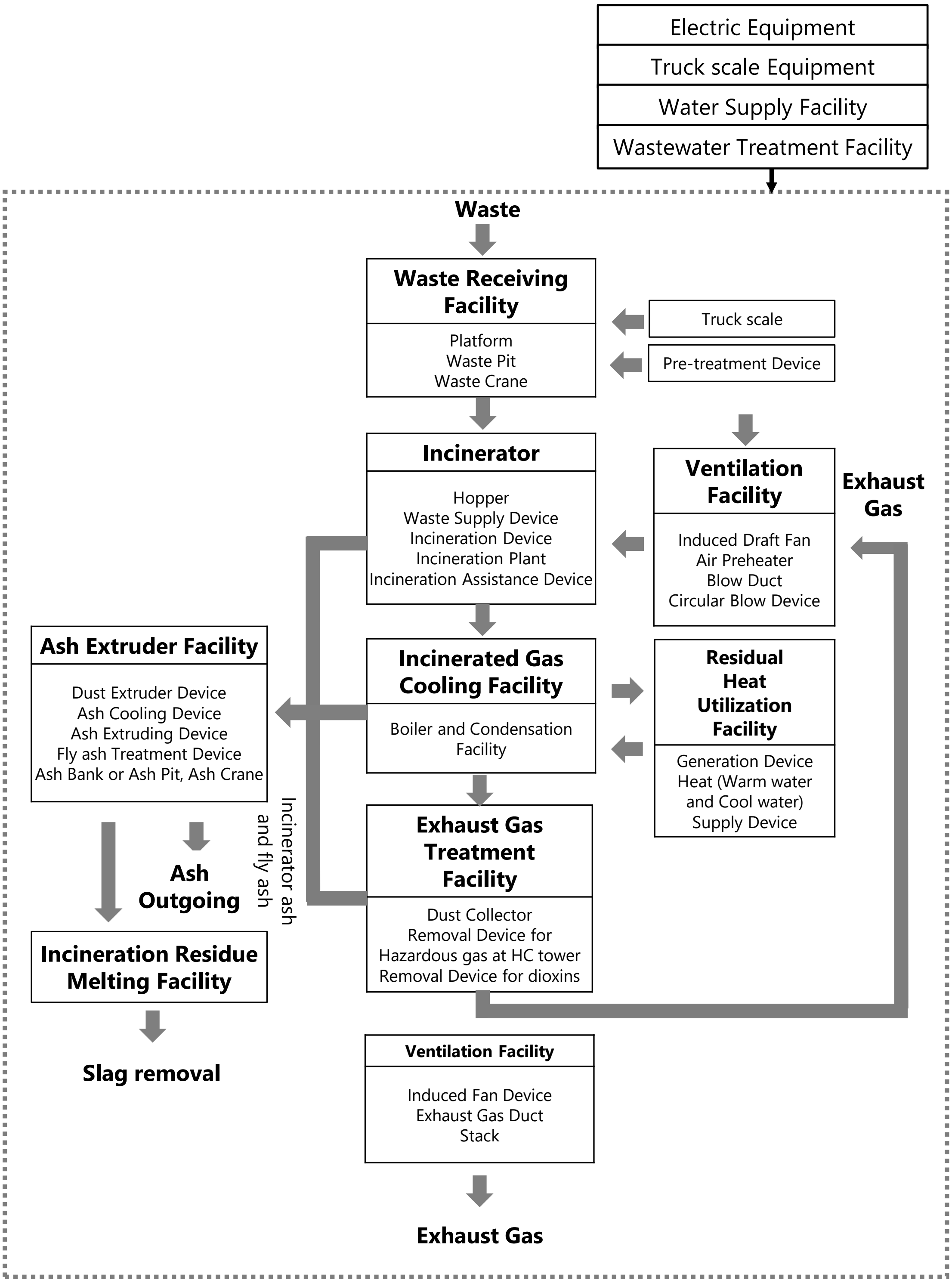
Source: Yachiyo Engineering Co., Ltd.

Photo 4-40 Funabashi North Incineration Plant

Source: Tokyo Metropolitan Government

Photo 4-41 Shin-Koto Incineration Plant

The structures and outline of the main facilities of waste incineration facilities are shown in Figure 4-12 and Table 4-14.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

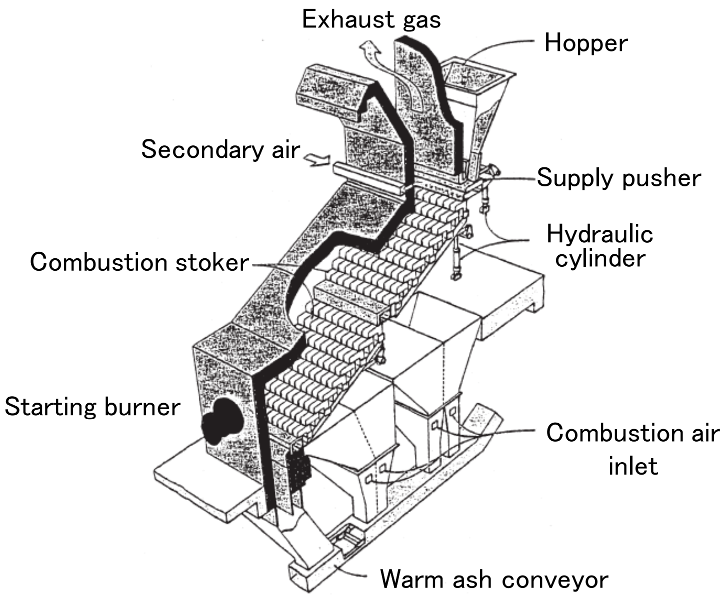
Figure 4-12 Structure of Facility of Waste Incineration Plant

Table 4-14 Outline of Major Waste Incineration Facilities

Major facilities	Facility outline
Unloading/loading facility	This facility comprises a weighing machine for weighing the amount of waste to be unloaded, entry/exit roads, a platform for a waste collection vehicle to unload to a waste pit, a dumping door for controlling access between a platform and a waste pit, a bunker or a waste pit for adjusting the waste amount to be collected and amount to be incinerated by storing the waste temporarily, and a crane for delivering the waste to a hopper. Equipment such as shredding and bag ripping may also be available for incineration pre-treatment depending on the quality of the waste and the type of the incinerator.
Combustion facility	This facility comprises a waste hopper for receiving the waste to be delivered to a furnace, a waste feeding facility for smoothly feeding the waste to a furnace, combustion equipment for incinerating waste, an incinerator main unit comprising refractory lining and so on to enable smooth combustion.
Combustion gas cooling facility	This facility is used for cooling a high-temperature combustion gas that is generated by burning waste. Available types are a waste heat boiler type and a type designed by combining a boiler and a water sprayer.
Exhaust gas treatment facility	This facility comprises a dust collector and dust removal equipment for removing dust and harmful gases such as hydrogen chloride (HCl) and dioxin that are contained in the exhaust gas that is generated as a result of combustion.
Waste heat utilization facility	When a boiler is installed, hot water can be made available by using a wastewater utilization facility (power generation facility, hot water equipment, heating and cooling system) and a hot water generator by using waste heat of combustion gas.
Ventilation facility	This facility comprises a pressure fan and air duct (airway) for sending air necessary for burning waste to the combustion equipment, an air preheater for heating air for combustion, an induced draft fan for discharging exhaust gas that was generated by burning, an exhaust gas duct (flue) for sending exhaust gas from a combustion facility to a stack, and a stack for releasing exhaust gas to the atmosphere.
Ash discharge facility	This facility comprises a dust transport and storage facility for properly transferring the dust discharged from the exhaust gas treatment facility and gas cooling facility, an ash cooling facility for extinguishing and cooling the incinerated ash that has been generated by completely incinerating waste by the combustion facility, as well as an ash conveyor for transferring falling ash, and an ash bunker or an ash pit for temporarily storing ash.
Incineration residue melting facility	Incineration residue is placed in a melting furnace after pre-treatment such as drying, screening, and magnetic separation as required and is turned into molten material in liquid state. Inorganic substances that make the most part of the incineration residue turn into a molten slag material. Some of the heavy metals enter in the matrix, preventing elution and at the same time, reducing the amount to one third or a half.
Water supply facility	This facility supplies water from a water supply source within the facility premises to each device and it has plant water supply pumps and equipment cooling water pumps. This also includes water supply for construction facilities.
Wastewater treatment facility	This facility treats wastewater that is discharged from the waste incineration facility and consists of a combination of various types of facilities to be able to handle recycling and meet the conditions of the discharge destination.
Electrical facility	This facility receives power required for all these facilities and distributes it to the required sections (motor, and so on) of each equipment. An instrumentation control facility is necessary for operating and controlling the facility.
Others	Common facilities such as various types of water supply pumps, hydraulic pumps, and compressors are installed as well as a vehicle washer and deodorizing equipment as required.

Source: Created based on Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Incineration (Stoker Furnace)

<table>
<tr><td>Conceptual Figure</td><td>
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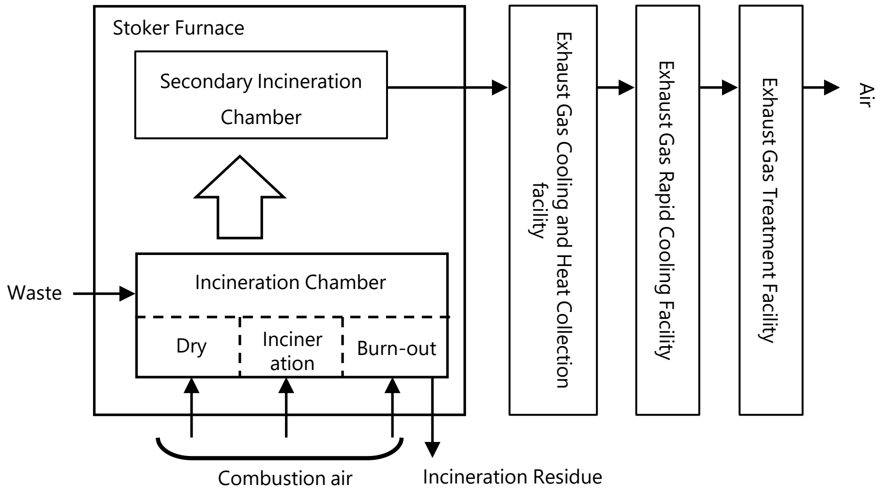
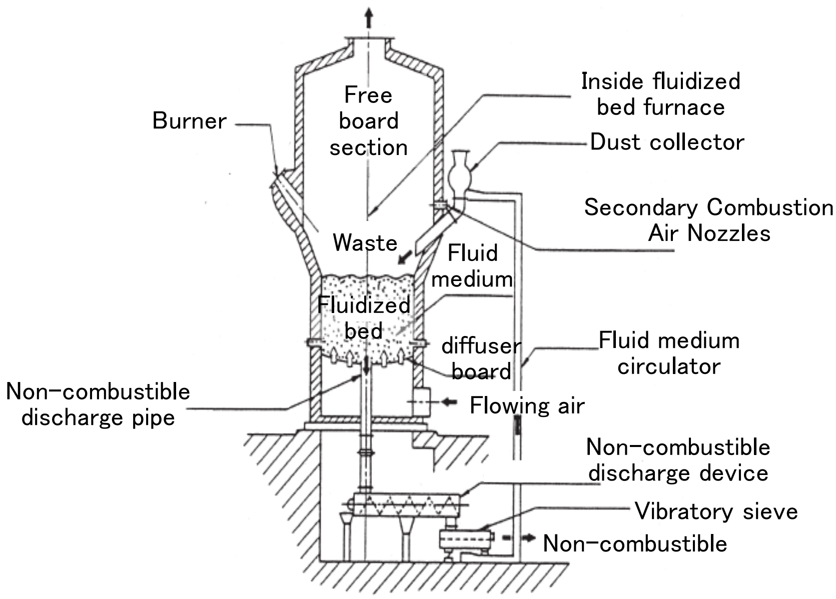
<tr><td>Flow</td><td>
</td></tr>
<tr><td>Principle</td><td>A stoker furnace is a thermal treatment facility that dries waste with hot air and treats waste by using oxygen in the air inside of the furnace at a temperature higher than the combustible material ignition temperature. Elements that make up the organic matters in the waste such as C, H, and O are oxidized by thermal treatment and are stabilized by transforming them to low molecular chemical compounds such as CO_2 and H_2O.
The basic principle of thermal treatment by a stoker furnace is the same as that of incineration furnaces such as fluidized bed furnace and rotary kiln.</td></tr>
<tr><td>Features</td><td>In this thermal treatment system, waste is placed on a metal fire grate for efficient combustion in large amounts and is dried and burnt by the combustion air that is supplied from the bottom of the grate by a fan.
By actuating a fire grate mechanically, the waste is mechanically supplied and transferred and the incineration residue is discharged. Urban waste is treated over a wide range of amounts from a daily incineration capacity of several tons to 1,000 tons per furnace.</td></tr>
</table>

Source: Central Environment Council “Outline of Incineration Plant and Melting Facility” (2013)

Incineration (Fluidized Bed Furnace)

<table>
<tr><td>Conceptual Figure</td><td>
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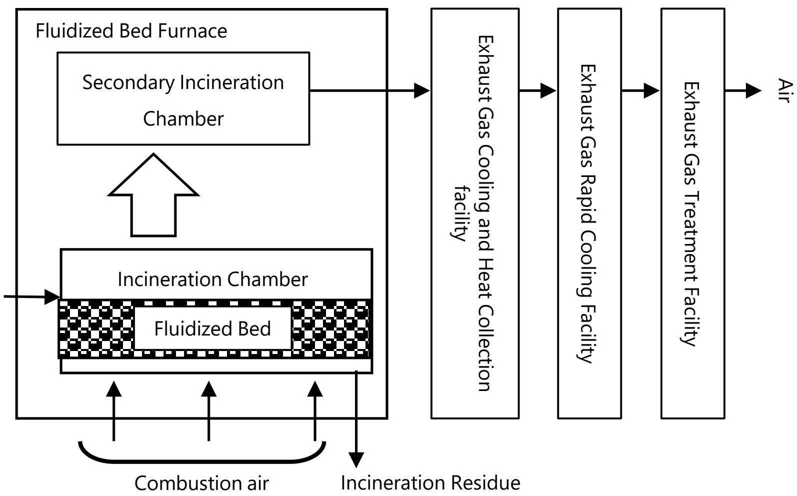
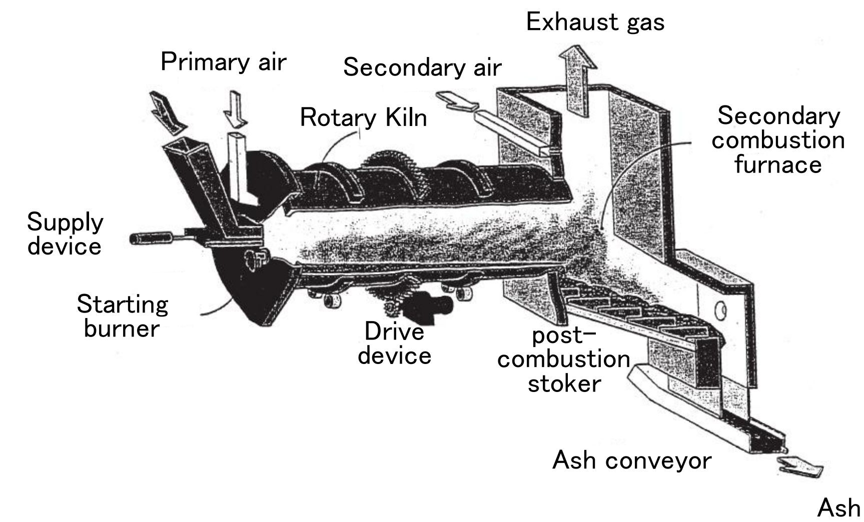
<tr><td>Flow</td><td>
</td></tr>
<tr><td>Principle</td><td>In this thermal treatment system, waste is delivered in a fluidized bed comprising inactive particles such as silica sand, which is maintained at a high temperature and is completely burnt in a short time with oxygen in the air that is supplied from the bottom of the furnace. Inorganic materials including metals and silica sand are discharged from the bottom of the furnace and incineration residue with low apparent specific gravity is captured by a dust collector in the form of fly ash.</td></tr>
<tr><td>Features</td><td>Since this system does not use a metal stoker, unlike a stoker furnace that is limited in heat resistance, the system can treat waste of high heat value and can handle a wide range of physical properties. It can treat low heat waste such as dewatered sludge, waste plastic, viscous substances such as oil mud, and substances of high heat values.
Inorganic substances are discharged in a dry state. Since most of the combustion residue becomes fly ash, a vast amount of fly ash is discharged in the fluidized bed furnace compared to stoker furnace and rotary kiln furnace.</td></tr>
</table>

Source: Central Environment Council "Outline of Incineration Plant and Melting Facility" (2013)

Incineration (Rotary Kiln)

<table>
<tr><td>Conceptual Figure</td><td>
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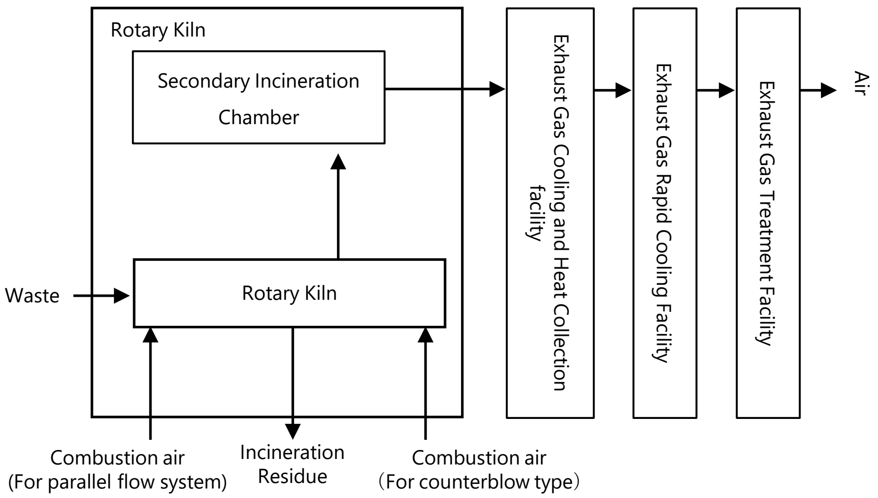
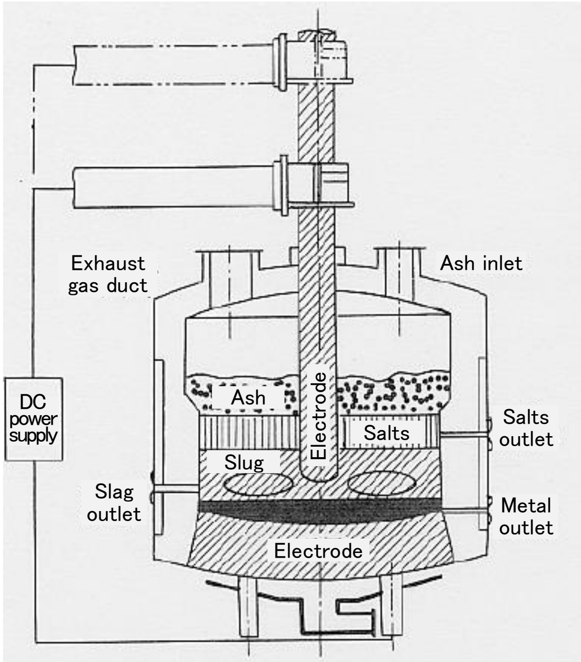
<tr><td>Flow</td><td>
</td></tr>
<tr><td>Principle</td><td>Waste is delivered to a rotary kiln that is installed with a gentle descent towards the discharge side. The kiln is lined with a refractory material and maintained at a high temperature. Waste is stirred and transferred by rotation of the kiln. In the case of a parallel flow system, combustion is completed by the oxygen in the air that is supplied from the waste input side and in the case of a counter flow type, combustion is completed by the oxygen in the combustion air that is supplied from the incineration residue discharge side.</td></tr>
<tr><td>Features</td><td>Since this system does not use a metal stoker, unlike a stoker furnace that is limited in heat resistance, it can treat waste of high heat value and can handle a wide range of physical properties. It can treat low heat waste such as dewatered sludge, waste plastic, viscous substances such as oil mud, and substances of high heat values.
To handle a variety of waste types, a kiln stoker designed by combining a rotary kiln stoker and stoker furnace in parallel and a kiln stoker designed by using a stoker furnace for after-burning are both available.</td></tr>
</table>

Source: Central Environment Council “Outline of Incineration Plant and Melting Facility” (2013)

<u>Ash Melting</u>

<table>
<tr><td>Conceptual Figure</td><td>
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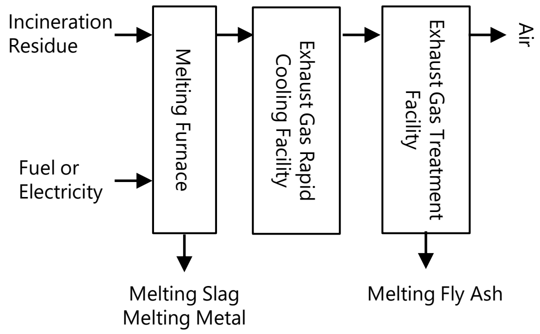
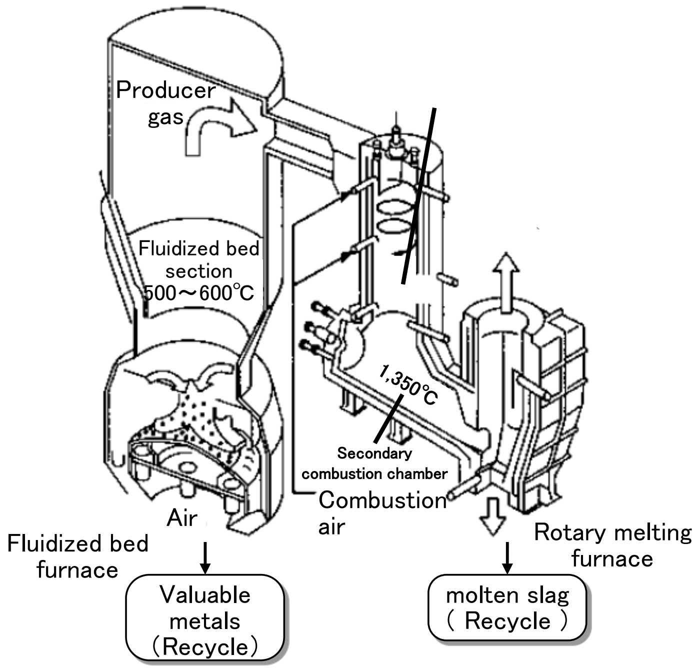
<tr><td>Flow</td><td>
</td></tr>
<tr><td>Principle</td><td>If incineration residue is heated to a temperature above the inorganic substance melting temperature by using fuel or electricity and then is cooled rapidly, unburned residue is mineralized and at the same time, silicon components in the inorganic substances bring heavy metals into the crystal structure and as a result, stabilized molten slag can be obtained. This melting furnace performs this process.</td></tr>
<tr><td>Features</td><td>Incineration residue and an incombustible portion can be separated into metals with iron as the main component and molten slag by melting and then cooling them. Metals can be recycled as metal resources and molten slag can be recycled as construction materials through some other processing. Depending on the cooling method applied to molten slag, the slag forms a different crystal structure such as water granulated slag formed by rapidly cooling with water, air cooled slag formed by naturally cooling in a container, and cold removal slag formed by cooling under a controlled temperature in a container. These types of slags can be used for different applications due to the differences of crystal structures.</td></tr>
</table>

Source: Central Environment Council “Outline of Incineration Plant and Melting Facility” (2013)

<u>Gasification Furnace</u>

<table>
<tr><td>Conceptual Figure</td><td>


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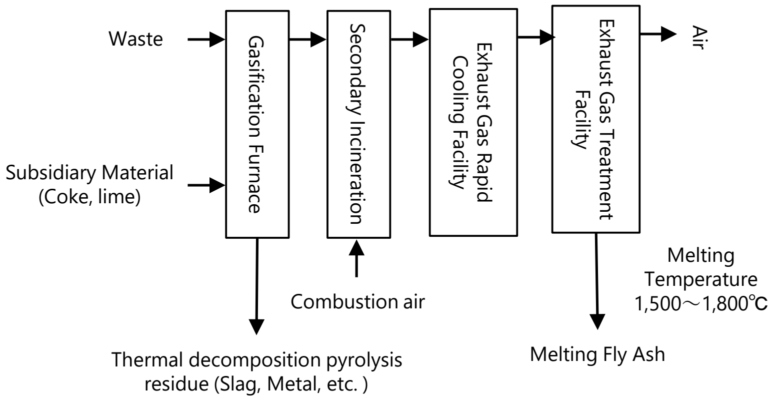


</td></tr>
<tr><td>Principle</td><td>This treatment system resolves the waste that was roughly shredded in the previous treatment facility into char of high carbon content and volatile pyrolysis gas by applying a temperature ranging from about 450℃ to 600℃ under oxygen-free atmosphere.
Ash may be melted by burning at high temperature by supplying air to the pyrolysis gas.</td></tr>
<tr><td>Features</td><td>Since waste is gasified at a high temperature, the amounts of dioxins that are generated are low. As a whole, the amount of exhaust gas is low due to the low excess air combustion.</td></tr>
</table>

Source: Central Environment Council “Outline of Incineration Plant and Melting Facility” (2013)

(2) Advantages and Disadvantages of Technologies Associated with Incineration

Incineration and gasification melting technologies are extremely effective for the sanitary treatment and amount reduction of waste. In addition, after having overcome various issues, Japan is now in possession of well-developed incineration technologies with performance records covering a long period of time.

On the other hand, facilities using technologies such as incineration require both technical and financial attention. Facility improvements require substantial cost and at the same time, the facility's operation and maintenance management requires securement of higher expenses and more advanced management than those of disposal sites.

In Japan, there are many waste treatment facility construction companies with a rich experience of established performances. There are also many private operators that are well qualified to manage the operation and maintenance of incineration facilities. Therefore, incineration technologies are being adopted by many municipalities in Japan for intermediate treatment of waste. In considering introduction of incineration, a detailed examination is conducted covering aspects of viability, necessity, and sustainability of incineration technologies, and considering the advantages and disadvantages of the types of incineration technologies, based on essential installation preconditions.

1) Incineration Technology

The following preconditions need to be satisfied for introduction of incineration technology:

Installation preconditions for incineration facilities:

- ✓ A fee collection system such as a tipping fee system has been established to ensure regular income. It is extremely difficult to fund the cost for the entire operation and maintenance management with only the revenue from power generation.
- ✓ It is possible to secure continuous and stable financial resources, including income from tipping fees, in order to cover the expected large costs that will be incurred in the operation management and regular maintenance of the facility.
- ✓ It is possible to secure the necessary engineers and provide training for them on operation management in order to ensure that they will possess the advanced technological skill that is required for the facility operation management.
- ✓ A site planned for the construction has either been already secured or it is certain that a site for construction may be secured on public land or the like.
- ✓ It is possible to obtain the understanding of residents living in the vicinity of the construction site on the facility development.

Table 4-15 shows the advantages and disadvantages of introducing waste incineration. In Japan, the stoker system is widely used due to its stable combustion. When considering the introduction of an incineration facility, it is necessary to understand the characteristics of each incineration method and compare the advantages and disadvantages based on past performance records.

Table 4-15 Advantages and Disadvantages of Incineration Technologies

Technology	Advantages	Effects
Incineration	✓ Waste can be treated sanitarily by burning at a high temperature (mineralization, sterilization, and stabilization). ✓ The amount of waste can be reduced. ✓ Power can be supplied by installing a power generation facility.	✓ Sound hygienic environment can be maintained by applying sanitary treatment, thereby ensuring that the occurrence of infectious diseases can be controlled. ✓ Since the amount of waste is reduced to one tenth, the amount at the final disposal is reduced dramatically, thereby reducing the strain at the disposal site. ✓ The facility can contribute to the region as a power generation facility.
	Disadvantages	**Issues**
	✓ The operation and maintenance management are costly in comparison to landfill. ✓ Advanced technical skills are required for operation and maintenance management of the facility.	✓ Secure funds, continuously and stably to cover the high operation and maintenance costs. ✓ Obtaining the technical skills necessary for the facility operation and maintenance management.

2) Gasification Melting Technology

The preconditions for installing the gasification melting technology are almost the same as for the incineration technology. Gasification melting has excellent heat recovery, and effective utilization of slag, but its operation is more complicated than that of incineration.

Table 4-16 Comparison between the Incineration and Gasification Melting Technologies

Technology	Features
Incineration	✓ Has performance records over a long period of time and has developed technically. ✓ Can be more easily operated than gasification melting.
Gasification melting	✓ Surpasses in thermal recovery as this technology treats waste at high temperature. ✓ Slag can be used effectively, and further reduce waste disposed in landfill sites.

(3) Other Uses of Incineration Technology

In Japan, in order to effectively utilize the energy generated by waste incineration treatment, many incineration facilities utilize residual heat and generate power. Waste heat is recovered and distributed to surrounding local communities as well as within the facility as a heat source. Regarding incineration power generation, the improvement in power generation efficiency brought about by technological progress has encouraged the promotion of power generation facilities and the utilization of the generated power.

1) Use of Waste Heat

The thermal energy that is generated by combustion in an incineration facility is used for heating, and hot water supply within the facility in the forms of air, steam, and hot water. The energy is stored and distributed to the local residents as an energy source for hot water for swimming pools in recreational centers, social welfare facilities, and community centers of the region, in addition to heating inside the incineration facility.

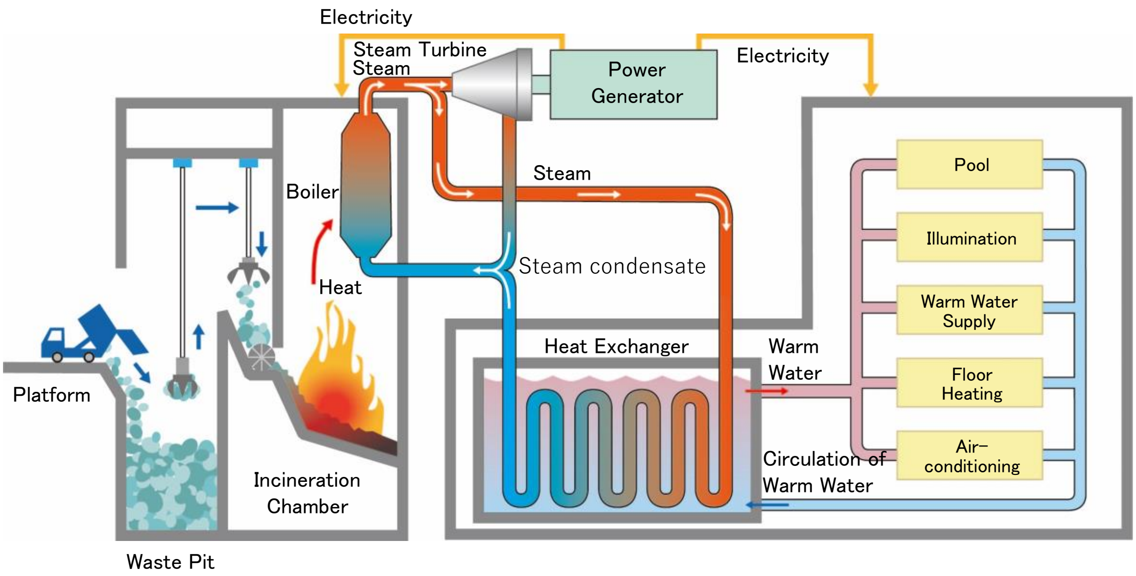


Figure 4-13 Schematic Diagram Showing Residual Heat Utilization

2) Incineration Power Generation

Steam is created by the waste heat that is generated during the incineration of waste. The steam is then utilized to turn a turbine, a device that converts thermal energy into kinetic energy and uses it as power to generate electricity. This is the process referred to here as incineration power generation. When considering the introduction of incineration power generation and developing the facility as a waste treatment plant with an additional function of electric power generation, various social, technical, and financial aspects need to be examined. These include understanding the development status of the power transmission line for connecting the generated power to the electricity grid and power selling unit prices, amongst others.

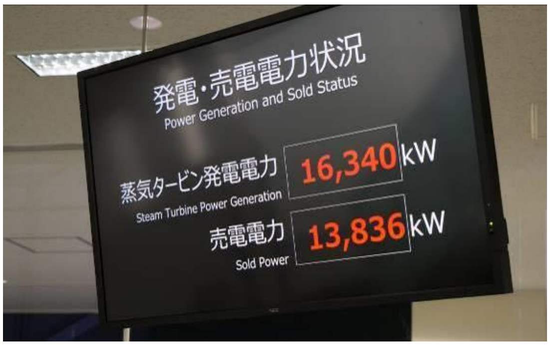


Photo 4-42　Monitor of Suginami Incineration Plant Showing Amounts of Power Generation and Sold Power

Photo 4-43　Steam Turbine in Suginami Incineration Plant

Source: Yachiyo Engineering Co., Ltd.

As a reference, Table 4-17 shows the pre-checklist for deciding on introduction of waste incineration power generation facilities indicated in the Guideline for Promoting Waste to Energy Facility Projects. The items on this list are important for gauging the requirements of the region before considering the introduction of waste incineration facilities with power generation facilities (i.e. waste to energy facilities).

Table 4-17 Pre-Checklist for Feasibility Study of Waste Power Generation Plant (WtE)

Classification	Importance	Item	Content
1) Social conditions	Most important	(1) Target city population	The target city population is 100,000 or more.(Or plant capacity is 70 ton/day or more).
	Inportant	(2) Social needs	There are high social needs, such as "The remaining capacity of final disposal sites is limited.", "Sanitary waste treatment is highly required."
	Recommended	(3) Development status of social infrastructure pertaining to environmental sanitation	Administrative services of energy, waterworks and sewerage works are provided in the target city without problems.
	Recommended	(4) Integration of environmental and social considerations	Laws with regards to pollution prevention and environmental impact assessment (environmental laws etc.) have been developed and enacted in target countries and target areas.
2) Understanding of residents	Most important	(1) Cooperation of residents in waste sorting	Cooperation of the residents concerning the sorting of wastes can be obtained. (Delivery of wastes not suitable for WtE can be controlled.)
	Most important	(2) Understanding of residents about WtE	Understanding of the residents about WtE has been obtained.
3) Institutional aspect	Most important	(1) Development of laws, enforcement orders and rules	In addition to laws with regards to solid waste management, enforcement orders and rules have been developed.
	Important	(2) Stability of administrative organization	There is an administrative organization in charge of the project for construction and operation of WtE and the organization is stable. Also, there is a personnel management system enabling long-term employment (for 3 years or longer) of the core staff.
	Important	(3) Adequacy of construction site	Construction site in which WtE can be built is available.
4) Governance capability of the government	Most important	(1) Positioning of WtE in upper level plan	WtE has its position in the upper level plans (comprehensive plan, regional development strategy, etc.).
	Most important	(2) Stance of the head of local government	The head of local government is positive towards WtE.
	Important	(3) Performance capability of the government	The government is able to leverage committees comprised of external experts and external specialist organizations, such as consulting firms, to perform the project appropriately.
	Important	(4) Technical standards and operation pertaining to selling electricity	By energy department and electric power company, technical standards and operation pertaining to selling electricity, and selling price of electricity are set forth.
5) Financial aspect	Most important	(1) Securing of financial resources	Project cost (construction cost and operating cost) of WtE can be secured. The government is prepared to bear the cost such as tipping fee (fee for outsourcing disposal) and reliable investors are expected to participate in the project.
	Important	(2) Tipping fee	It is possible to set the tipping fee at a stable price over a long period by contract.
	Important	(3) Revenue by selling electricity	It is reasonable to assume selling price and the amount of electricity and recyclable waste.
	Recommended	(4) Project scheme	Project schemes (DB, DBO, BTO, etc.) are being discussed among stakeholders.
	Recommended	(5) Project risks	Major project risks are confirmed and the difference of responsibility division points according to project schemes are understood.
5) Technical aspect	Most important	(1) Collecting basic data concerning waste	Basic data and information concerning waste (amount and composition of waste, waste treatment process etc.) have been clalified.
	Important	(2) Technical capacity of manufacturers	Reliable manufacturers (of stoker incinerators) are expected to participate in the project.
	Important	(3) Proper disposal of incineration residue (incineration ash)	Proper disposal of incineration residue (incineration ash) is possible. (For example, measures for preventing the outflow of leachate have been taken at the final disposal site.)
	Recommended	(4) Environmental monitoring system	Laboratories for analysis of exhaust gas, wastewater, noise, vibration, odor, etc. exist and enable perform appropriate monitoring.
	Recommended	(5) Track record of similar facilities	Similar facilities, such as thermal power plants, exist and are managed appropriately.
	Recommended	(6) Securing of engineers	It is possible to secure engineers (personnel with skills equivalent to technical high school graduates).

Importance of evaluation indicators

Most important: It is considered extremely difficult to introduce WtE if this criterion is not fulfilled.

Important: The criterion should be fulfilled for and is expected to be fulfilled if assistance is provided.

Recommended: This criterion should desirably be fulfilled.

Source: JICA "Guideline for Promoting Waste to Energy (WtE) Facility Projects" (2017)

2.3 RDF/RPF Conversion Technology

(1) Overview of the Technology Associated with RDF/RPF Conversion

RDF (Refuse Derived Fuel) / RPF (Refuse derived Paper and plastics densified Fuel) is a solid fuel that can be obtained by forming combustibles into cylinders through shredding or sorting. RDF/RPF conversion ensures not only the proper treatment of waste, but also provides a fuel with high heat value and stable combustion which can be used as a heating and energy source in paper mills, cement factories, and public facilities.

On the other hand, while RDF/RPF is suitable for use in various facilities, in order to prevent troubles and accidents due to heat generation and ignition, sufficient attention should be paid to manufacturing, storage, and safe operation management at the facilities where the fuel will be used.

RDF (Refuse Derived Fuel) is a solid fuel that is produced from combustible waste - kitchen waste, paper waste, plastic waste, and so on. The combustible waste is solidified through the processes of shredding, sorting, drying, and molding. RDF can be stored for a comparatively long period of time due to its low biodegradability and can be transported more easily than waste due to its reduced amount and molding into more usable shapes.

Stable combustion is another major feature of RDF because of its generally constant shape and heat value.

Table 4-18 General Properties of RDF

Item	Quality
Shape	Cylindrical: Around 10mm to 50mm in diameter
Unit weight	0.3 tons to 0.7 tons/m^3
Low-level heat value	3,000 kcal/kg（12,500 kJ/kg） or more
Composition	Moisture content: 10% or less, Ash content: 20% or less

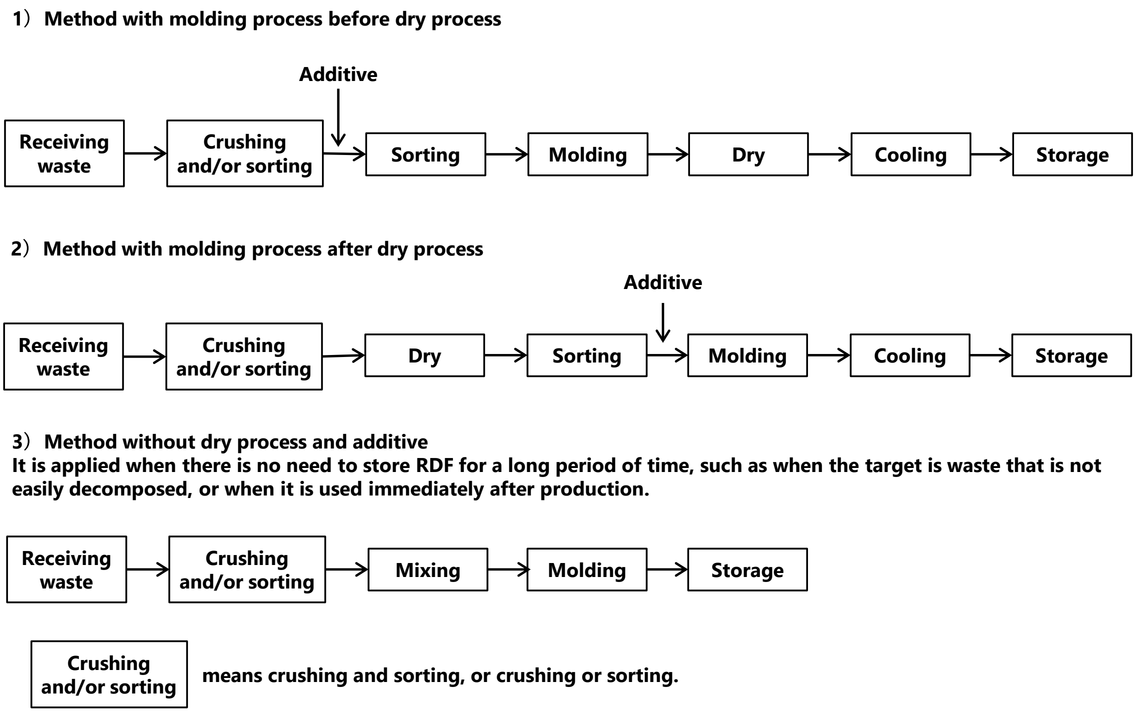
Photo 4-44 RDF

Photo 4-45 RPF

Source: Study Group on Appropriate Management of RDF “Report of Study Group on Appropriate Management of RDF (2003)” (RDF) (Photo 4-44)
Source: Japan RPF Association Website “What is RPF?” https://www.jrpf.gr.jp/rpf-1 (accessed January 10, 2022) (Photo 4-45)

RPF (Refuse derived Paper and plastics densified Fuel) is a solid fuel that is manufactured mainly from paper and waste plastics discharged in industrial waste and specifically selected municipal waste, that are difficult to recycle as raw materials. RPF can be used as a fuel in the same way as RDF, however, since RPF is produced from selected waste, it is characterized by having less foreign matter content, lower moisture content, and higher heat value (5,000kcal/kg or more).

Figure 4-14 shows the treatment methods at the intermediate treatment facility where RDF/RPF conversion technology is applied.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 4-14 Treatment Process of RDF Facility

Table 4-19 Outline of Major Equipment of an RDF Facility

Major equipment	Equipment outline
Unloading/loading equipment	This equipment comprises a weighing machine, a delivery door, a receiving hopper, a receiving conveyer, a waste pit, and a waste crane.
Shredding equipment	This equipment comprises a bag ripping machine for ripping the bags that are unloaded and a shredder that shreds waste of specified amount and quality into intended sizes.
Sorting equipment	This equipment is used for sorting waste into combustibles that are suitable for converting to a solid fuel and waste unsuitable for conversion to a fuel.
Drying equipment	This equipment is used for producing RDF of a target moisture content or lower by drying waste of planned quality in a specified amount.
Solidification equipment	This equipment is used for solidifying waste to a specified quality and shape. It comprises a molding machine, adding equipment, a reactor, and a cooler that adjusts the temperature of the solidified material to the temperature suitable for storage and transport. Adding equipment is used for adding lime to prevent decay during storage or as a chlorine removal measure when RDF is used as a fuel. This equipment can supply add-in materials in a fixed amount.
Transfer equipment	This equipment transfers municipal waste, shredded waste, dried waste, RDF, and waste unsuitable for fuel conversion.
Pooling/transport equipment	A pooling equipment is used for temporarily storing waste for transport and a storage equipment is used for storing waste for a certain period of time. Each equipment is used according to the amount of RDF or waste unsuitable for fuel conversion to be transported.
Deodorization equipment	This equipment is used for treating malodorous gases that are generated from the facility.
Dust collector	A dust collector is used for removing dust from the facility. To maintain the work and surrounding environment, dust collection measures are taken at the dumping section, shredding section, sorting section, storage section, and transfer/transport section.
Others	A water supply equipment and a wastewater treatment equipment are available as basic facilities of the RDF conversion facility.

Source: Created based on Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

(2) Advantages and disadvantages of technologies associated with RDF/RPF conversion

In Japan, the use of RDF/RPF has been promoted as one of the appropriate waste treatment methods and at the same time considering the advantage of being able to be used as an energy source in other facilities. While RDF/RPF contributes to the effective use of energy, issues concerning safety need to be addressed in the operation management and storage of RDF/RPF.

In addition, since RDF/PRF is produced using waste that is discharged daily as the raw material, it is necessary to secure continuous supply destinations. In order to secure supply source for RDF/RPF, it must also be noted that development of a network of RDF/PRF supply destinations over a wide area is required.

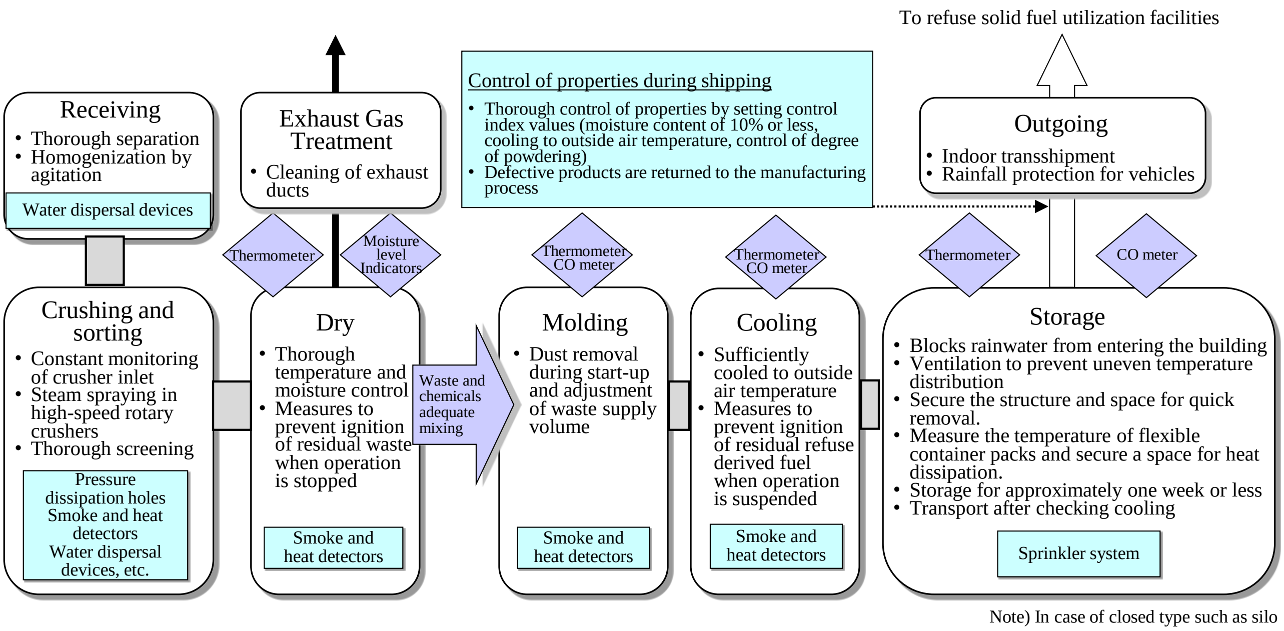
Table 4-20 shows the advantages and disadvantages of introducing RDF/RPF conversion technology. In particular, caution should be taken not to fall into a situation where stable supply destinations cannot be secured after RDF/RPF production and there are no sales destinations.

Table 4-20 Advantages and Disadvantages of RDF/RPF Conversion Technology

Technology	Advantages	Disadvantages
RDF/RPF	✓ Can be handled easily due to its stable quality. ✓ The quality can be adjusted according to the application. ✓ Can be used efficiently as an energy source due to its high heat value in comparison with waste. ✓ Burns stably due to its low moisture content and homogeneous properties in comparison with waste. ✓ Can be used according to a fixed schedule since it is dry and can therefore be stored for a long period of time.	✓ Development of a separate RDF/RPF facility is necessary. Development cost is required. ✓ Securement of stable and continuous supply destinations (markets) of RDF/RPF is required. Need to balance between demand and supply. ✓ Consideration is necessary for the storage of RDF/RPF.

Source: Created based on the Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 4-15 and Table 4-21 show the items to be noted in operation management of an RDF/RPF conversion facility. Adequate measures are necessary for the production process and storage of RDF/RPF due to the high fire risk of RDF/RPF.



Source: Study Group on Proper Management of Refuse Derived Fuel "Proper Management Measures for Refuse Derived Fuel" (2003)

Figure 4-15 Countermeasures in RDF/RPF Facility

Table 4-21 Measures to be Taken for an RDF/RPF Conversion Facility

Process	Measure
Receiving process	Thoroughly sort waste into dangerous substances and incombustibles. Stir waste well to ensure uniform properties as much as possible. Place sprinklers and fire hydrants appropriately in case of fire breakout.
Shredding/sorting process	Constantly monitor the conditions around the inlet of the shredder. When using a high-speed rotary shredder, take fire prevention measures such as steam spraying. Install a fire extinguisher together with a heat sensor inside the chamber.
Drying process	Monitor constantly and properly the dryer exhaust temperature and the dried waste moisture content indicator. Take measures to prevent the waste remaining inside the drying furnace from being ignited when the operation stops. Clean the inside of the exhaust duct regularly. Install a heat sensor inside the chamber.
Chemical agent adding process	Design and control properly so that waste and additives can be mixed thoroughly.
Molding process	Measure the temperature and the concentration of carbon monoxide continuously. Before starting the machine, remove dust and check the amount of waste to be supplied. Install a heat sensor inside the chamber. Mold the RDF/RPF to an appropriate hardness.
Cooling process	Cool the solid fuel down to a temperature in the range of the outside air temperature by checking that fuel is adequately cooled up to the center of the fuel. Measure the air temperature of the cooler continuously and control the cooler. Take measures to prevent the waste remaining inside the drying furnace from being ignited when the operation stops. Install a heat sensor inside the chamber.
Storage/transport process (measures when storing a small amount)	Prevent rainwater from getting into the facility by wind and rain. Ventilate the tank and chamber to prevent the temperatures inside the tank and chamber from deviating. When storing in a closed type facility, measure the carbon dioxide and temperature continuously and design the structure of the facility so that solid waste fuel can be removed quickly. The permissible storage period is up to one week and take heat accumulation prevention measures when a fuel is stored for a long period of time. After checking that the fuel is cooled down to a temperature in the range of the outside air temperature, transfer it.
Property management at transport	Determine control index values of moisture content, temperature, and so on and measure and monitor them daily. Control the process thoroughly by returning the solid fuel that did not satisfy the index values to the production process.

Source: Study Group on Appropriate Management of Solid Waste Fuel "About Appropriate Management Measures for Solid Waste Fuel" (2003)

Column: Examples of Accidents Associated with RDF

1. Outline of Examples of Accidents/Troubles

Example A

On December 12, 2002, an accident occurred in the solid fuel power generation plant owned by a municipality. A part of the solid fuel was ignited at the bottom of the silo containing solid waste fuel and the fire was extinguished by spraying inside the silo.

As a result, the use of the silo was suspended and the solid waste fuel was removed from the tank and was inspected. At the same time, measures to improve properties of the solid waste fuel to be delivered were taken to prevent accident recurrence, and the use of the silo for storage resumed from February, 2003.

However, heat generation/ignition from the solid waste fuel inside the silo was confirmed in July 2003. Although removal of the solid waste fuel that generated heat or was ignited and cooling of the silo were attempted, satisfactory results could not be achieved. In the meantime, an explosion occurred within the silo in August 2003, causing injuries to four workers. Furthermore, the silo exploded in the process of extinguishing the fire, and the roof was blown out, causing death and injuries to three persons.

Example B

In September, 2003, an abnormality was confirmed from a private power plant. The temperature around the center cone (protruding equipment at the center of the bottom of the silo storage tank) inside the silo storage tank (same type as the silo of Example A) for storing solid waste fuel increased by about 2°C.

When the inspection panel of the conveyor at the bottom of the storage tank was opened, the presence of white smoke together with a discharge of a carbonized solid fuel from the delivery conveyor were confirmed. Consequently, the solid waste fuel was removed from the tank while injecting nitrogen gas from the bottom of the silo storage tank.

Example C

In October, 2003, an abnormality was confirmed at the RDF center that was built by a local union. An increase of the temperature by several degrees Centigrade was detected at the upper section of the silo storage tank (same type as the silo of Example A) storing solid waste fuel. When the surface temperature of the solid waste fuel at the top was measured, it was confirmed to be around 40°C (normally, it should be around room temperature).

Therefore, while injecting nitrogen gas, the refuse solid fuel was taken out. It was found that during the discharge of solid waste fuel, smoke was being generated from refuse solid fuel at the delivery conveyor at the bottom of the tank in October 2003. Subsequently, the removal operation was suspended and after continuous injection of nitrogen gas, the removal was resumed after confirming the decrease of the oxygen concentration and temperature and their stabilization.

2. Insights Obtained from the Accidents

(1) Heat Generation/Ignition in the Storage Tank (silo)

It is assumed that the heat generation/ignition in the storage tank (silo) was caused by the following process: Due to the causes from 1) to 4) below, localized concentration of moisture occurred due to inflow of moist air or condensation, the solid waste fuel absorbed the moisture, and heat was generated as a result of the fermentation of organic substances.

In addition, solid waste fuels of at least from 600 tons to 700 tons were stored inside the storage tank, making it extremely difficult for heat to escape. Therefore, the solid waste fuel that generated heat as a result of fermentation became hotter through self-heating by chemical oxidization of organic substances (low-temperature oxidization), thereby causing ignition.

<Main Cause of Heat Generation/Ignition>

1) The structure of the storage tank allowed in-flow of air.
2) Since the sweep device had not been operated, possibly a solid waste fuel remained in the dead space for a long period of time.
3) Fuel was input again without completing the removal of the solid waste fuel at the regular inspection.
4) The solid waste fuel that had been stored in another warehouse for a long period of time was input.

(2) Explosion in the Storage Tank (silo)

The concentration of carbon monoxide at the top of the storage tank showed an abnormal value exceeding 300 ppm before stopping the delivery of fuel to the storage tank. Although fire break-out was confirmed, the inside of the storage tank was kept at high temperature for a long period of time without taking sufficient measures.

Consequently, a combustible gas was generated by various reactions such as thermal decomposition, and the cavity created by removal of solid waste fuel and the upper space were filled with the gas. Combined with air inflow and water discharge, the mixture reached the explosion limit and an explosion occurred from some sort of fire source.

(3) Heat Generation/Ignition in the Storage Facility

As for the cause of the heat generation and ignition, an accident in the storage facility was assumed. Alternatively, after heat, such as frictional heat generated from the molding machine of the facility was accumulated, a solid waste fuel that had not been completely cooled was delivered inside the storage facility and the heat was accumulated by low temperature oxidization of organic substances, ultimately leading to ignition. Such possibility was suggested.

Source: Study Group on Appropriate Management of Solid Waste Fuel "About Appropriate Management Measures for Solid Waste Fuel" (2003)

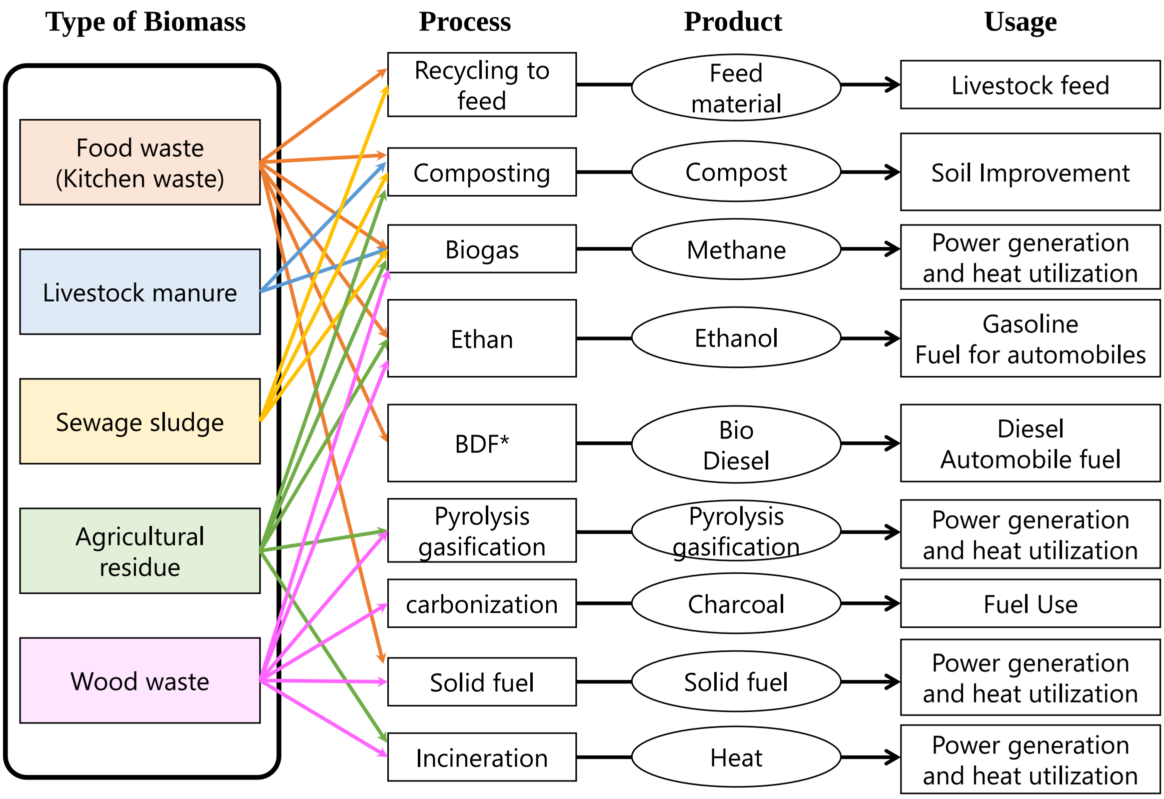
2.4 Organic Waste Recycling Technology

(1) Overview and Types of Technologies Related to Organic Waste Recycling

Kitchen waste from homes accounts for about 40 percent of the total organic waste and a large portion of the rest is the residue from the food processing sector and leftovers from restaurants. This situation highlights the issue of how to effectively recycle this waste stream in order to reduce the waste amount at final disposal. Conventionally, composting and manufacturing livestock feed have been used to promote the recycling of organic waste. In order to cope with this problem, new technologies are being developed, such as conversion of organic waste to methane gas for effective utilization which is a global warming countermeasure because it helps reduce emissions of greenhouse gases. Japan is not only using these diverse technologies to revitalize local communities and create a sound material-cycle society, but is also developing biomass (organic waste) recycling to create a low carbon society.

Biomass refers to organic resources from animals and plants, excluding fossil fuels. It is a sustainable and renewable resource that can be utilized as renewable energy and may be produced as long as there is life and solar energy.

To realize a sound material-cycle and low carbon society and to escape from the dependency on fossil fuels, it will be necessary to utilize organic waste. To that end, the spotlight is on green energy that uses biomass that is both renewable and carbon neutral. In 2009, Japan enacted the *Basic Law for Promotion of Utilization of Biomass* to revitalize rural areas and realize a sound material-cycle society through policies that promote the utilization of biomass. Biomass is a sustainable and renewable energy resource. In Japan, utilization of biomass is being promoted according to the regional characteristics, and promoting the utilization of biomass included in organic waste is part of Japan's efforts to construct a sound material-cycle society. Figure 4-16 shows the different ways to recycle organic waste. This section mainly deals with the recycling methods of converting organic waste to methane gas (biogasification), composting, and turning waste into livestock feed.



*: BDF : Bio Diesel Fuel

Source: Ministry of the Environment Website "Types and Uses of Waste Biomass" http://www.env.go.jp/recycle/waste/biomass/biomass.html (accessed January 27, 2022)

Figure 4-16 Types and Uses of Waste Biomass

Table 4-22 shows two methods to collect the biomass (kitchen waste, etc.) for use as raw material: The first methods is source separation and separate collection of food waste that has been separated by citizens at source, and the second methods is mixed collection and mechanical sorting of food waste that has been discharged together with other waste without separation, and then is mechanically sorted at an intermediate treatment facility. The decision on whether to use separate collection or mixed collection should be determined by considering the local characteristics of the collection area.

Table 4-22 Comparison of Biomass (Kitchen Waste, etc.) Collection Methods

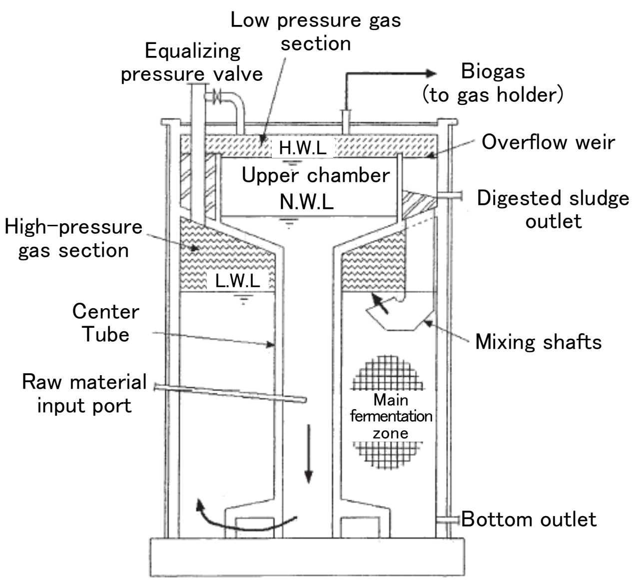
Classification	Source separation + separate collection	Mixed collection + Mechanical sorting
Methane fermentation	Either wet or dry fermentation	Dry fermentation that has fewer requirements can be adopted because of the high probability of the presence of materials not suited for methane fermentation in the waste.
Composting	High quality compost can be produced.	A mechanical sorting process is added. It will be necessary to purchase and operate the necessary equipment. Quality is problematic because foreign matter may be mixed in with the compost.
Cooperation of citizens	It is necessary to acquire the citizens understanding and cooperation for source separation and separate discharge.	There is no need to acquire the cooperation of citizens for separation.
Changes in collection containers	It is necessary to prepare dedicated kitchen waste bags. In some cases special collection containers are allocated at the collection stations.	Regular collection containers can be used.
Changes in collection frequency	In some cases the frequency of collection times is increased.	The frequency of collection times does not change.
Reuse of by-products	Wastewater generated in the treatment process can be converted to liquid fertilizer and fermentation residue can be converted to compost.	Utilization of generated wastewater as liquid fertilizer and compost is difficult because there is a high probability of the presence of materials not suited for fermentation. Incineration followed by thermal recovery are more appropriate.
Fermentation residue	Relatively low	Relatively high
Waste collection and transport costs	Tend to be high. It may be necessary to increase collection days to collect the separated waste.	No change from the present.
Required area	Small	Relatively large. Area for mechanical sorting is necessary.

Source: Ministry of the Environment Website “Waste and recycling measures”
http://www.env.go.jp/recycle/waste/biomass/supportinformation.html (accessed December 15, 2021)

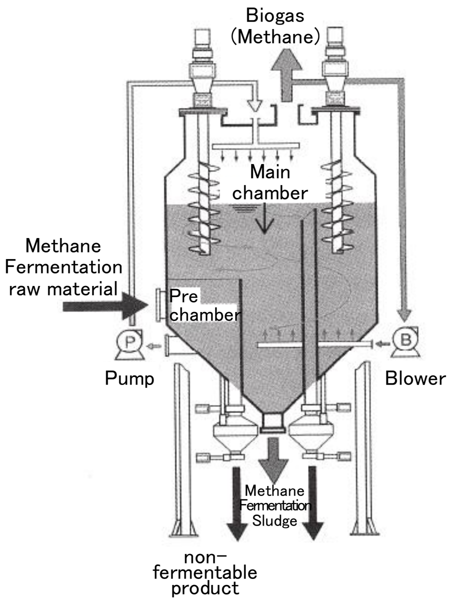
(2) Overview of Methane Gasification Technology

Methane gasification is a technology in which methane fermentation is used to basically produce and recover methane. Not only is biogas usable, but the fermentation residue can also be used as fertilizer, material for cement, etc. Therefore, introduction of methane gasification not only helps to reduce the quantity of waste that is incinerated, but it can also support the establishment of a local sound material-cycle society by producing energy from the methane gas and using the residue locally as fertilizer.

Methane gas facilities ferment the organic waste that is acquired by separate collection and from mechanical sorting of collected mixed waste, and recover the biogas from the produced methane. Figure 4-17 shows an example of the structure of a methane fermentation tank and Figure 4-18 shows the process.



Example 1

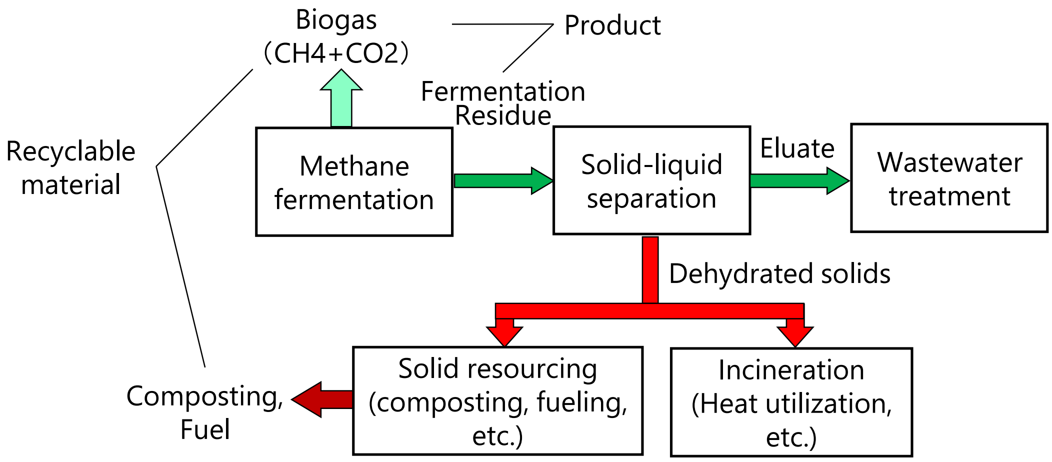


Example 2

Source: Created based on Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 4-17 Examples of the Structure of a Methane Fermentation Tank

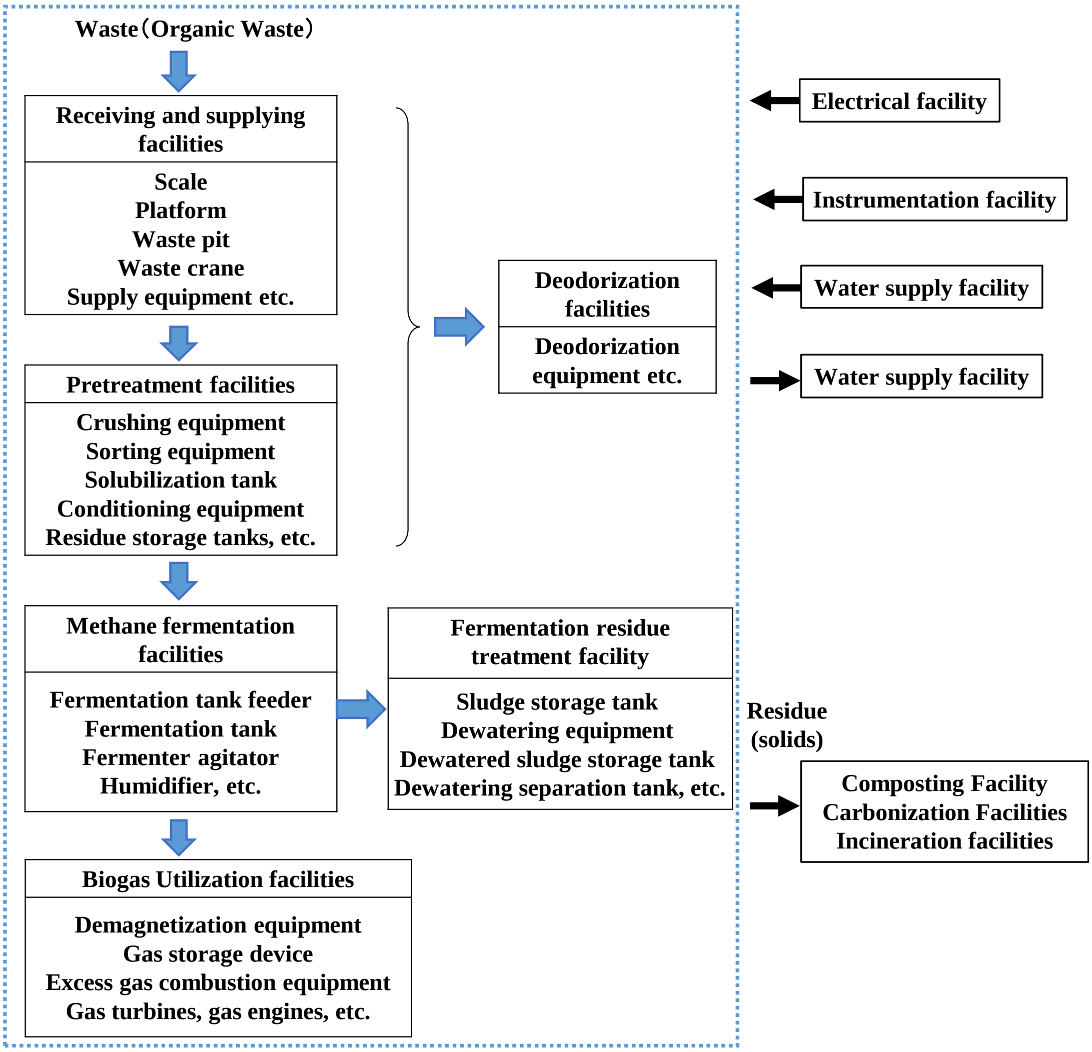
1. Biogas and fermentation residue are produced from methane gasification.
2. Dehydrated solids are used as fertilizer, etc. Or, after drying into solids, they can be incinerated.
3. Fermentation residue is used as liquid fertilizer, after disinfection. Or, after dehydration, the eliminated liquid is treated as wastewater.



Source: Ministry of the Environment Website "Methane Gasification Technology"
https://www.env.go.jp/recycle/waste/biomass/technical.html (accessed January 20, 2022)

Figure 4-18 Process of Methane Fermentation

Figure 4-19 shows the configuration and overview of the main facilities and equipment at a methane gasification facility. In general, a methane gasification facility is made up of receiving and supplying facilities, pretreatment facilities, methane fermentation facilities, and the biogas utilization equipment. The fermentation residue is also processed at the facility.



Source: Ministry of the Environment "Guidance for application for subsidy for establishing a Sound Material-Cycle Society (For Facility)" (2021)

Figure 4-19 Components and Equipment in a Methane Gasification Facility

Photo 4-46 Methane Gasification Facility in Nagaoka City, Niigata Prefecture

Photo 4-47 Methane Gasification Facility in Hofu City, Yamaguchi Prefecture

Source: Ministry of the Environment Website "Examples of Methane Gasification Facilities"
https://www.env.go.jp/recycle/waste/biomass/example.html (accessed January 20, 2022)

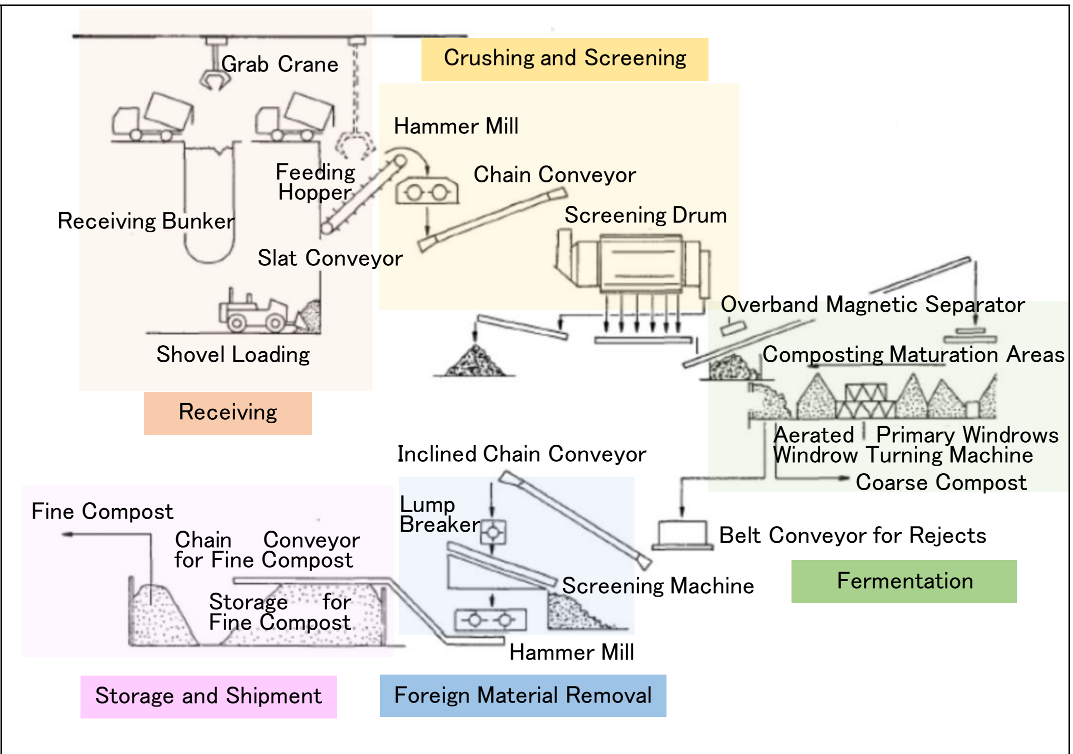
(3) Overview of Composting Technology

Composting is a technology that uses microbes to convert organic waste into compost. This technology has been used in Japan for ages, and in modern society composting is often used in rural areas because it is relatively easy to find buyers there for the compost that is produced. In order to produce good quality compost, it is important to make sure that incompatible wastes, plastics, and other non-organic matter are not mixed in the collected kitchen waste.

In composting, the organic waste in kitchen waste and the like is broken down and made into compost by microbes under aerobic conditions. This technology has been used for recycling kitchen waste in Japan for ages. In composting, the raw material used is kitchen waste and agricultural residue, livestock manure, branches and leaves, etc. It is necessary to understand that citizens will have to cooperate in separating kitchen waste at source and that buyers must be found for the compost that is produced. In developing countries, the key points are whether there is demand from local farmers and if the price is low enough for them. Before introducing composting technology, it is important to make sure that there will be continuous buyers for the compost and to secure them beforehand. For reference an example of the compost center built at Shibushi City is provided in “Topic 6, 4. Activities at Shibushi City, 4.3 Current Waste Treatment Activities, (2) Compost”.

<u>Composting</u>

Flow



Source: JAPAN ENVIRONMENTAL SANITATION CENTER “Waste management technology in Japan (JICA training text)” (2017)

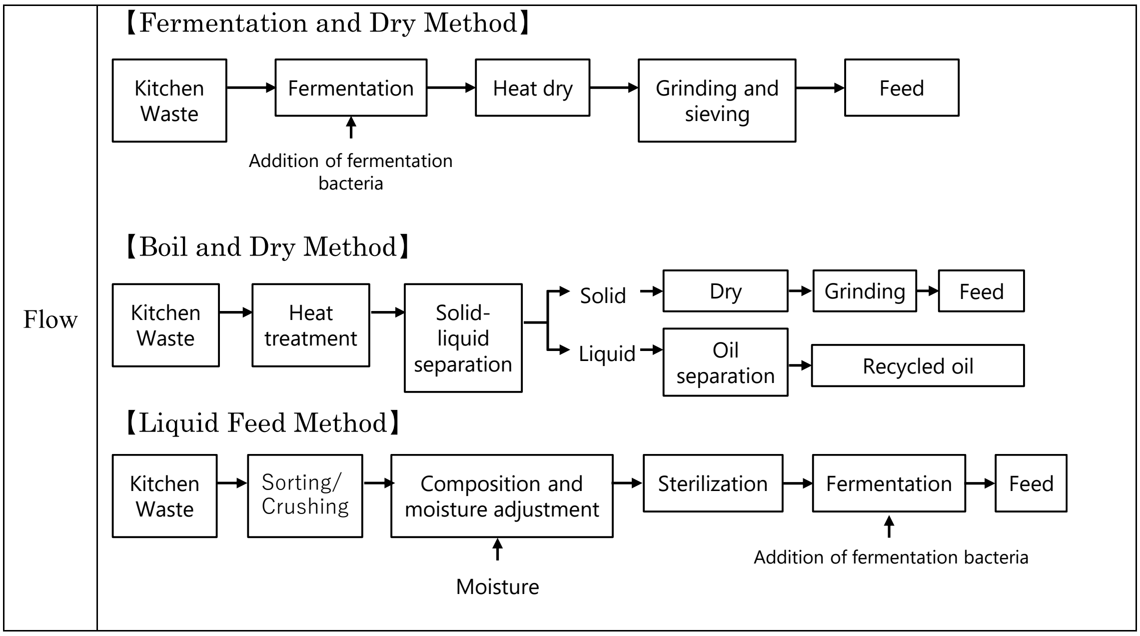
Figure 4-20 Flow of Composting

(4) Overview of Technology Related to Turning Waste into Livestock Feed

Turning waste into livestock feed is a technology that involves thermal treatment and drying of kitchen waste and agricultural residue, adjusting the oil and fat content, then producing livestock feed pellets. This technology has also been used for some time. As is the case with composting, it is important to take precautions in the production process and to ensure that there are buyers for the produced feed.

Under this technology livestock feed is produced from kitchen waste and other organic waste. As is the case with composting, this is a food recycling technology that has been used in Japan for ages. The main technologies involved in turning waste into livestock feed are reducing the water content through thermal treatment and drying, and adjusting the oil and fat content.

Livestock feed



Source: Ministry of the Environment Website "Types and uses of waste biomass"
http://www.env.go.jp/recycle/waste/biomass/biomass.html (accessed January 27, 2022)

Figure 4-21 Flow Chart of Recycling to Feed

Column: The History of Utilizing Kitchen Waste in Japan

In Japan, kitchen waste has been returned to farmland since ancient times as fertilizer by incinerating it and spreading the ashes. After World War II and when there was little plastic and metal mixed in the waste in the 1950s, a large amount of the waste from urban areas was used in rural areas as fertilizer. However, the growth of urban areas, the increased use of chemical fertilizers, and the sudden deterioration of rural areas due to the aging of the populations there, led to major changes in waste treatment in urban areas.

Geographically, Japan has few locations suitable for landfill sites and seasons with high temperatures and humidity. Due to these conditions and additionally from the viewpoints of reducing waste and maintaining sanitary conditions, incineration became the mainstream waste treatment method in the 1960s. However, there were some municipalities that built composting facilities to make compost from kitchen waste and return it to rural areas. However, most of the composting projects that used urban kitchen waste, especially that from households, confronted the problems described below. As a result, there were no users for the compost that was produced and it ended up in landfill sites. Therefore, most of the composting projects faded away except in some cities near farming areas.

1) Issue of Foreign Matter

From the 1950s to the 1960s, the standard of living improved rapidly. With many different consumer products becoming available, many different types of foreign matter were discharged together with kitchen waste, such as glass from bottles and jars, metals from cans, and plastics from containers and daily goods. At that time, there was no concept of waste separating at source and as a result the produced compost included contaminants. It therefore became impossible to assure the quality necessary for farm usage and farms stopped using the compost that was being produced.

2) Issue of Odor

Because of Japan's high temperatures and high humidity, kitchen waste rots easily and composting requires sufficient countermeasures to reduce the resulting odor. However, these measures were not sufficient at the composting facilities at the time so local residents considered these facilities troublesome.

3) Issue of Farm Labor

From the 1950s to the 1960s, young workers moved from rural to urban areas which lead to a gradual growth in the age of rural farmers. While farmers knew that using organic fertilizers was more effective for continued farming, it became increasingly impractical to use organic fertilizers due to the related hard work required. The result was that chemical fertilizer usage spread because it was easier for the aging farmers to supply just the necessary components.

Source: Based on the Ministry of the Environment “White Paper on the Environment” (2008)

Column: Takakura Composting Method that Spread in Developing Countries

The Takakura composting technology was part of the overseas aid activities conducted by Kitakyushu City in 2004. The technology was established as part of the studies to reduce and reuse the waste in Surabaya, Indonesia. The technology was named the Takakura Composting Method after the specialist, Kohji Takakura.

In the Takakura Composting Method, local natural materials are used to increase fermenting bacteria to make composting more efficient. Special fermenting bacteria are not needed and only locally available fermenting bacteria (indigenous bacteria) are used. Fermenting bacteria can be acquired from (1) food fermenting bacteria (yogurt, mushrooms, yeast, etc.), (2) leaf mold, (3) soil from organic farms, and (4) other natural items (rotting trees, hay, rice husks, etc.). It is more effective to collect as many types of bacteria as possible.

The process for making compost is shown in Figure 4-22. First, fermentation liquor is made, the fermentation liquor and bacterial bed are mixed to make bacterial colonies, and the bacterial colonies and kitchen waste are repeatedly mixed or agitated, then dried to make compost.

The Takakura Composting Method has been accepted by developing countries for the following reasons.

1) Ease of Introduction

It was easy for the receiving country to accept composting technology because it is familiar in developing countries. Additionally, by carefully explaining this technology from the basic theory through to the entire process, the composting of kitchen waste was successful.

2) Production is Easy Using Local Items

Due to the fact that the Takakura Composting Method is easy to implement using local materials, the hurdles to introduction and continuation of composting were low. Another feature of this method is that the composting period is about one or two weeks which is much shorter than usual composting periods of about three months.

3) Adaptability to Various Scales

The basic theory behind the Takakura Composting Method is not limited to small-scale kitchen waste composting in households. It can also be applied to large-scale composting facilities. If the local needs are not for household composting but for relatively large-scale composting projects that encompass communities or entire regions, the Takakura Composting Method may be effectively used for that purpose as well.

4) Developing Human Resources for Local Expansion

In the Surabaya project attempts were made to increase understanding of the basic theory by assigning community leaders to lead the way in improving the environment in their communities. Locally developed human resources have helped to spread the adoption of the Takakura Composting Method in the area.

Step 1 Preparation of fermentation liquid

Leave both liquids to ferment for about 3 to 5 days each, until they smell like alcohol.
Liquid A: Fermented food + sugar water
Liquid B: Fruits and vegetables + salt water

Step 2 Mixing of fermentation liquid and bacterial bed

Completion of the seed bacteria.

Preparation of bacterial beds using rice husks, wood chips, fallen leaves, etc.
Mix the fermentation liquid and the bacterial bed (adjust the moisture content to 40-60%).
Fermentation (cover the entire area with a porous cloth to maintain a temperature of 60-80℃)

Step 3 Composting

Mix seed bacteria and food scraps.
Stirring (at least once a day)
After the temperature drops and the fermentation is finished, dry it. (After drying, it can be used as seed bacteria again.)

Step 4 Utilization

Compost is not yet completely decomposed from organic matter, so when mixing compost into the soil, leave it for at least 2-3 weeks to allow the fermentation bacteria to settle before planting.

Figure 4-22 Steps of Takakura Composting Method

*: For more information on the Takakura composting method, please refer to the Takakura composting Manual.
English version: (https://kitakyushu.iges.or.jp/publication/Takakura/Takakura_Method_Full.pdf)

Photo 4-48 Fermentation Liquid Left (A), Right (B)

Photo 4-49 Mixing of Fermentation Liquid and Bacterial Bed

Photo 4-50 Inside the Compost Center

Photo 4-51 Home Composting

Source: Yachiyo Engineering Co., Ltd.

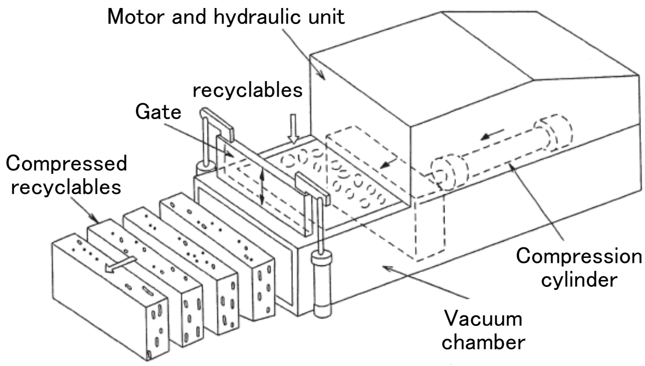
Example of Takakura Composting in Ecuador

2.5 Recycling Technology

(1) Overview and Types of Recycling Technologies

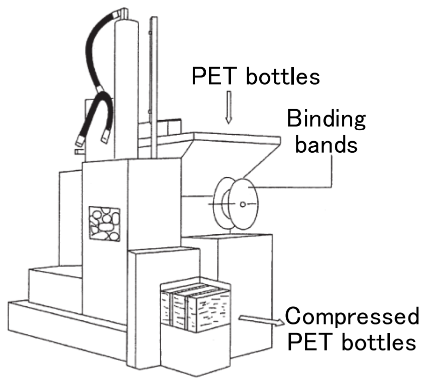
Facilities for recycling use technologies such as sorting, shredding, compression, drying, and solidifying to promote recycling of waste materials as resources. The methods and equipment used differ depending on the material that is to be recycled. Recycling is an effective technology to promote material reuse and create a sound material-cycle society.

In order to create a sound material-cycle society, the effective use of resources and recycling is very important. In Japan, various recycling laws have been enacted to promote recycling. It is necessary to economically and safely process waste using methods suitable for source separation and separate collection. The main technologies related to recycling are sorting, shredding, compression, drying, and solidifying. For reference the recycling center built at Shibushi City is provided as an example in “Topic 6-4.3 (3) Sorting Waste for Recycling”.



Source: Japan Waste Management Association “Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version” (2017)

Figure 4-23 Metal Press Machine



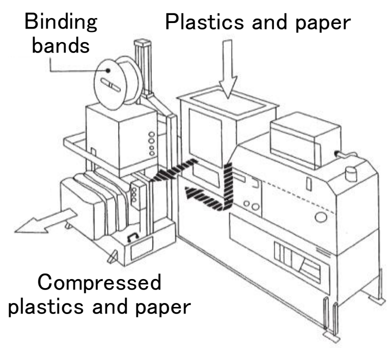
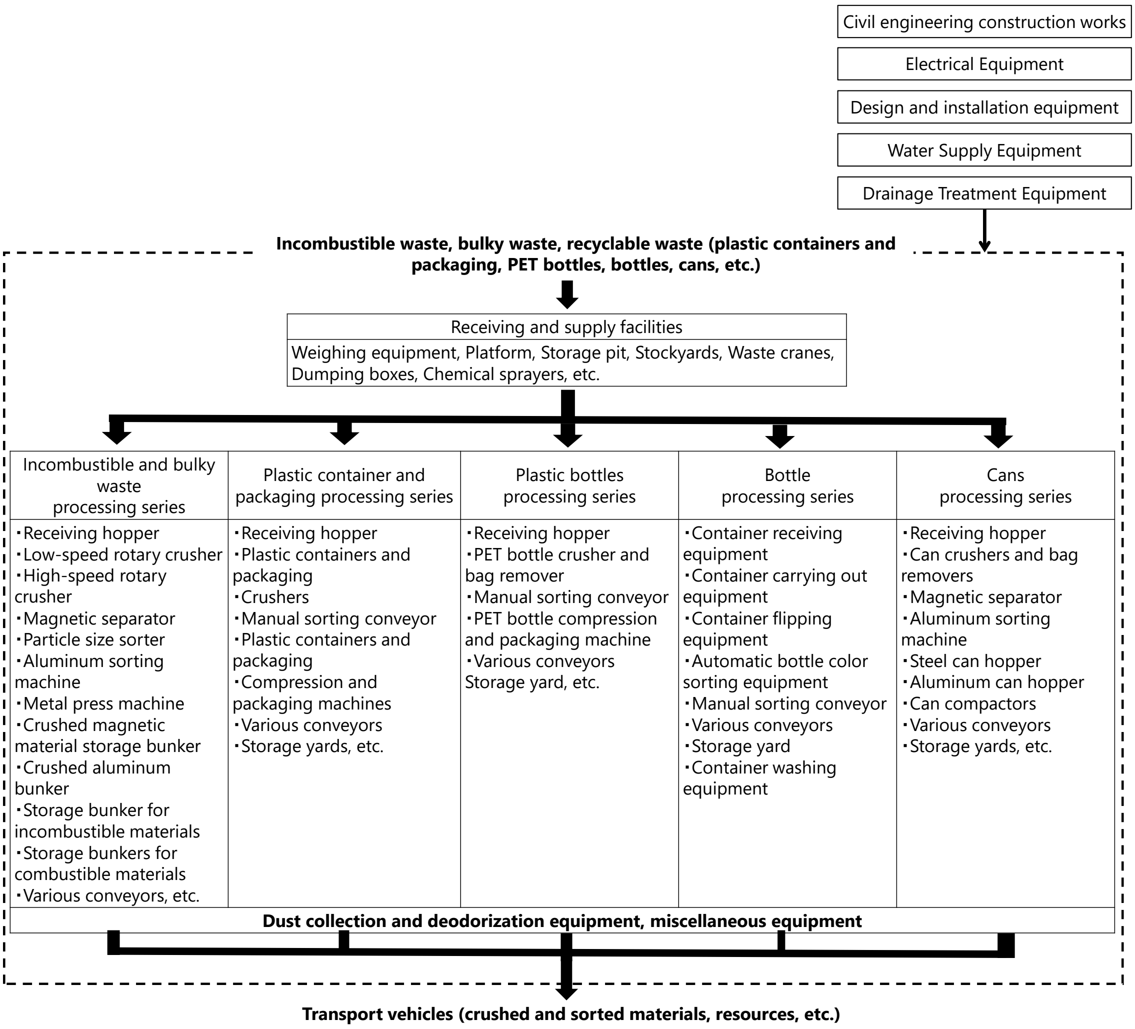


Figure 4-24 PET Bottle Compaction and Baling Machine

Figure 4-25 Plastic Container Packaging Compaction and Baling Machine

Source: Japan Waste Management Association “Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version” (2017)

Figure 4-26 and Table 4-23 provide overviews and configurations of the main equipment used at recycling facilities.



Source: Ministry of the Environment “Guidance for application for subsidy for establishing a sound material-cycle society (Facility)” (2021)

Figure 4-26 Components of Recycle Facility Equipment

Table 4-23 Overview of the Main Equipment at Recycling Facilities

Main equipment	Equipment overview
Receiving and supplying equipment	Made up of the following: Weighing machines to weigh incoming waste and outgoing recycled materials; entrance and exit roads; platforms for receiving waste from collection trucks for the storage pits and stockyards; waste input doors to separate the platforms and storage pits; waste crane to feed waste from the storage pit into the receiving hopper; dumping boxes for sorting of hazardous waste, difficult-to-process waste, and recyclables; chemical spraying equipment to prevent stench at the platforms; etc.
Incombustible and bulky waste treatment systems	Made up of the following: Receiving hoppers that receive the incombustible and bulky waste from waste cranes and excavator loaders; low-speed rotating shredders that make it easier to transport and sort incombustible and bulky waste; high-speed rotating shredders; magnetic sorters that recover iron from the shredded waste; granular separators that recover incombustible waste after scrap iron is removed from shredded waste; aluminum separators that recover aluminum scraps from the shredded waste; metal compressors or storage that compress recovered iron and aluminum scraps for reuse and storage; shredded magnetic material storage bunkers for shipping out; shredded aluminum bunkers; incombustible waste storage bunkers and combustible material storage bunkers for storage and shipping out incombustible and combustible material.
Plastic container and packaging treatment systems	Made up of the following: Receiving hoppers that receive the plastic containers and packaging from waste cranes and excavator loaders; plastic containers and packaging bag openers that make it easier to separate plastic containers and packaging; manual sorting conveyor belts to remove foreign matter from the opened bags; recycling the recovered plastic containers and packaging; plastic containers and packaging compressing and bailing machines to compress for storage; storage for compressed bails; and storage yards for shipping.
PET bottle treatment systems	Made up of the following: Receiving hoppers that receive the PET bottles from waste cranes and excavator loaders; bag openers to make it easier to separate the PET bottles; PET bottle bag openers to remove them from the bags; manual sorting conveyor belts to remove foreign matter from the opened bags and their contents; recycling of recovered PET bottles; compressing and bailing machines to compress PET bottles for storage; storage for compressed bails; and storage yards for shipping.
Bottle treatment systems	Made up of the following: Container receiving unit to receive bottles collected in containers; container conveying unit to convey the containers with bottles inside; container inverting units to invert the containers with bottles inside; automatic bottle color separators to automatically separate the inverted bottles by color or manual sorting conveyor belts for manual sorting; storage yards for storing and shipping recovered bottles; and container washing machines to clean the containers that were used when receiving the bottles.
Can treatment systems	Made up of the following: Receiving hoppers that receive the cans from waste cranes and excavator loaders; can bag opening and debagging machines to make it easier to sort the cans; can separating machines to recover the steel cans from the waste from the bags; aluminum can separator machines to recover the aluminum cans; steel can hoppers and aluminum can hoppers to store the recovered steel and aluminum cans; can compressing machines to compress the steel and aluminum cans for recycling; storage yard for storing and shipping compressed materials.

Main equipment	Equipment overview
Dust collection and deodorizing equipment	Made up of the following: Cyclones, bug filters, and blowers for dust collecting; deodorizers for deodorizing; blowers for deodorizing; ducts connecting the various equipment.
Water supply equipment	Made up of the following: Water tanks to supply city water, industrial water, well water, etc. for use in the plant and regular use; pumps; etc.
Wastewater treatment equipment	Made up of the following: Wastewater screens to process the floor washing water and daily wastewater from the platforms and shipping rooms; water tanks; pumps; sludge treatment units.
Electric equipment	Receives power for all of the above and distributes it to the necessary sections of the various equipment (motors, etc.).
Instruments	Instruments, control equipment, ITVs, data processing, and other equipment necessary for operation control.
Miscellaneous equipment	General air compressor, car washing machine, and other equipment necessary to maintain the work environment within the plant.
Other	Buildings and building equipment are necessary for the installation of equipment, the administration building, and various access roads. Rooms and spaces for the purpose of improving public awareness on the 3Rs by holding seminars and disseminating information related to waste and recycling, locating equipment to recycle used and discarded items, equipment necessary to store, display, and replace things in the recycling process.

Source: Ministry of the Environment "Guidance for application for subsidy for establishing a sound material-cycle society (Facility)" (2021)

(2) Roles of Technologies Related to Recycling

Recycling technologies such as sorting, shredding, and compressing can also perform the following roles for promoting efficient recycling.

<u>Roles of recycling technology</u>

- Shredding combustible bulky waste into sizes that can be incinerated.
- Shredding organic waste into sizes suitable for intermediate treatment.
- Shredding and sorting incombustible waste and bulky waste to enable recovery of recyclable materials.
- Reducing waste disposal by shredding and compressing waste.
- Reducing final disposal amount by recovering recyclable materials.
- Reducing waste generation amount.
- Resources recovery.

2.6 Standards Related to Intermediate Treatment Facilities and Their Maintenance

To assure that operators can prevent air and water pollution, they must have facilities that can satisfy the various regulatory standards and maintain suitable operations and maintenance. The various standards related to intermediate treatment facilities are regulated by laws and ordinances.

The construction and operation of a waste treatment facility must consider the surrounding environment. As Figure 4-27 and Table 4-26 show, standards have been developed for a variety of items. Table 4-24 shows the differences between environmental standards and regulatory standards.

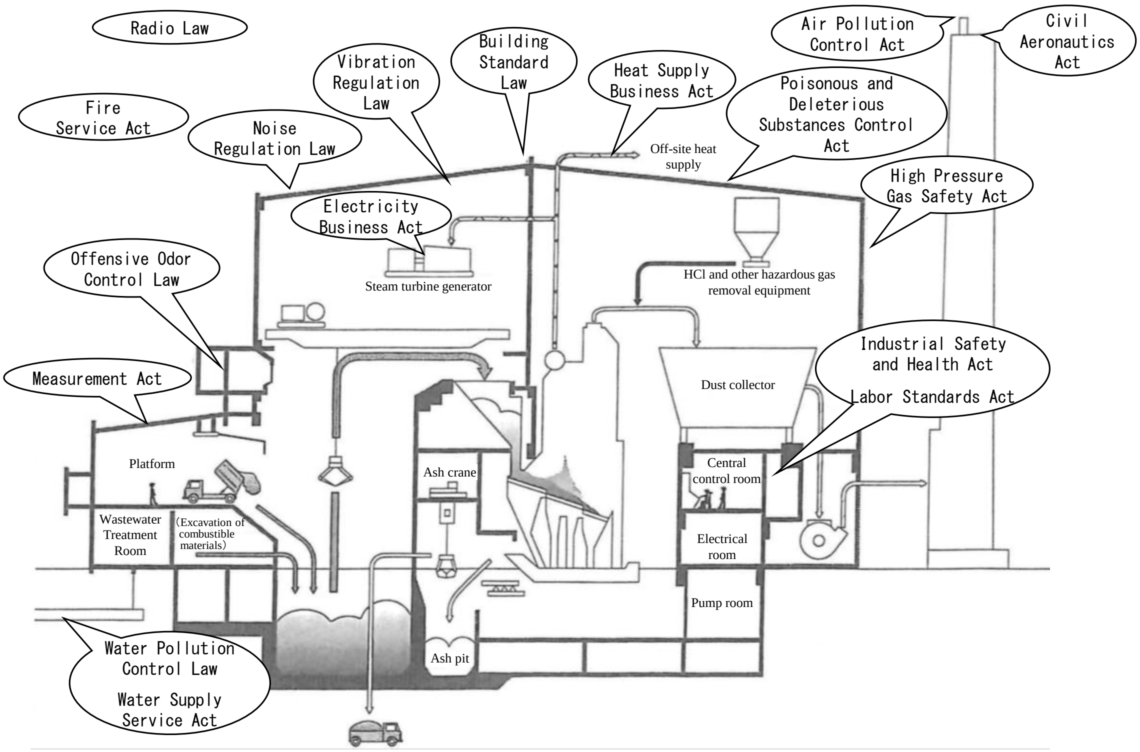
These are especially important for incineration plants because the gases they emit can be a major cause of pollution to the surrounding environment. Moreover, they can cause issues of odor and noise in the surrounding community.

Table 4-24 Difference between Environmental Standards and Regulatory Standards

Standards	Contents
Environmental standards	As standards that should be maintained to protect human health and maintain the environment, these have the ultimate goal of determining to what levels of quality air, water, soil, and noise must be maintained. These are only environmental standards that should be maintained, and there are no penalties when they are not met. .
Regulatory standards (tolerance limits)	In order to prevent pollution, these standards must be met to regulate the emission concentrations and quality of air and water from plants. If the standards cannot be met, then notifications or guidance will be issued by the relevant administration agencies, and if improvements are not made, then penalties will be applied.

Table 4-25 Summary of Relevant Laws and Regulations Relating to the Planning of the Facility

No.	Laws	Enactment Year	Outline
1	Fire Service Act	1948	Law to prevent and mitigate damage caused by disasters such as fires and earthquakes.
2	Offensive Odor Control Law	1971	Law to protect health by imposing necessary regulations on odors generated by business activities in factories and workplaces in regulated areas.
3	Measurement Act	1992	Law to establish standards for measurement and to ensure proper implementation of measurement.
4	Water Pollution Control Law	1970	Law to regulate water discharge and underground penetration from factories and business sites into public water bodies and to prevent pollution of public water bodies and groundwater.
5	Water Supply Service Act	1958	Law to establish standards for the installation and other management of sewage systems and to improve the healthy development of cities and public health, as well as to protect the quality of water.
6	Radio Law	1950	Law to ensure the fair and efficient use of radio waves and to promote public welfare.
7	Noise Regulation Law	1968	Law to protect the living environment by regulating the noise generated by business activities and construction work at factories and workplaces, and by regulating automobile noise.
8	Vibration Regulation Law	1976	Law to protect the living environment by regulating vibration and road traffic vibration caused by business activities and construction works in factories and workplaces.
9	Electricity Business Act	1964	Law to ensure public safety by regulating the proper operation of electric utilities and the construction, maintenance, and operation of electric facilities.
10	Building Standard Law	1950	Law to protect health and property by establishing standards for building sites, structures, facilities, and uses.
11	Heat Supply Business Act	1972	Law to ensure public safety by regulating the proper operation of heat supply businesses and the construction, maintenance, and operation of heat supply facilities.
12	Poisonous and Deleterious Substances Control Act	1950	Law to control poisonous and deleterious substances as necessary for health and hygiene.
13	Air Pollution Control Act	1968	Law to protect health and the environment by regulating air pollutant emissions from business activities at factories and workplaces and by setting required limits for automobile emissions.
14	High Pressure Gas Safety Act	1951	Law to prevent fires caused by high-pressure gas by regulating the manufacture, storage, sale, import, transfer, consumption, and disposal of high-pressure gas.
15	Industrial Safety and Health Act	1972	Law to protect workers' health and safety and promote the formation of a comfortable work environment by promoting comprehensive and systematic measures to prevent industrial accidents.
16	Labor Standards Act	1947	Law to protect workers' rights by establishing standards related to labor, such as employment regulations, working hours, and wages.
17	Civil Aeronautics Act	1952	Law to ensure the safety of aircraft transportation by prescribing methods to ensure the safety of aircraft navigation and the prevention of obstructions caused by aircraft navigation.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 4-27 Relevant Laws and Regulations Pertaining to the Planning of Facilities

Table 4-26 Standards Related to the Construction and Maintenance of Facilities

Item	Standard	Subject	Applicable laws
Air quality	Environmental standard	・All areas*1	・Basic Environment Law ・Act on Special Measures concerning Countermeasures against Dioxins, etc.
	Emission standard (regulatory standard)	・Gas emissions from waste incinerators, etc.	・Waste Management Act ・Air Pollution Control Act ・Act on Special Measures concerning Countermeasures against Dioxins
Noise	Environmental standard	・Areas that are not facing roads. ・Areas that are facing roads.	・Basic Environment Law
	Regulatory standard	・Plant noise pollution ・Construction noise pollution, etc.	・Noise Regulation Law
Vibrations	Regulatory standard	・Plant vibrations ・Construction work vibrations, etc.	・Vibration Regulation Law
Odors	Regulatory standard	・Site boundaries ・Gas outlets ・Drainage outlets	・Offensive Odor Control Law
Water quality	Environmental standard	・Rivers, lakes, seas ・Groundwater, etc.	・Basic Environment Law ・Act on Special Measures concerning Countermeasures against Dioxins
	Drainage standard (regulatory standard)	・Drainage from plants and facilities	・Waste Management Act ・Water Pollution Control Law ・Act on Special Measures concerning Countermeasures against Dioxins
Soil pollution	Environmental standard	・ All areas*2	・Basic Environment Law ・Act on Special Measures concerning Countermeasures against Dioxins
	Specified hazardous substances	—	・Soil Contamination Countermeasures Act

*1: Not applicable to dedicated industrial areas, or roads, general areas, and locations which the general public usually does not use.

*2: Not applicable to the soil of locations where it is clear that the pollution is from a natural source, and the soil of areas where raw materials are deposited, waste landfills, and other areas where the items listed in the separate table are used or processed and actually stored.

*3: The ordinances of various local governments can also be the basis of standards for all items.

(1) Standards Based on the Waste Management Act

The technical standards related to the operation and maintenance management of municipal waste treatment plants are regulated by the *Waste Management Act*. There are detailed standards that specifically regulate incineration plants which must be met. (for more details on the *Waste Management Act*, refer to “Topic 2-2.2 (3) Wastes Management and Public Cleansing Law”.

(2) Maintenance and Control of Plants

Meeting the established standards will protect the surrounding environment and help gain the trust of residents. Therefore, executing a planned operation and maintenance program for the plant and stopping operation for even the slightest problem are important actions for safety.

Waste treatment plants must be operated and maintained under the strictest control to satisfy the related standards. The operation controls to reduce dioxins at incineration plants are described in Figure 4-28. It is extremely important to have a combustion chamber that can meet the conditions for perfect combustion to reduce dioxins, cooling equipment that can cool the gas after incineration, and to maintain the functionality of exhaust gas treatment equipment including dust collector that removes dust. If any of the equipment indicates a problem that could lead to operation interference, the operation must be stopped immediately to solve the problem. Once an accident occurs, the trust of residents will be lost, so operators must always act on the side of caution.

Another important way to gain the trust of the surrounding residents is to monitor exhaust gas concentration in real-time and publicize the results on a website or at the plant.

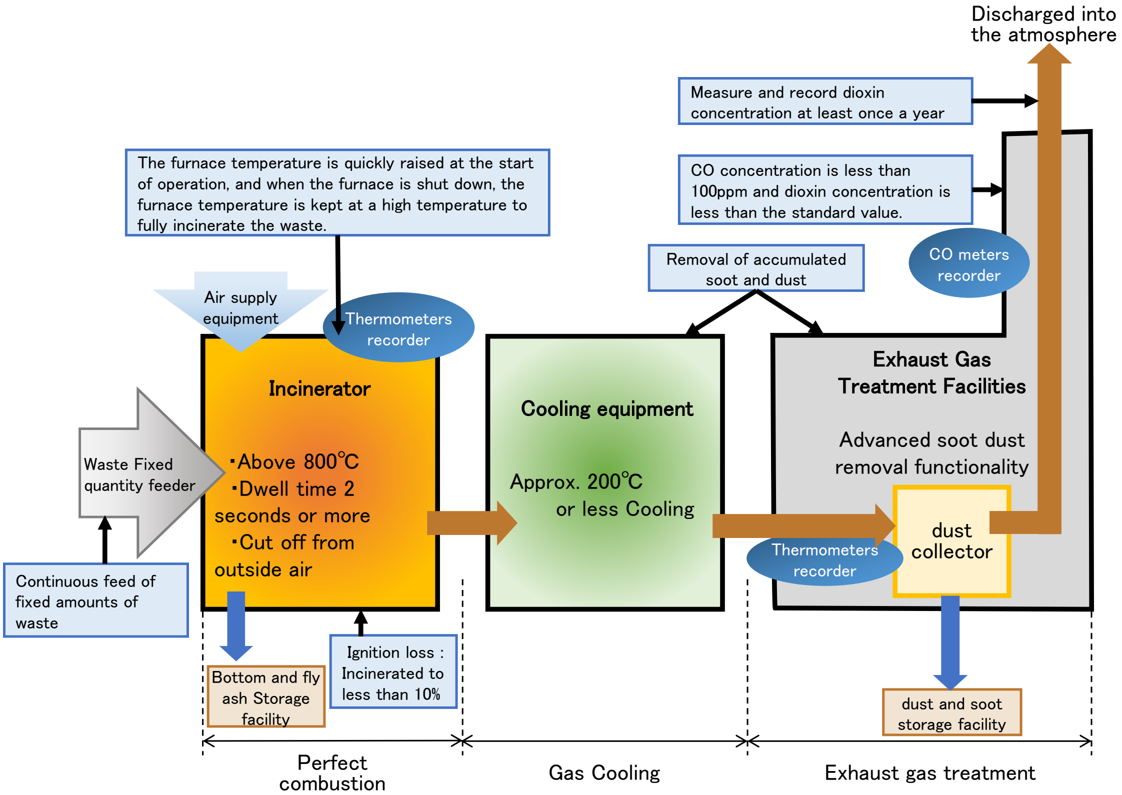


Figure 4-28 Proper Operation and Maintenance of Incineration Plant

Photo 4-52 Disclosure of Exhaust Gas Status at Suginami Incineration Plant

Photo 4-53 Disclosure of Exhaust Gas Status at Shibuya Incineration Plant

Source: Yachiyo Engineering Co., Ltd.

3 Final Disposal

3.1 History of Disposal Sites

Various types of disposal sites were developed depending on the background of each period, the realities of the local society and the types of waste being disposed - organic waste, inorganic waste, hazardous waste, etc. Technical standards and guidelines were established to assure suitable disposal site management and to reduce the effects on the surrounding environment. Due to these guidelines and the strict operations followed by local municipalities, it has become possible for them to build suitable disposal sites and operate and maintain them in a sanitary manner. As a result, these facilities have been accepted by the local residents.

Before the introduction of intermediate treatment, kitchen waste and other types of waste were disposed of at designated locations. However, this caused problems for the surrounding environment such as the generation of odor, pests (mosquitos, flies, etc.), and spontaneous fires caused by gas produced from the disposed waste.

During the period of high economic growth in the 1960s, waste increased, the remaining capacity of landfill site was shortened and it became necessary to promote the reduction of waste disposal amount at landfills by incineration.

In the 1970s, the *Waste Management Act* was revised and technical standards for disposal sites covering construction, operation and maintenance, and decommissioning were established. Disposal sites were divided into three categories, namely inert landfill sites, controlled landfill sites, and isolated landfill sites and standards were established for each.

Then, the “Structural Guidelines for Final Waste Disposal Sites” were established in 1979 and the “Performance Guidelines for Final Waste Disposal Sites” were established in 2000. These guidelines dealt with the issues of suitable landfill control, and helped to alleviate the shortage on landfill sites and solved the problems related to the surrounding environment, such as the generation of hexavalent chromium and hydrogen sulfide.

The shortage of landfill sites furthered the need for more sites which was one problem, but on the other hand it was becoming more difficult to gain the understanding of surrounding residents to construct new sites. Therefore, local harmonized landfill sites were proposed, underpinned by the operation and maintenance being strictly controlled and implemented with the understanding of residents. As a result, closed system landfills were adopted as landfill sites for municipal waste. There were 1,620 municipal waste final disposal sites in FY2019, and 83 closed system landfill sites in FY2018.

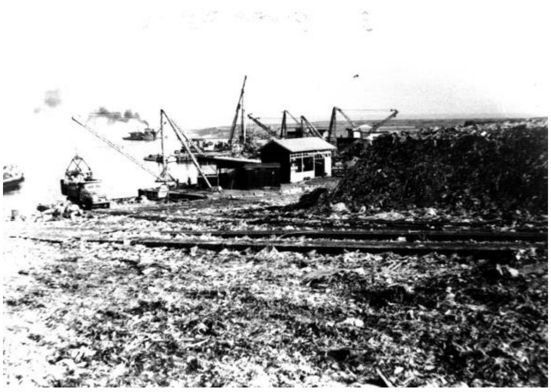


Photo 4-54 A landfill Site in Tokyo where Spontaneous Combustion was Occurring Because the Waste was Directly Disposed with no Intermediate Treatment and no Soil Cover Application – circa 1957

Photo 4-55 Stress on Landfills due to Increase in Waste Amount and Diversification of Waste quality (1965)

Photo 4-56 Previous Conditions of a Landfill in Tokyo that was Swarming with Wild Birds (1989)

Photo 4-57 Shortage of Landfill Sites due to Increasing Amount and Diversification of Waste Quality (1992)

Source: Tokyo Metropolitan Government Bureau of Environment (Photo 4-54, Photo 4-55)

Source: Tokyo Metropolitan Government (Photo 4-56, Photo 4-57)

Column: Open Dumping in Developing Countries

Open dumping is the uncontrolled dumping of waste at a disposal site and is practiced in many disposal sites in developing countries. Table 4-27 and Figure 4-29 describe the concerns of open dumping. In order to reduce the risks of open dumping, proper management at the disposal site is important, including the development of appropriate facilities, leveling and compaction of dumped waste, and soil covering.

Table 4-27 Concerns Related to Open Dumping

Risk	Content
Landfill Gas (Fire and air pollution)	Methane gas and other gases produced in landfills cause fires which generate toxic substances.
Scattering	There are concerns about the impact on the surrounding environment due to the scattering of waste.
Water Leaching	Since leachate is discharged outside the landfill without any treatment, there is concern about the impact on the surrounding aquatic environment, such as rivers and groundwater. There is also concern about land pollution as leachate percolates into the soil.
Sanitary Environment	The stagnation of water in the landfilled area generates large numbers of mosquitoes and flies, which worsen sanitary conditions.
Stench	The stench generated from the decomposing waste at the disposal site affects the surrounding residents.
Waste collapse	If disposal works of leveling and compaction, landfill height control, and mild slopes of the disposed waste are not implemented, there is a risk of collapse of the landfilled waste, which may cause injuries or casualties to workers and other personnel.
Waste pickers	The poor sanitary conditions in the landfilled area are a health hazard for waste pickers active at the site. Of particular concern is infectious waste, such as injection needles, when mixed with medical wastes.

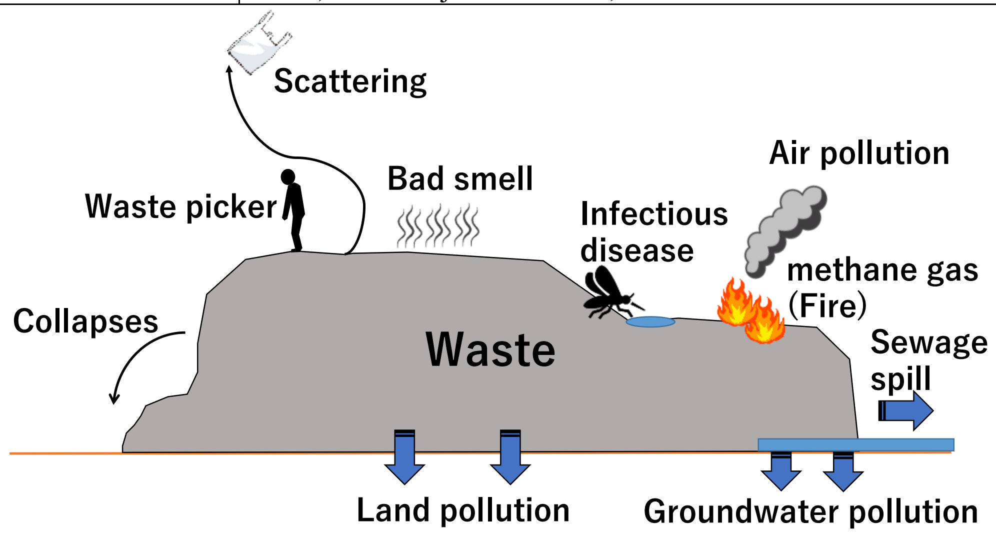


Figure 4-29 Concerns Related to Open Dumping

Photo 4-58 Open fire - Nigeria, 2016

Photo 4-59 Waste Scattering - Nigeria, 2016

Photo 4-60 Piling of Waste - Indonesia, 2019

Photo 4-61 Waste Pickers - Cambodia, 2000

Photo 4-62 Stagnant Water Puddles - Cuba 2002

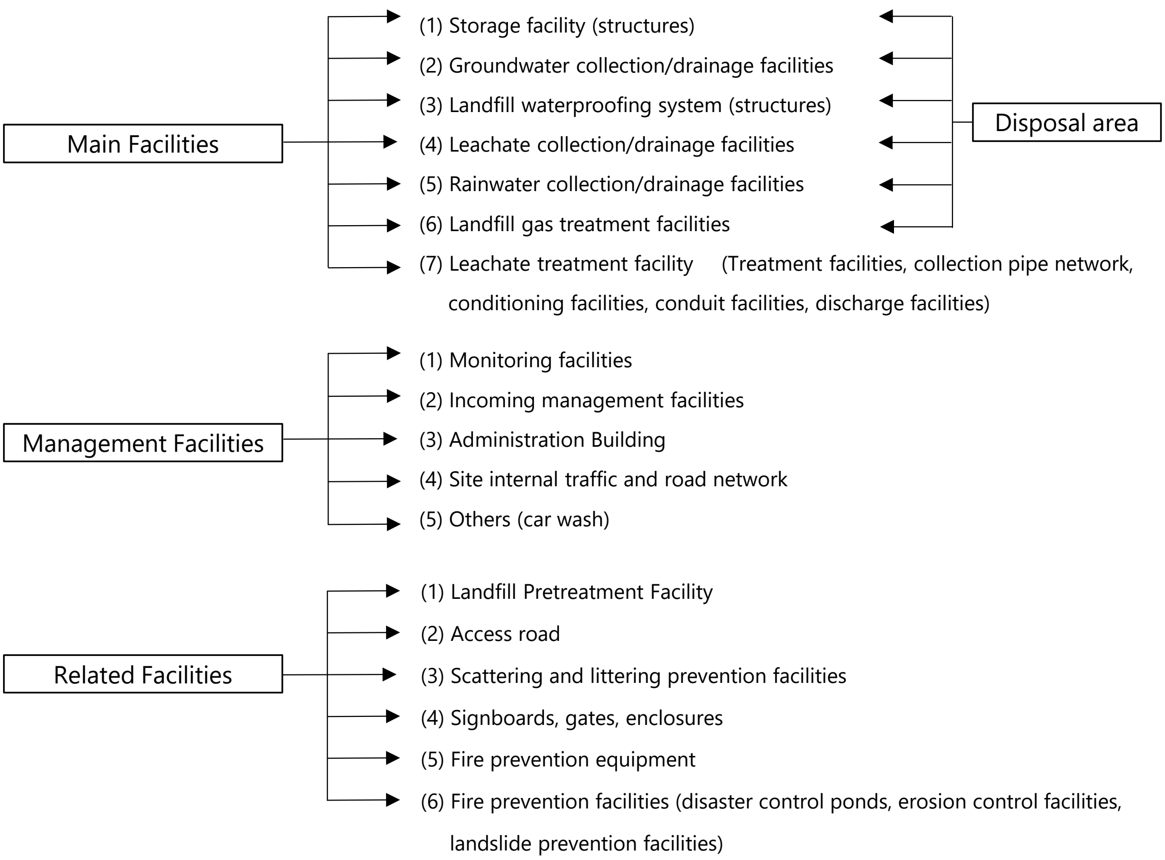
Photo 4-63 Water pollution - Myanmar, 2000

Source: Yachiyo Engineering Co., Ltd.

Examples of Concerns in Open Dumping Sites in Developing Countries

3.2 Functions and Features of Landfill Site Facilities and Equipment

The main functions required of landfill sites are as follows: waste storage function to stably store the waste in the landfill; water sealing functions to prevent groundwater from entering the landfill site, and prevent water from the waste in the landfill from being discharged outside the disposal area; and cleaning functions to facilitate the decomposition of organic waste and washing out contaminated matter. The main facilities are storage structures, waterproofing liner system construction, leachate treatment facilities, monitoring facilities, and generated gas treatment facilities. Figure 4-30 and Table 4-28 show the main facilities of landfill sites.



Source: Based on the Japan Waste Management Association "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition" (2010)

Figure 4-30 Outline and Flow of Main Facilities of Landfill Sites

Table 4-28 Overview of the Main Facilities of Landfill Sites

Main facilities	Equipment overview
Storage structures	These structures, often referred to as waste disposal cells, contain the waste layers within designated disposal areas and prevent collapsing, and are used to safely store waste.
Groundwater collection/drainage facilities	These facilities effectively collect groundwater and spring water, and quickly drain them. In general, there are upstream and downstream main lines connected to horizontal branches.
Water waterproofing construction	These are a series of facilities used to prevent water pollution caused by leachate. There are mainly two types: Surface sealing construction (impermeable liner membranes construction, impermeable soil liner construction, etc.) and vertical sealing construction.
Rainwater collection/drainage facilities	These are facilities to collect and drain rainwater. They prevent rainwater that falls outside the landfill site from entering the site and rain that falls on active disposal sections of the site before they are covered from penetrating into the waste layers.
Leachate collection and drainage facilities	These are facilities used to collect the moisture content of the waste disposed in the landfill and the leachate that has seeped through the waste layers and discharge the collected leachate to the leachate treatment facility.
Leachate treatment facilities	These are facilities used to treat the leachate collected by the leachate collection/drainage facilities so that the liquid does not pollute public waters and groundwater after being discharged.
Landfill gas treatment facilities	These are either vertical or inclined ventilation facilities installed in the landfill to collect and vent any gas produced in the landfill site.
Covering facilities	These are facilities such as roofing that cover the surface of landfill sites so that rainwater cannot enter.
Incoming waste control facilities	These facilities are used to weigh the waste delivered to the landfill site, analyze the quality, conduct deployment inspections, manage records, etc.
Environmental monitoring facilities	During and after final completion of waste filling operations, these facilities monitor water quality, landfill gas, the quantity and quality of delivered waste during operation, groundwater quality, noise and vibrations, scattering of waste, etc.
Administration building	This building is used to do all of the following work in a systematic manner: environmental monitoring; assuring safety; inspecting and weighing the delivered waste to assure economically efficient site operation; confirming the compliance of the landfill conditions with the landfill plans; securing coverage materials; installing section embankments; operating and maintaining leachate treatment facilities; monitoring; etc.
Controlled roads	In addition to daily management, inspection, and maintenance of the various facilities, fire prevention, and safety management, these roads are also used for the delivery of materials, etc.
Pre-landfill treatment facilities	These are facilities used for pre-treatment before landfill treatment and include shredding and sorting of waste, melting treatment, crushing of waste, etc.
Delivery access road	This is a road used to deliver waste and soil cover materials to the landfill site. It is made up of a public road that is also used by general vehicles as well as the entrance from the public road to the landfill site.

Main facilities	Equipment overview
Scattering prevention facilities	These are facilities used to prevent the waste from being scattered by strong winds and birds and polluting the surrounding environment. In general, scattering is prevented together with daily management, such as by covering with soil and by sprinkling water.
Signage, gates, and enclosure facilities	In addition to a sign and gate at the entrance of the landfill site, there is an enclosure around the landfill site to mainly ensure site access control.
Fire prevention facilities	Availability of fire extinguishers, fire prevention water and soil (which can also be used as cover soil), construction of fire break zones, and using sprinkler trucks and bulldozers in place of fire trucks are all effective.
Disaster prevention facilities	These facilities and equipment are used to prevent possible landfill site disasters.

Source: Based on the Japan Waste Management Association "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition" (2010)

3.3 Types of Disposal Sites

Disposal sites are categorized according to the site location where they will be constructed, their structure, the types of waste they will be receiving, and the environmental conditions in the landfill site. In addition, since the appropriate shape of the disposal site is dictated by the site location, surrounding environment, presence of residents, waste disposal conditions in the relevant area, etc., it is important to consider the plan for the disposal site after fully understanding the current situation of the planned site.

Landfill sites are facilities for disposing of wastes that are difficult to undergo intermediate treatment - such as incineration, recycling, etc., waste items that are difficult to reuse, and the residue from intermediate treatment. They are facilities where waste is appropriately stored without negatively impacting the surrounding environment. The number of landfill sites in Japan and their remaining capacities are discussed in “Topic 1. 1.2 Waste Management Condition (5) Final Disposal of Waste”.

This section will introduce the types of disposal sites according to the various categorization methods.

(1) Categorizing by Location: Disposal Sites in Mountainous areas, in Plains Land, and in Land Reclamation Sites at Sea

Generally, landfill sites are constructed in mountainous terrain by adopting the topographical features there or by excavation in plains. In Japan due to limitations of finding sites for constructing landfills, the method of constructing a seawall in a coastal area and constructing a landfill at sea, i.e. land reclamation, is also implemented. Table 4-29 shows examples of disposal sites categorized by location.

(2) Categorizing by Facility Structure: Open and closed Systems

In Japan, learning from past experience that construction of landfills was difficult due to opposition from local residents, in recent years closed system landfill sites in which waste is disposed of in enclosed structures have been constructed as regional-friendly facilities that are accepted by the residents. Moreover, operation and maintenance of closed system landfill sites are not affected by the weather and has the advantage of being able to effectively minimize leachate generation as intake of rainwater can be controlled. Tables 4-30 and Table 4-31 show the features of open and closed systems of landfill sites.

Table 4-29 Features of Disposal Sites Categorized by Location

Photos	Types and Features
	Disposal sites in mountainous terrain: These are disposal sites built in the valleys between mountains. Their advantage is that they can be built far from urban areas. About 70 percent of all disposal sites in Japan are of this type.
	Disposal sites in plains: Where construction in mountainous areas is difficult, disposal sites are constructed in plains on level ground by excavating spaces for waste disposal. These can be near urban areas and one important consideration point is how the land will be used in the future after the completion of disposal activity there.
	Disposal sites by land reclamation: These are disposal sites that were constructed by land reclamation at sea because of the limited land area in Japan. Their construction requires advanced marine civil engineering technology. A feature compared with disposal sites on land is that the area per disposal site is large.

Source: Tsuruoka City Website "Tsuruoka City Municipal Waste Landfill"
https://www.city.tsuruoka.lg.jp/kurashi/gomi-seikatsu/shorishisetsu/saishushobunjou.html (accessed March 1, 2022)
Niigata City Website "Fourth Akatsuka Landfill"
https://www.city.niigata.lg.jp/smph/nishi/shisetsu/seikatsu/dai4akatuka.html (accessed March 1, 2022)
Utsunomiya City Website "When landfill waste is brought to a processing facility"
https://www.city.ube.yamaguchi.jp/kurashi/gomi/dashikata/1001977/1001994/1001998.html (accessed March 1, 2022)

Table 4-30 Features of Open System Landfill Sites

<table>
<tr><th colspan="2">Item</th><th>Content</th></tr>
<tr><td colspan="2">Overview</td><td>・Disposal sites are constructed according to the site geography and geology.
・Rain and snow that fall on a disposal site generate leachate.
・Many facilities of this category have been constructed.</td></tr>
<tr><td rowspan="3">Environment</td><td>Natural environment</td><td>Daily soil cover application is necessary to mitigate the effects of rain and wind on active disposal cells in the site.</td></tr>
<tr><td>Effect on living environment</td><td>Operation and maintenance must be thorough. Measures such as leak detector systems must be installed to prevent against water leak risks.</td></tr>
<tr><td>Landfill facilities environment</td><td>In order to prevent scattering of waste, daily, intermediate and final soil covers need to be applied</td></tr>
<tr><td rowspan="6">Facilities planning</td><td>Stabilization of landfill site</td><td>In principle there is natural stabilization.
Natural rain and semi-aerobic landfills promote stability.</td></tr>
<tr><td>Landfill capacity</td><td>Large landfill capacity can be assured by effectively utilizing the terrain. Additionally, it is relatively easy to make structural changes in order to expand disposal capacities.</td></tr>
<tr><td>Storage structures</td><td>Depending on the site geography and geology, storage spaces are prepared by constructing dams, excavating pits or utilizing retaining slopes.
Many storage facilities are of soil structure so they are relatively inexpensive to construct and maintain.</td></tr>
<tr><td>Waterproofing construction</td><td>Waterproofing is often provided through laying of a double layer of impermeable membrane sheets as liner.</td></tr>
<tr><td>Leachate treatment facilities</td><td>The scales of these facilities is determined by the amount of rain and snow falls, and are large when compared to the closed system landfill sites.</td></tr>
<tr><td>Landfill work</td><td>The space inside landfills is open and there are few obstacles and limiting conditions while working there.</td></tr>
<tr><td rowspan="2">Economy</td><td>Construction costs</td><td>While the scale of the leachate treatment facilities (treatment equipment, adjustment tanks, etc.) will be large, in terms of construction costs they are cheaper than for closed systems.</td></tr>
<tr><td>Maintenance and control costs</td><td>There is more leachate treatment than for closed systems, so the operation and maintenance expenses are high during the facility operation period.</td></tr>
<tr><td colspan="2">Summary</td><td>Open system landfill sites are affected by storms, typhoons, and other weather conditions. Leachate generated from rain falling on the site cannot be reduced. However, there are few limiting conditions at these sites, and expanding the site and changing the structure are relatively easy. There is an established track record with these sites and the technology for construction, operation and maintenance, and safe closing are all established.</td></tr>
</table>

Source: Sagamihara City, "Sagamihara City Basic Concept Plan for the Next Municipal Waste Final Disposal Site" (2021)

Photo 4-64 Landfill of Minami-Ashikaga City

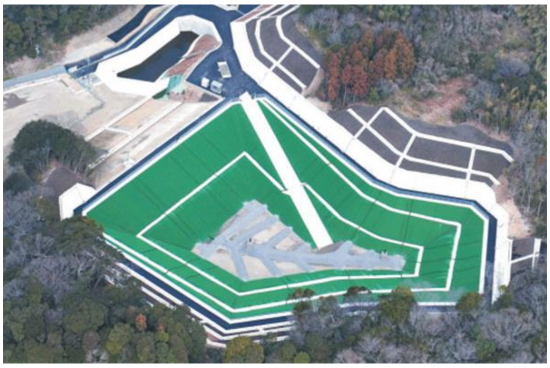


Photo 4-65 Landfill of Minami-Chita Association

Photo 4-66 Landfill of Sagamihara City

Source: Minami-Ashikaga City Website "Landfill"
https://www.city.minamiashigara.kanagawa.jp/shisetsu/kankyou/saisyusyobunjyou.html (accessed March 1, 2022)
Minami-Chita association Website "Landfill for Municipal Waste"
http://chitananbu.com/%E4%B8%80%E8%88%AC%E5%BB%83%E6%A3%84%E7%89%A9%E6%9C%80%E7%B5%82%E5%87%A6%E5%88%86%E5%A0%B4/ (accessed March 1, 2022)
Sagamihara City "Landfill site for municipal waste in Sagamihara City" (2019)

Table 4-31 Features of Closed System Landfill Sites

Item		Content
Overview		・ The landfill is covered by installation of roofs. ・ Landfills are not affected by rain or snow and can be stabilized with scheduled water sprinkling. ・ The technology was developed to obtain the residents' consensus.
Environment	Natural environment	Because sites are closed spaces they are not affected by rain, and scattering of waste and other problems can be controlled.
	Effect on living environment	Operation and maintenance must be thorough. Measures such as leak detector systems must be installed to prevent against water leak risks.
	Landfill facility internal environment	The possibility of waste scattering is low because the site is covered so in many cases the soil cover is not applied daily on the waste. Because the space is closed, ventilation, lighting, and odor countermeasures are necessary to maintain the internal work environment.
Facilities planning	Stabilization of site location	Stabilization is artificially promoted. Stabilization can be promoted by water sprinkling and either aerobic or semi-aerobic operation.
	Landfill capacity	Covered facilities tend to be less economical with larger landfill areas and therefore many of them are constructed with small areas and therefore limited landfill capacities. However, with the emphasis on mitigating the effects on the living environment in recent years outweighing the economic concerns, more of these facilities with large disposal capacities are being constructed. Because these facilities have covering structures, there is a limit to the available space and structural modifications, such as increasing landfill capacity are not easy.
	Storage structures	This is similar to open systems in that because the landfill area is small, in many cases the slopes of pit type and the like are steep. Therefore, there is a tendency for construction costs to increase due to the installation of concrete structures, etc.
	Waterproofing construction	Waterproofing sealing is often provided through laying of a double layer of impermeable membrane sheets as liner.
	Leaching treatment facilities	Because the covered facilities are not affected by rain and snow, the leachate produced is limited, so these facilities are smaller when compared to the open system.
	Landfill work	Because the space is closed, caution must be taken in maintaining the work environment. Disposal works require careful attention not to damage the roof, pillars and walls, in addition to many other limiting conditions.
Economy	Construction costs	Covered facilities increase construction costs. Although leachate treatment related facilities (treatment equipment, adjustment tanks, etc.) may be smaller in scale compared to those of open systems, their construction costs are higher than those of open systems.
	Maintenance and control costs	Because the quantity of leachate treated is small when compared with open systems, the operation and maintenance costs during the landfill operation period are lower.
Summary		These facilities are hardly affected by storms and typhoons so stable operation and maintenance management is possible. However, there are many limitations in operating in the landfill site so special care is required during landfilling work. In addition, it is difficult to expand the sites and make structural changes.

Source: Sagamihara City, "Sagamihara City Basic Concept Plan for the Next Municipal Waste Final Disposal Site" (2021)

Source: Yugawara-cho Manazuru Sanitary Association, "Municipal Waste Final Disposal Facility Pamphlet" (2021)

Photo 4-67 Outside View of the Landfill **Photo 4-68 Inside the Landfill**

Landfill of Yugawara and Manazuru Towns Association

Source: Tokachi Environmental Complex Office Association, "Municipal Waste Final Disposal Facility Ume-ru Center Mikato Pamphlet" (2021)

Photo 4-69 Outside View of the Landfill **Photo 4-70 Inside the Landfill**

"Ume-ru Center Mikato" Landfill of Tokachi Environmental Complex Office Association

(3) Categorizing by Facility Structure and Functions: Inert, Controlled and Isolated Landfills

Landfill sites are categorized into landfill sites for municipal waste and landfill sites for industrial waste. Landfill sites for industrial waste are categorized into inert, controlled and isolated landfill sites. Landfill sites for municipal waste are almost identical to controlled landfill sites for industrial waste.

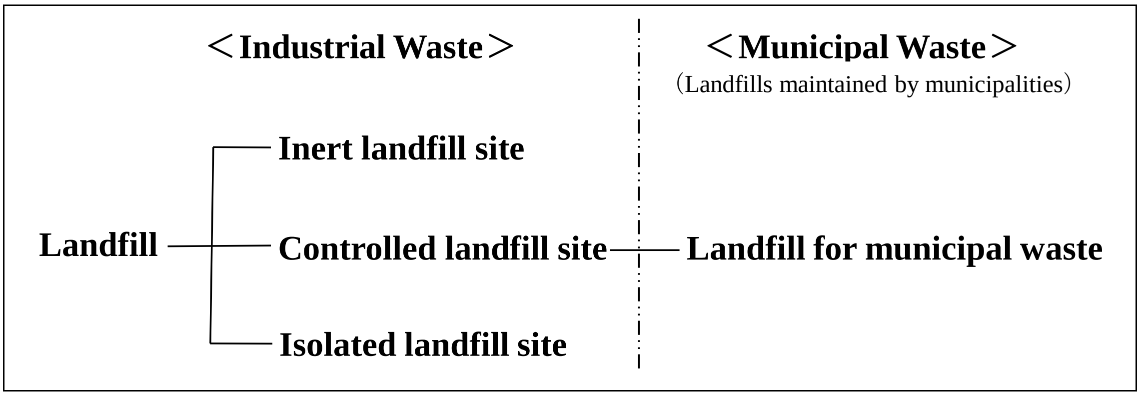


Figure 4-31 Types of Landfill

1) Inert Landfill Sites

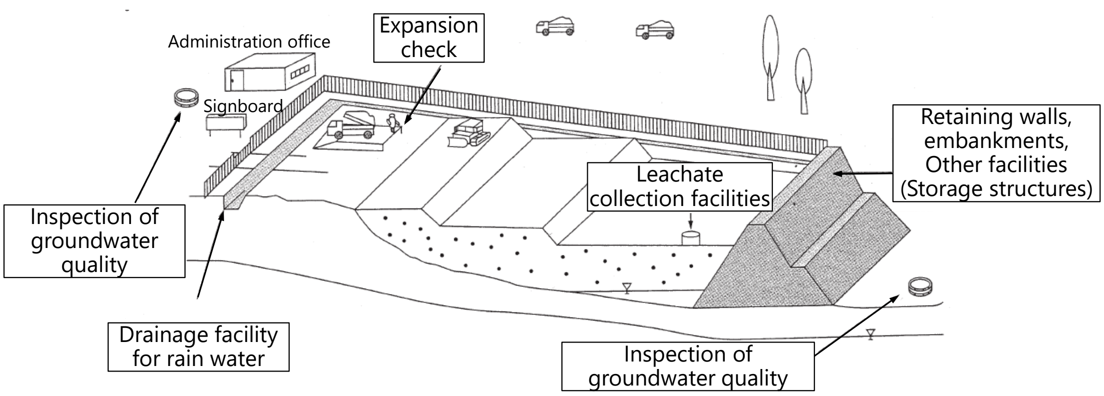
Inert landfill sites are landfill sites where only waste that cannot affect the surrounding environment can be filled. The materials include general debris, broken glass, concrete debris, waste plastics, metal scraps, rubber scraps, and other materials that do not contain harmful or organic matter.

Therefore, inert landfill sites do not have leachate treatment and water collection facilities, such as waterproofing liner construction.

Table 4-32 Waste that can be Disposed of in Inert Landfill Sites

Type	Details
Waste plastics (excluding automobile shreds, discarded printed circuit boards, and discarded containers and packaging)	Must be pretreated with one of the following methods. (1) Must be shredded or cut so that they are solid and with a maximum circumference of 15 cm or less, or they must have been melted at a melting facility. (2) Incinerate at an incineration plant or decompose with heat at a thermal decomposition facility.
Rubber scraps	Must be pretreated with one of the following methods. (1) Must be shredded or cut so that the maximum circumference is 15 cm or less. (2) Incinerate at an incineration plant or decompose with heat at a thermal decomposition facility.
Metal scraps (excluding automobile shreds, discarded printed circuit boards, the poles of lead batteries, lead pipes and plates, and containers and packaging.)	
Glass, concrete, and ceramic debris (excluding automobile shreds, discarded CRTs, discarded plasterboard, and containers and packaging).	
Debris	

Source: Enforcement Order of the Waste Disposal and Public Cleansing Act (Cabinet Order No. 300 of 1971)



Source: Ministry of the Environment "Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007" (2007)

Figure 4-32 Example of Inert Landfill Site Structure

2) Controlled Landfill Sites

Controlled landfill sites can accept the following waste materials in industrial waste: combustion residue, sludge, paper scraps, tree scraps, and other organic waste that meet the standards for harmful materials.

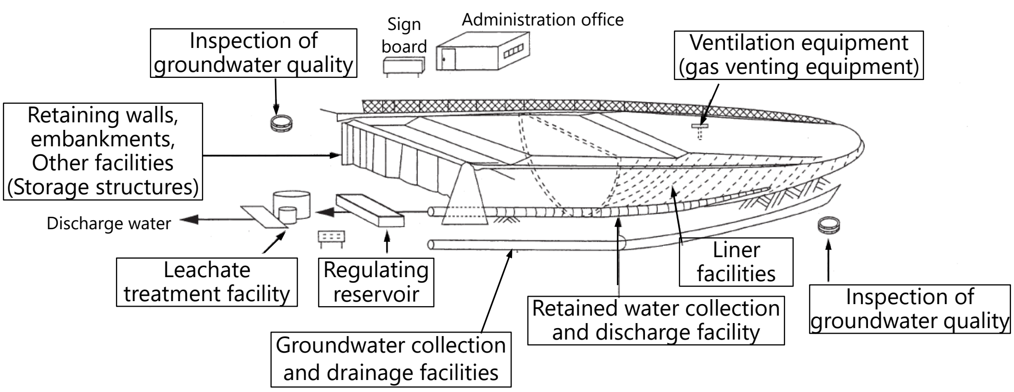
They can also be used to dispose of municipal waste that can be decomposed to produce leachates and gas.

Leachate is produced at controlled landfill sites because of the decomposition of the waste, so waterproofing liner construction and leachate treatment facilities are mandatory.

Table 4-33 Waste that can be Disposed of in Controlled Landfill Sites

Type	Details
Sludge	Must be pretreated with one of the following methods. (1) Incinerate at an incineration plant or decompose with heat at a thermal decomposition facility. (2) Treat until the water content is 85% or less.
Combustion residue, ash, etc.	Must be pretreated with one of the following methods. (1) Do not spread around in a specific part of the disposal site. (2) Apply soil cover or take other measures so that residue and ash are not scattered either inside the disposal site or to areas outside the site. (3) Add moisture, solidify, bail, or take other measures so that residue and ash are not scattered into the air. (4) Wash vehicles and take other necessary measures.
Animal residue, animal related solid waste, animal manure, animal bodies	Must be pretreated with one of the following methods. The thickness of a layer of industrial waste should be about 3 m or less (about 50 cm or less if 40% or more is decomposing matter), and the surface of each layer should be covered with about 50 cm of soil.
Paper waste, tree waste, textile waste, slag, plasterboard (Combustion residue, sludge, slag, and ash must be equal to or less than the standards for each.)	

Source: Enforcement Order of the Waste Disposal and Public Cleansing Act (Cabinet Order No. 300 of 1971)



Source: Ministry of the Environment "Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007" (2007)

Figure 4-33 Example of Controlled Landfill Site Structure

3) Isolated Landfill Sites

Isolated landfill sites are used to dispose of industrial waste that must be sealed from the outside because of including harmful matter that has not met the legal standards.

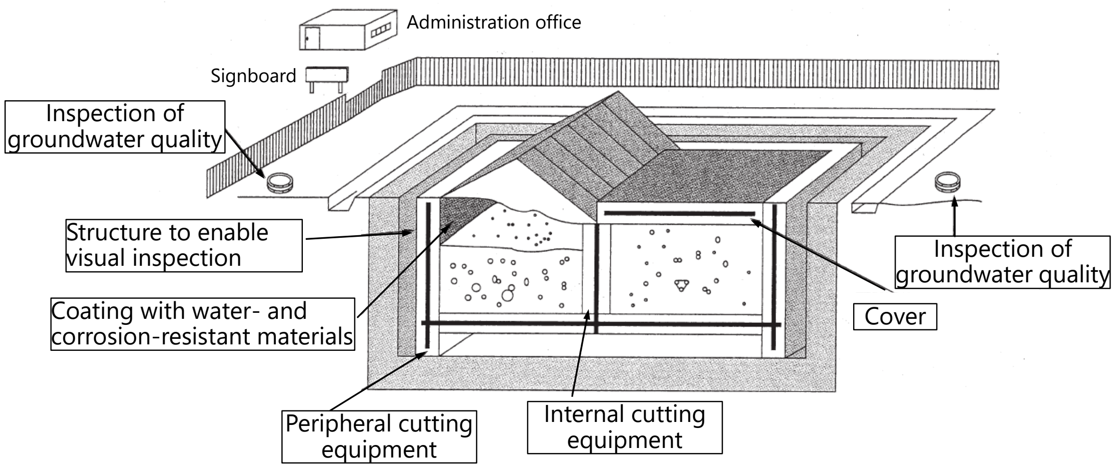
Therefore, isolated landfill sites are sealed in concrete structures and roofs and isolated from their surroundings.

Table 4-34 Waste that can be Disposed of in Isolated Landfill Sites

Type	Details
Combustion residue, sludge, slag, ash	Matter that exceeds the standards. Industrial waste (combustion residue, sludge, ash, etc.) that contains a certain level or more of harmful substances (heavy metals).

*: Disposal of PCB waste, waste that contains dioxins, infectious waste, liquid waste, waste acid, and waste alkali are prohibited.

Source: Enforcement Order of the Waste Disposal and Public Cleansing Act (Cabinet Order No. 300 of 1971)



Source: Ministry of the Environment "Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007" (2007)

Figure 4-34 Example of Isolated Landfill Site Structure

(4) Categorizing by Microbe Environment: Anaerobic, Semi-aerobic, and Aerobic Landfills

The behavior of microorganisms within a disposed waste layer varies depending on the environment inside the landfill. Under aerobic conditions, where oxygen is supplied within the disposed waste layer, aerobic microorganisms are more active. On the other hand, under conditions of limited oxygen supply, the disposed waste layer becomes an anaerobic environment, and anaerobic microorganisms that do not require oxygen become active.

Disposal sites can be categorized into anaerobic, semi-aerobic, and aerobic landfill sites depending on condition of oxygen supply, in other words, the microbe environment in the disposed waste layers.

The features of landfill sites by the differences in microbe environment are shown below. Aerobic landfill is expected to improve the quality of leachate by promoting the decomposition of landfill waste and reducing the generation of methane gas because the environment of the waste layers inside the landfill site become aerobic. However, the blowers used to supply air to create this aerobic environment require financial resources for operation and electricity, and if the moisture content of the soil is high, the blowers come under pressure leading to failures.

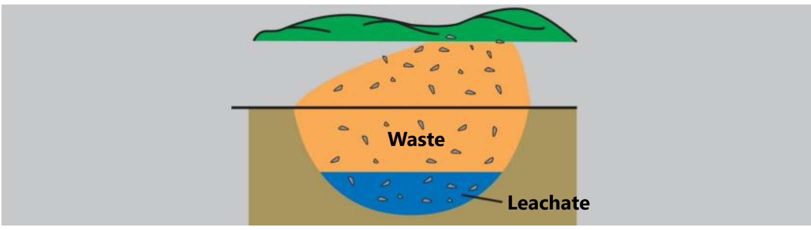
Anaerobic landfills can reduce construction and maintenance costs because no equipment is required to maintain an anaerobic environment within the disposed waste layers. On the other hand, the anaerobic environment within the disposed waste layers prevents the speedy decomposition of the disposed waste, resulting in long-term operation of the landfill. In addition, the activity of anaerobic microorganisms produces more methane gas than aerobic ones.

Table 4-35 Features of Landfill Sites by Microbe Environment Differences

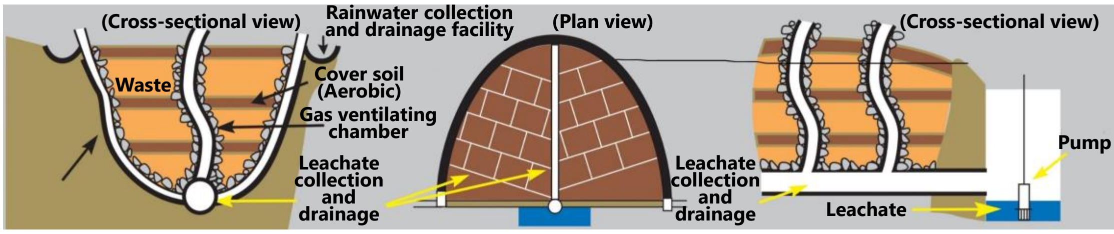
Landfill type	Anaerobic	Semi-aerobic	Aerobic
Overview	General method used in Europe	Method developed in Japan	-
	Waste is disposed of in excavated flat ground or valleys, and the waste has a high moisture content and is anaerobic.	These landfill sites have perforated gas release pipes and leachate collection pipes and as water is drained through the pipe network fresh air is supplied to the waste layers creating an aerobic environment.	Blowers and air pipes are used to force air into the waste layer interior to make it more aerobic.
Construction and operation /control costs	Inexpensive	Normal	Expensive
Methane gas emissions	High	Low	Low*
Precautions	The pollutants in the waste do not decompose and may remain in the soil for decades.	-	If the water content in the soil is high during rainy periods, pressure will be placed on the blowers leading to malfunctions.

*: Although aerobic landfills produce less methane than anaerobic landfills, the operation of blowers can lead to a significant generation of carbon dioxide.

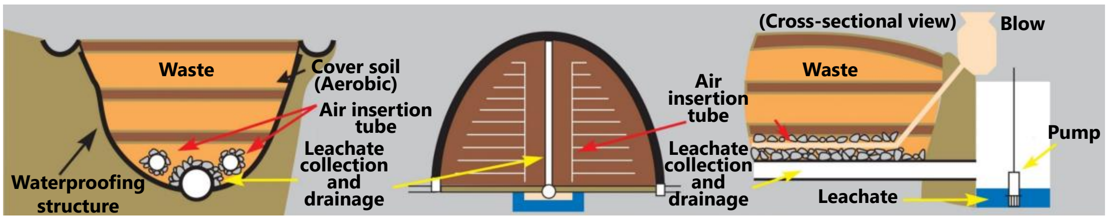
Anaerobic Landfill



Semi-aerobic Landfill



Aerobic Landfill



Source: Fukuoka City "What is the Fukuoka method of semi-aerobic landfill construction?" (2013)

Figure 4-35 Structural Diagram of Landfill System with Different Microbial Environments

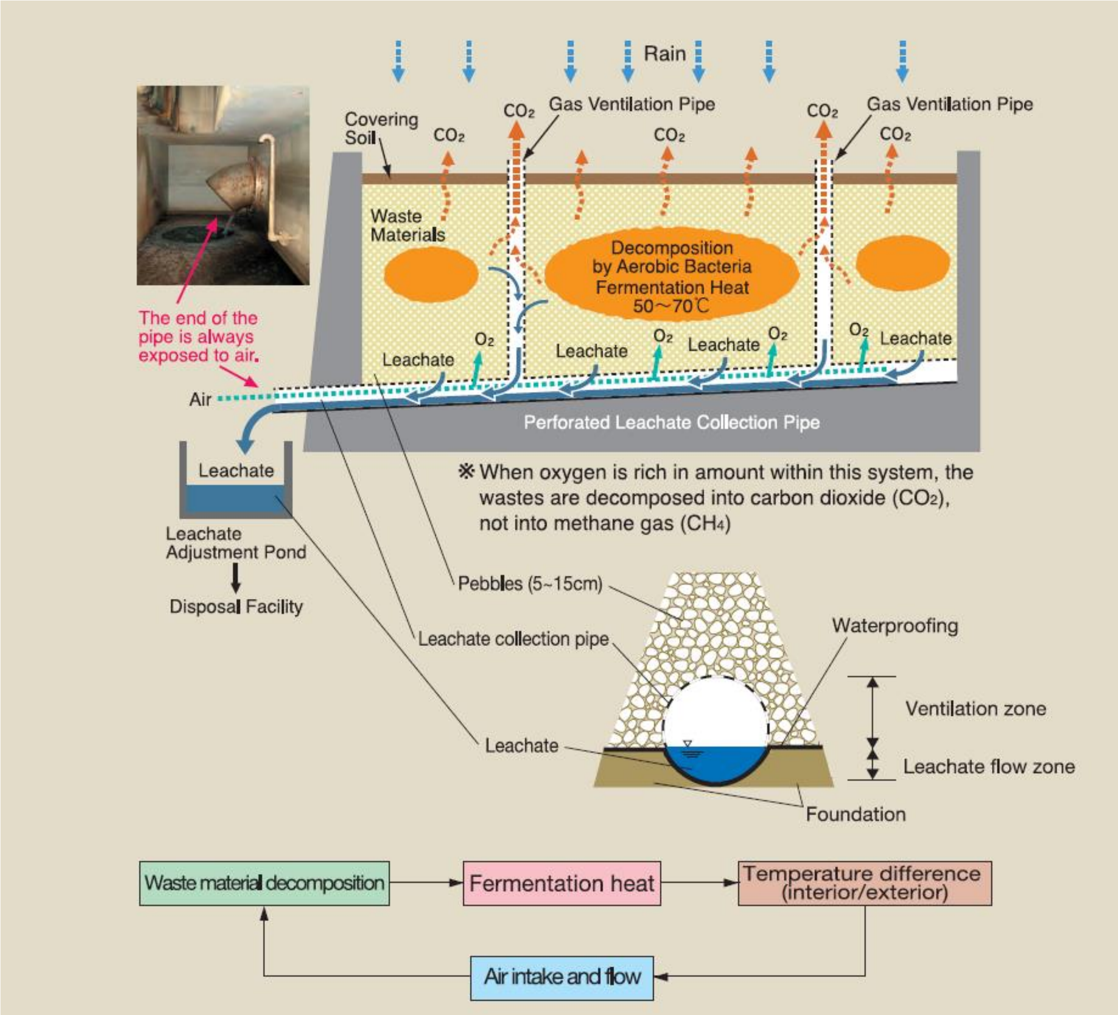
Fukuoka Method (Semi-aerobic Landfill Construction)

The Fukuoka Method is a semi-aerobic landfill type that was developed when Japan was still disposing of kitchen waste in landfills. Therefore, at the time there was no intermediate treatment. As these conditions were similar to those present in developing countries that mainly use direct landfill disposal, this technology is very suitable for those countries. Moreover, due to the fact that the construction of Fukuoka Method landfill sites can use locally available alternative materials, it has spread widely among developing countries.

The semi-aerobic landfill construction method was researched and developed by professor emeritus Hanashima of Fukuoka University with the cooperation of Fukuoka City. At the time, Fukuoka City was confronted with pollution issues from landfill sites used for kitchen waste that caused water pollution, odor, gas, and pests. Therefore, professor Hanashima and Fukuoka City jointly conducted a study for three years from 1973 to improve the leachate quality and in turn the landfill sites. As a result of these experiments, the basic concept of semi-aerobic landfill construction that uses leachate collection pipes to supply air to the interior of landfill sites was proposed. In 1975, the first semi-aerobic landfill site was constructed at the Shinkamata landfill site. Then, the semi-aerobic landfill construction method was adopted throughout Japan under the name of the Fukuoka Method.

Because the Fukuoka Method technology was developed when intermediate treatment was not sufficient and kitchen waste was being directly disposed of in landfills, at present there are only limited uses of this technology in Japan because intermediate treatment, such as incineration, has greatly developed since then. However, this technology is effective in developing countries which are in circumstances similar to those faced by Japan in the past when it did not have intermediate treatment. These countries are confronting problems of leachates, odor, etc. Therefore, this technology has been adopted in many locations in Asia, Africa, and Oceania.

In July 2011, improvements to existing landfills by using semi-aerobic landfill construction (Fukuoka Method) were certified as a new method by the Clean Development Mechanism (CDM) stipulated by the United Nations Framework Convention on Climate Change. By promoting the decomposition of waste in landfills by maintaining aerobic conditions, this technology can improve the water quality of leachates and reduce the production of methane gas so it can help to reduce emissions of greenhouse gases.



Source: Fukuoka Prefecture "Guide to Introducing The Fukuoka Method" (2020)
English: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086159_misc.pdf
Vietnamese: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086163_misc.pdf
Thai: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086164_misc.pdf

Figure 4-36　Conceptual Figure of Semi-aerobic Landfill Construction

Column: Introduction of the Semi-aerobic Landfill Method (Fukuoka Method) Landfills in Developing Countries

The semi-aerobic landfill method (Fukuoka Method) that is being introduced in developing countries is a Japanese technology (refer to "Topic 7-4.2 (1) Construction and Proper Maintenance, Management and Expansion of Sanitary Landfill Sites Using the Fukuoka Method" for an example of a Fukuoka Method landfill in El Salvador).

The main reasons that the Fukuoka Method spread in developing countries are described below.

(1) Utilization of Locally Available Materials

Developing countries cannot acquire sufficient materials, so they cannot construct landfill sites according to their blueprints and maintain them. The basic system in the Fukuoka Method is simple and there is a high degree of flexibility for the materials that can be used, so locally available materials can be adopted.

Source: Yachiyo Engineering Co., Ltd.

Photo 4-71 Example of Beer Bottle Case Usage

For example, when the gravel needed for encircling the gas ventilation pipes were not available, cases used for carrying beer bottles were utilized instead. When soil for coverage was not available, old waste was excavated and used as cover. There are other examples of working together with local administrators and workers to find alternatives through trial and error. From the viewpoint of protecting waterproofing liner sheets from heavy construction equipment, liner sheets were only used in the downstream leachate adjustment pond where there is a high risk of polluting the outside water environment by the leachates collected in the pond. Simple sheets or clay were used in other sections. In this way, it is possible to reduce the construction and maintenance costs depending on the innovations used.

Note that the gradient of leachate collecting and drainage pipes is about 1 to 2 degrees, so the speed of the leachate is slow. This will require a careful design because the pipe diameter will have to be two or three times that of sewage pipes.

(2) Improving the Motivation of Landfill Operators Personnel by Making Visual Improvements

The construction of Fukuoka Method landfill sites has changed the appearance and environment of the working place when compared with open dumping, and this has improved the motivation of operators personnel. Additionally, this improved the understanding of the theory behind the Fukuoka Method as well as its operation and maintenance methods among operators in developing countries, which contributed to the spreading of this technology within the country.

Photo 4-72 Appearance of the Landfill **Photo 4-73 Gas Venting Pipes**

Source: Yachiyo Engineering Co., Ltd.

Fukuoka Method Landfill in Macas City, Ecuador (2016)

3.4 Operation and Maintenance Management of Landfill Sites

In Japan, an operation and maintenance plan stipulated by law must be attached to the notification of establishment of a landfill to be submitted before starting operation of the landfill site. This plan should include the relevant details agreed upon with local residents. By formulating and implementing a plan that includes the agreed items, it is possible to obtain the understanding of local residents regarding the necessity of the facility.

When local governments need to develop landfill sites, they must apply to their prefectural governments. Together with their application, they must submit an operation and maintenance management plan. The understanding and cooperation of local residents are extremely important to facilitate the operation and maintenance of the facility, and the prepared operation and maintenance plan should carefully consider local conditions and aspirations and the plan contents need to be thoroughly discussed with local residents. Once commissioned, the facility should be operated and maintained in accordance with the prepared plan.

Waste Delivery Control

In order to manage and operate a landfill site according to plans, it is important to understand the types, quantities, and characteristics of the waste that will be delivered to the landfill. Therefore, when daily waste is delivered, in addition to the types and quantities of the waste and the amount and material of the covering soil, the following items should also be recorded. Appropriate delivery management will make it possible to confirm variations in the amounts of waste disposal and estimate the remaining capacity of the landfill and remaining years of operation at any given time. These estimates will be very important for determining future landfill construction requirements and preparing the necessary development plans.

Table 4-36 Daily Recording Items Related to Waste Delivery Control

No.	Recording item	No.	Recording item
1	Delivery time and date	6	Type of waste
2	Vehicle number and type	7	Source of the waste (collection area, intermediate treatment facility, business, generating region, etc.)
3	Vehicle empty weight		
4	Gross weight	8	Delivering vendor, driver name
5	Quantity of delivered waste		

Source: Based on the "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition," (2010), Japan Waste Management Association.

Landfill Work Management

Carrying out landfill work as planned is necessary not only for securing disposal capacity at the landfill site, but also for stabilizing landfill waste and managing leachate and landfill gas generated from the landfill. Information on the types and amounts of waste disposed in each landfill disposal cell is also necessary from the perspective of long-term landfill management, including the prevention of environmental pollution during the period after completion of disposal operations and abolition of the landfill and consideration of the land use after abolition.

Facility Operation and Maintenance Management

If the functions of each facility are not fully utilized, the disposal site will become unsanitary, causing problems such as environmental pollution to the surrounding area and negative impacts on the health of workers. In addition, since it takes a long time, in some cases several decades, from the completion of disposal operations to the abolition of the landfill, it is necessary to keep in mind that each facility will be operated for a long period of time.

Table 4-37 shows the important items for the suitable long-term operation and maintenance management of landfill sites.

Table 4-37 Items to be Recorded for the Operation and Maintenance Management of Landfill Sites

<table>
<tr><th colspan="2">Item</th><th colspan="2">Recording content</th></tr>
<tr><td rowspan="4">Plan/ operation</td><td>Type and quantity of waste
(Daily recording)</td><td colspan="2">・The types and quantities of landfilled waste monthly.</td></tr>
<tr><td>Water quality inspection
(1 time/ 6 months)</td><td colspan="2">・Locations where groundwater and discharged water were sampled.
・Dates when groundwater and discharged water were sampled.
・Dates when water quality inspection results were acquired.
・Water quality inspection results</td></tr>
<tr><td>Investigation of water quality deterioration and countermeasures</td><td colspan="2">・Date when action was taken.
・Contents of the action</td></tr>
<tr><td>Remaining capacity
(1 time/ year)</td><td colspan="2">・Date when the landfill remaining capacity was measured and calculated, and the results.</td></tr>
<tr><td rowspan="4">Facility</td><td>Retaining walls, etc.</td><td rowspan="4">・Date when the inspection was conducted and results.
(1 time /year)</td><td>・If an inspection shows that a retaining wall or another facility may be damaged, the date when action was taken and the content of the action.</td></tr>
<tr><td>Water liner construction</td><td>・If an inspection shows that waterproofing liner damage is suspected, the date when action was taken and the content of the action.</td></tr>
<tr><td>Leachate adjustment pond equipment</td><td>・If an inspection shows that an adjustment pond may be damaged, the date when action was taken and the content of the action.</td></tr>
<tr><td>Leachate treatment equipment</td><td>・If an inspection shows that the leachate treatment equipment functions are abnormal, the date when action was taken and the content of the action.</td></tr>
</table>

Source: Based on the Japan Waste Management Association “Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition” (2010)

3.5 Appropriate Closing and Use of the Site

In Japan, landfill sites are appropriately operated and maintained according to standards. This applies to the plans and design when a landfill is being constructed, and also to the operation and maintenance once it is operational. Various standards for suitable closing, monitoring period and abolishing are also in place for after the termination of disposal operation of the landfill. Because the landfill site is strictly managed until it is abolished, it is possible to use the site effectively after the landfill site has been abolished. Additionally, there are guidelines for using the site.

(1) Appropriate Closing

In Japan, when waste is no longer received at a landfill site and landfilling work is terminated, facility services are ended by taking actions, such as the final covering with soil to close it appropriately. When a facility is closed, although there is no new delivery of waste, the disposed waste has not completely decomposed, so the water quality of leachate and gas from the landfill must continue to be controlled according to the facility standards, and operation and maintenance standard. Once a landfill site is closed, entrance to the site is limited and managed so that landfill waste is not agitated.

After a monitoring period during which the decomposition of the landfill waste has stabilized, the water quality of leachate, landfill gas emissions, and landfill waste temperature are confirmed to make sure that they comply with the standards. If the abolition standards are met, a new project may be commenced at the site according to the guidelines related to site usage of landfill sites.

Figure 4-37 shows the flow from the start of a landfill site until the site is reused for another purpose.

<u>Flow Chart from the Start of Landfill to the Abolished Landfill Site and Reuse</u>

- **From "Start of Landfill" to "End of Landfill"**

The landfill period of a landfill site is the period from the commencement of waste delivery to the end of landfill after the last waste delivery to the landfill. During the landfill period, it is necessary to manage the disposal site in compliance with the structure standards, and operation and maintenance standards.

- **"Closuring" of the Landfill Site**

For landfill site where waste has been delivered and landfilling has been completed, the landfill site is closed to maintain the site in a safe condition by applying the final soil cover and other measures.

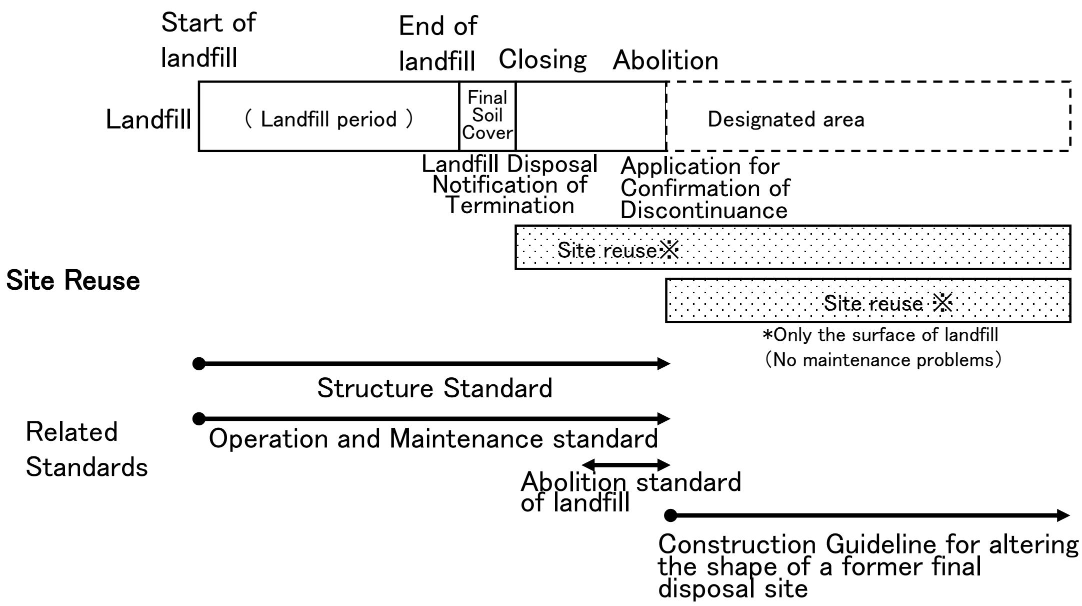
- **"Abolition" of a Landfill Site**

A closed landfill site can be abolished when it is confirmed that the waste disposed inside the landfill is sufficiently stable and that the quality of leachate generated and the gas emissions do not adversely affect the environment in the landfill site and the surrounding area, and when there is no longer a risk to the living environment with the discontinuation of operation and maintenance.

In order to abolish a landfill site, it must meet the criteria for abolition standards, as shown in Figure 4-38.

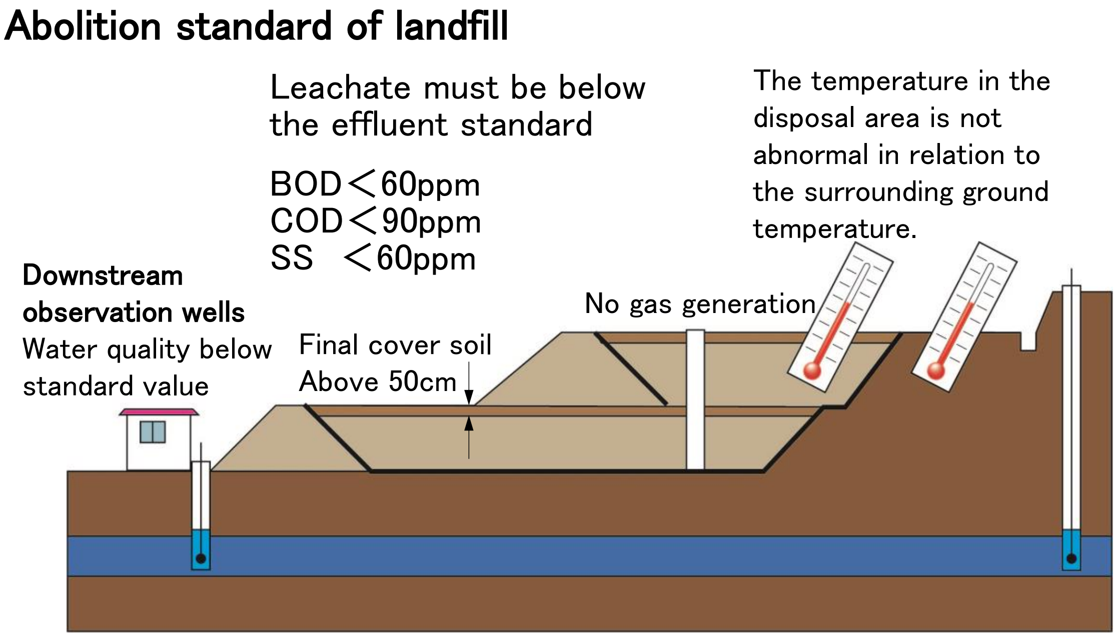
- **"Site Reuse" of Landfill Site**

In accordance with the guideline, an abolished landfill site can be reused as park, etc.



Source: Japan Waste Management Association "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition" (2010).

Figure 4-37 Final Disposal Site Utilization and Related Standards



*: BOD : Biochemical Oxygen Demand
COD : Chemical Oxygen Demand
SS : Suspended Solids

Figure 4-38 Abolition Standard of Landfill

(2) Site Reuse

After landfilling at landfill sites has been terminated, the site will be relatively large and flat and similar to a vacant lot very much like the condition just before the development of the landfill. It is therefore possible, after a site has been used as a landfill site, to reuse it effectively to help develop or revitalize the area. The site reuse is expected to deepen residents' awareness and understanding of the construction of landfill sites and promote the locating of new landfill sites. Table 4-38 shows typical land uses for landfill sites reuse.

Table 4-38 Typical Land Uses for Landfill Sites Reuse (Surface Utilization)

Type	Example	Features
Parks	Nagaoka Park, Utsunomiya City, Tochigi 	The site of Nagaoka landfill has been reused to develop Nagaoka Park. It is being heralded as a park that "would be a waste not to use". The theme of Nagaoka Park is "Creating greenery and formation of a community". Landfill capacity: 490,000 m^3 Landfill area: 60,000 m^2 Landfill period: 1983 to 2005
Sports facilities	Senogawa Park, Hiroshima City, Hiroshima 	This park was built on the site of the Senogawa landfill site, which was the final disposal site of Hiroshima City. There is a baseball field, tennis courts, indoor exercise facility, and a park golf course. Landfill capacity: 2.75 million m^3 Landfill area: 210,000 m^2 Landfill period: 1974 to 1990 Reuse period: 1994 -
Solar power generation	Saitama Environmental Center (Osato-gun, Saitama) 	The Saitama Prefectural landfill site is being reused as a solar power generation facility. [Only the solar power generation area] Landfill capacity: 530,000 m^3 Landfill area: 60,000 m^2 Landfill period: 1993 to 2007 Reuse period: 2013 -

Source: Utsunomiya City Website "Nagaoka Park" https://www.city.utsunomiya.tochigi.jp/kurashi/machi/1020735/1015510/1015537.html (accessed February 24, 2022)
Senogawa Park Website "Overview of the Park" https://www.midori-gr.com/senogawa/overview/ (accessed February 24, 2022)
Ministry of the Environment, EX Research Institute Ltd. "Report on the Commissioned Study of Measures to Promote the Introduction of Photovoltaic Power Generation into Landfill Sites, etc., in Fiscal Year 2015" (2016)

Column: Beautiful "Moerenuma Park" where Nature and Art Merge

Moerenuma Park with its green hills is located in the northeast of Sapporo, Hokkaido. Construction of this park started in 1982 and it opened in 2005. The basic design was done by the world-famous sculptor, Isamu Noguchi. The park covers a wide expanse of 1.888 million square meters featuring hills, playgrounds, fountains, etc.

This wonderful facility which is much loved by the citizens, was originally a municipal waste landfill. From 1979 to 1990, about 2.7 million tons of waste was disposed of here. To reconfigure the land, construction waste soil from public works projects was used. As of 2022, the Sapporo municipal government monitors the quality of discharge water, and the water in surrounding rivers.

Source: Based on Moerenuma Park Website https://moerenumapark.jp/ (accessed on March 15, 2022)

Photo 4-74 Landfill (1985)

Photo 4-75 Moerenuma Park (2007)

Photo 4-76 Mt. Moere in the Park

Photo 4-77 Play Hill in the Park

Source: Sapporo City "Waste Disposal Administration/3R Policy in Sapporo City (JICA training materials)" (2019) (Photo 4-74, Photo 4-75)
Yachiyo Engineering Co., Ltd. (Photo 4-76, Photo 4-77)