

Chapter 2

History of Japan's Sound Material-Cycle Society

History shows that Japan did once successfully create a society in harmony with nature, as did other countries and regions, based on “mottainai,” the spirit of avoiding being wasteful with goods and a desire to keep things clean. This white paper calls this the primitive sound material-cycle (SMC) society and examines it in detail.

This chapter looks back on the Edo and later eras to analyze what kinds of systems Japan formed as part of

this primitive SMC Society. In the Edo era, there were systems that are still applicable to modern society and can still serve as useful models for certain countries today.

The later part of the chapter describes Japan's 21st century path to a new SMC Society, while looking back over how Japan has, since the Meiji era, moved towards a mass-production and mass-consumption society in order to achieve economic growth.

Section 1 The Edo era and its systems for a sustainable society

It is believed that, in the Edo era, Japan had a SMC Society driven mainly by community activities. Compared with the modern world, people in those days were engaged in social activities involving lower carbon emissions and they lived their lives with a deeper awareness of being in harmony with nature. Evidence from this period strongly suggests that a sustainable society can be established through the comprehensive promotion of a low-carbon society, a society in harmony with nature and a sound material-cycle society.

(1) Edo's sanitary material-cycle system

The city of Edo is believed to have been more sanitary than any other city in the world at that time in history. This is because its social system was centered on rice-growing and all organic matter such as night soil and kitchen garbage was recycled as fertilizer and returned to the soil in rural villages so that it never remained in urban areas. Modern European cities failed to take such effective measures to dispose of night soil and, consequently, infectious diseases like the plague and cholera became rampant. In Japan, such diseases were relatively rare because night soil, which could potentially transmit pathogens, was made good use of and never left uncontrolled and unattended.

The concept of “SMC blocks,” spelled out in the new Fundamental Plan for the Establishing a SMC Society, emphasizes the significance of forming a material cycle of optimal size, in accordance with the regional characteristics and properties of circulative resources (CRs). In light of this, the following sections outline how Edo successful-

ly created a SMC Society, establishing regional SMC blocks based on the characteristics of the communities and products involved.

A Establishment of SMC blocks that take advantage of the characteristics of the communities and products involved

People in the Edo era considered it important to make the most of the characteristics of their local communities and products. For example, they used the expression “*sanri shiho*,” which means that you can stay healthy and live longer if you eat vegetables grown within a radius of three ri (approximately 12 kilometers). There seems to be some variation in the travel distances cited for vegetables, as demonstrated by similar expressions such as “*shiri shiho*” (within a radius of four ri) and “*gori shiho*” (five ri) in other regions. However, these expressions all stress the importance placed on the characteristics of local com-



[A farmer carrying night soil buckets]

Source: Yowatari Fuzoku Zue (Collected Genre Paintings of the World)

munities and products. This concept has been passed down over generations and still exists in the modern expression of “local production for local consumption.”

In the Edo era, night soil and ash from urban areas were effectively used to fertilize the soil in farmland and to

grow vegetables. These wastes were not only accepted by farmers but also traded and bartered for money or vegetables. As well as helping suburban farmers fertilize their farm soil, such practices even fostered the development of SMC blocks between cities and the surrounding farm vil-

Column

Safe and sanitary night soil reservoirs in Japan

Rice cultivation was introduced to Japan from China during the Yayoi era. Initially, cultivation technologies were developed under the technical guidance of settlers from the Korean Peninsula. However, original irrigation technologies and farming methods, more suitable for the climate and the natural features of Japan, were also developed by the Japanese people themselves. In the early years of rice cultivation, fertilizer was available in the form of young leaves and weeds or ash from slash-and-burn agriculture. As the population grew and paddy fields expanded, farmers began using cow and horse manure. Later, when the double-cropping of rice and wheat began, during the Heian era, people also began using night soil as fertilizer.

However, there is a problem associated with handling night soil in that it can harm the living environment and has a bad odor if left untreated. If any live pathogenic bacteria or parasitic worm eggs are present, night soil can even spread infectious diseases. Another problem is that, if used as fertilizer without any treatment first, night soil may damage plant roots because it generates heat and releases hazardous gases such as ammonia during decomposition.

Hence, before being used as a fertilizer, night soil needs to be chemically or biochemically stabilized in order to prevent decomposition and it must be processed to ensure sanitary safety and prevent infectious diseases spreading throughout society. The key question here is how people, long ago, were able to stabilize night soil and make it safe to use.

The answer is the night soil reservoir. Night soil reservoirs are facilities to ferment night soil and convert it into fertilizer. These facilities could be as simple as a hole dug beside a field and covered with a lid.

Farmers mixed rice straw into the night soil inside the reservoir. When night soil, which is a mixture of carbohydrate, fat, nitrogen compounds and many other organic substances, is stored in an airtight chamber with the lid closed (under anaerobic conditions) and with rice straw added, it then decomposes into substances with a relatively simple structure (such as

organic acids, fatty acids and amino acids) as a result of the metabolic activities of various anaerobic bacteria. Subsequently, methane bacteria then generate gases such as carbon dioxide, methane, hydrogen, nitrogen, ammonia and hydrogen sulfide. Eventually, night soil is stabilized and rendered free of almost all roundworms, which are killed by the heat generated during the fermentation process.

In the Edo era, the shogunate government ordered all citizens to install a large cesspool with each toilet, in order to efficiently store all night soil. This led to the installation of cesspools in rural and urban houses alike. The night soil stored in these tanks underwent partial anaerobic decomposition before being collected and transported to suburban farms by boat or by horse or ox-drawn wagons. This night soil was then stored in night soil reservoirs for stabilization and sanitation before being spread on the fields as fertilizer.

During the Edo era, Japan therefore had a true SMC Society in which night soil was sanitarily treated for effective use without affecting the living environment, thereby making the best possible use of the limited resources available. People today, who no longer make use of night soil, can learn a great deal from the sanitary recycling of night soil in the Edo era. It is important that Japan should share the benefits of its experience with developing countries, especially from the perspective of hygiene education and village development.



[Sanitary use of the night soil reservoir]
Source: Ministry of the Environment

lages, contributing to both the farmers' economic self-reliance and to urban development. This was a good example of a virtuous circle for both the economy and the environment.

B SMC blocks, as demonstrated by the use of night soil as a fertilizer for rice and vegetable cultivation

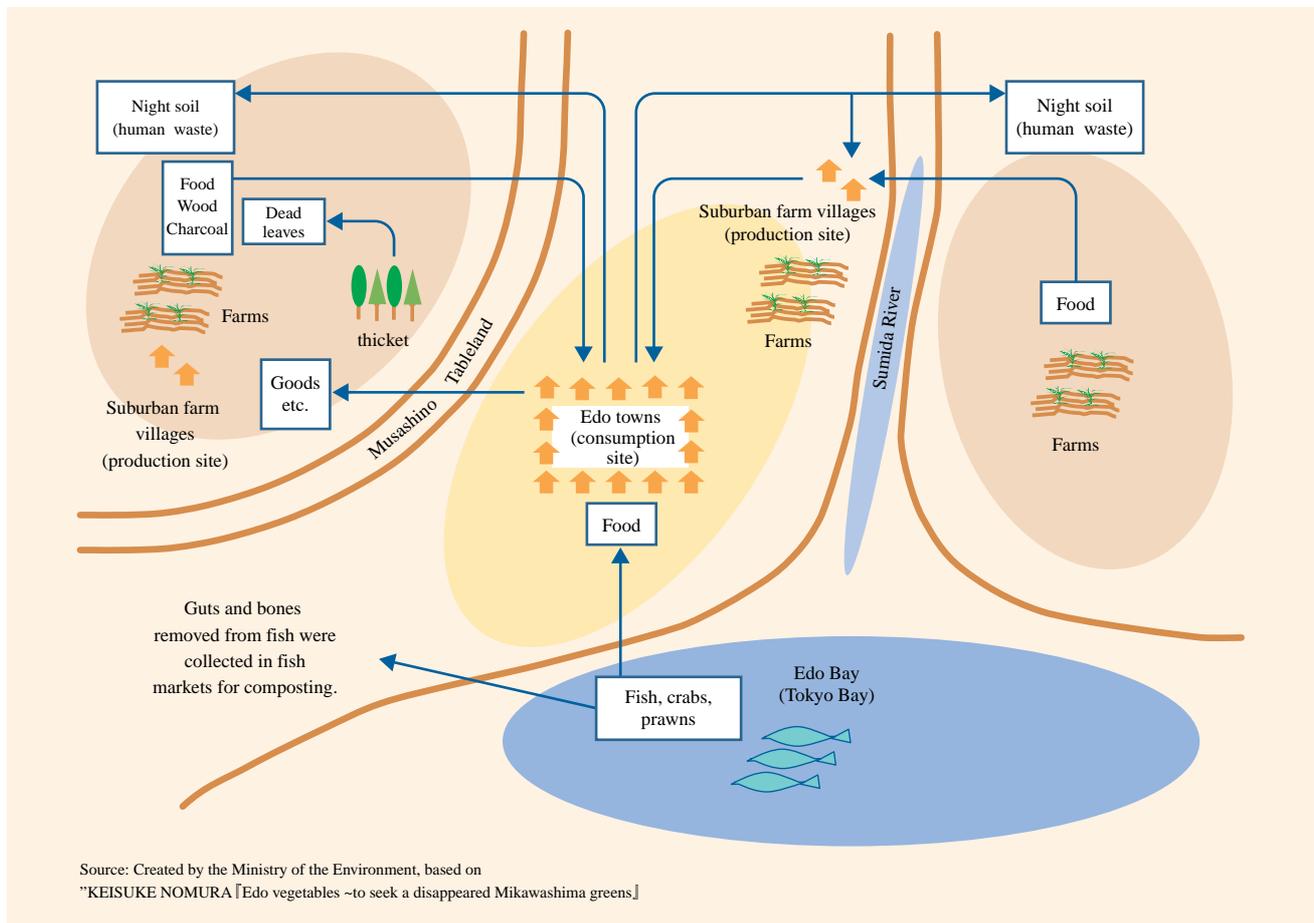
Since rice production capacity was the key to political power in the Edo era, the shogunate government and domain governments considered the implementation of measures to develop new fields and improve rice production capacity a high-priority policy.

As a result, the cultivated area for rice increased from about 1.6 million hectares in the Keicho period (1596-1614) to about 3 million hectares in the Kyoho period (1716-1735). This means that an 80% increase in production area was achieved in about a century. Over the same period, the accumulation of experience and new technologies also contributed to improvements in rice productivity. For example, *Nogyo Zensho* (Encyclopedia of Agriculture, Yasusada Miyazaki, 1696), a leading agricultural book in the Edo era, includes descriptions of advances in fertilizer research: "There is an urgent need to

put night soil on infertile land. Farmers must build a shack to store night soil. This should be used to store everything from rotten food to kitchen wastewater and bathing wastewater, and to fully ferment them for use as fertilizer. Cattle and horse feces should be stored in layers. Pile them up if you have too much. There are many kinds of fertilizers. Good fertilizers can be made by mixing night soil with oilcake, dried sardines and residues from whale processing." Other technologies developed in this era included the use of water wheels to pump irrigation water and sluices and dikes for stream management.

Such advances in agriculture were, in fact, closely related to the issue of how to secure adequate amounts of fertilizer for use on the fields. One solution to this was allowing large amounts of night soil and ash, generated in urban areas, to be effectively used in surrounding farm villages as fertilizer. As mentioned earlier, during the Edo era, a material cycle existed so that farmers could obtain the valuable urban night soil and ash, spread it on their fields as fertilizer, then grow rice and vegetables which provided food for the people in the city of Edo. Urban communities promoted a material cycle in which both they and the rural villages each played their respective

Figure 4-2-1 Night soil use



roles and maintained relatively high sanitary levels as a result. Night soil (human waste) was even a source of financial gain for urban citizens (Figure4-2-1).

Night soil remained a valuable organic resource throughout the Edo era. Night soil produced in the city of Edo, a megalopolis with an estimated population of 1 million, was transported to suburban farms and stored in special night soil reservoirs. These night soil reservoirs made use of the heat generated by fermentation to sanitize the night soil and produce good quality manure which was then used for suburban vegetable farming.

Toilets in the Edo era (called *koka* in Edo and *secchin* in the Kamigata region, including Kyoto and Osaka) were usually shared between several families in cities, where terrace houses called *nagaya* were common. Toilets were designed so that night soil could be easily collected from them.

To ensure an adequate supply of night soil for manure production, farmers in the suburbs of Edo contracted with the owners of samurai residences and *nagaya* houses in order to obtain the rights to collect night soil in exchange for money or goods. In the mid-Edo era, brokerage groups emerged to arrange night soil trading between urban citizens and farmers, boosting night soil use. The late Edo era even saw instances of farmers in Tokyo suburbs facing serious financial difficulties due to increasing night soil prices, and petitioning the shogunate government. This shows just how important the use of urban night soil for

fertilizer production was for farmers.

Large amounts of ash were also produced during the Edo period because people used wood for cooking. This ash was also used as fertilizer by local farmers. Urban citizens accumulated their domestic ash, which was then collected by ash brokers who sold it on to farmers for use as fertilizer. Although ash had many other uses, it is a good example of CRs that were circulated between cities and rural villages.



[Cooking stoves in Edo]

Source: Ehon Edo Murasaki (Illustrated Book 'Edo Violet')

Figure 4-2-2 Edo vegetable-producing districts



Column

Night soil prices

In the Edo era, a price was placed on night soil for trading purposes, and these prices varied depending on the person's class in society. Since the nitrogen and phosphorus contents were an essential determinant of fertilizer quality, it is believed that the value placed on night soil as a fertilizer was determined by the person's diet.

An analysis of night soil in the early Showa period (performed by Dr. Kerner, professor of the School of Agriculture and Forestry (now the Faculty of Agriculture, the University of Tokyo)) shows that the nitrogen and phosphoric acid contents of night soil differed between people with different jobs, such as farmers and soldiers.

Composition of night soil (%)

Contents	Class	Farmer	Tokyo citizen	Middle class gov. official	Military person
Water		95.4	95.4	94.5	94.6
Organic matter		3.03	3.18	3.89	4.07
Nitrogen		0.55	0.59	0.57	0.80
Phosphoric acid		0.12	0.13	0.15	0.30
Potassium		0.30	0.29	0.24	0.21
Soda		0.51	0.41	0.45	0.26
Lime		0.01	0.02	0.02	0.03
Magnesium		0.03	0.05	0.06	0.05
Sulfuric acid		0.07	0.04	0.05	0.07
Chlorine		0.70	0.55	0.61	0.51
Silicic acid & sand		0.04	0.10	0.11	0.04
Iron oxide & aluminite		0.03	0.02	0.06	0.06

Source: Kazue Kurokawa, "A Study of Soil Fertilizers since the Meiji Era in Japan"

Many local products and specialties emerged during the Edo era. Vegetables were cultivated in and around Edo as local specialties. Nerima radish, Komatsuna greens (produced around Komatsugawa) and Takinogawa burdocks are examples of "Edo vegetables" which satisfied the appetite of Edo people in terms of both quality and quantity. The ability to produce large amounts of this sort of local produce was a major benefit resulting from the effective use of night soil as fertilizer (Figure4-2-2).

C SMC blocks, according to regional characteristics

Efforts to create a SMC in accordance with regional characteristics were also observed in regions outside Edo. In the Kamigata region, including Osaka and Kyoto, night soil was also utilized and fostered the formation of intraregional material cycles well-suited to regional characteristics. For example, farmers in Settsu and Kawachi contracted with urban dwellers in Osaka in order to collect night soil for use as fertilizer. Another example of the utilization of night soil was found in the domain of Kaga (governed by the Maeda clan).

As shown by these selected cases, SMC blocks were established in many parts of Japan in a way that took full advantage of regional characteristics.

(2) Systems for appropriate waste disposal

A typical example of waste disposal in the Edo era, and one that may still be applicable to today's society, is the system by which government-authorized contractors collected waste and carried it to final disposal sites in order

to ensure its appropriate disposal. Establishing such a system for the correct disposal of waste is a necessary prerequisite to forming a SMC.

A Edo's waste disposal system

The initial waste disposal method used in Edo was the dumping of waste within the grounds of each residence or in empty lots, rivers and moats. Another dumpsite was a place called the "kaisho-chi," which was a vacant lot that each district of Edo had at its center and which was used partly as a dumpsite. However, dumping in these places had harmful effects, such as obstructing roads, waterways and firebreaks and bothering neighbors with bad odors, mosquitoes and flies.

In light of this unsatisfactory situation, the magistrate's



[Collection and transport in Edo]
Source: Yowatari Fuzoku Zue (Collected Genre Paintings of the World)

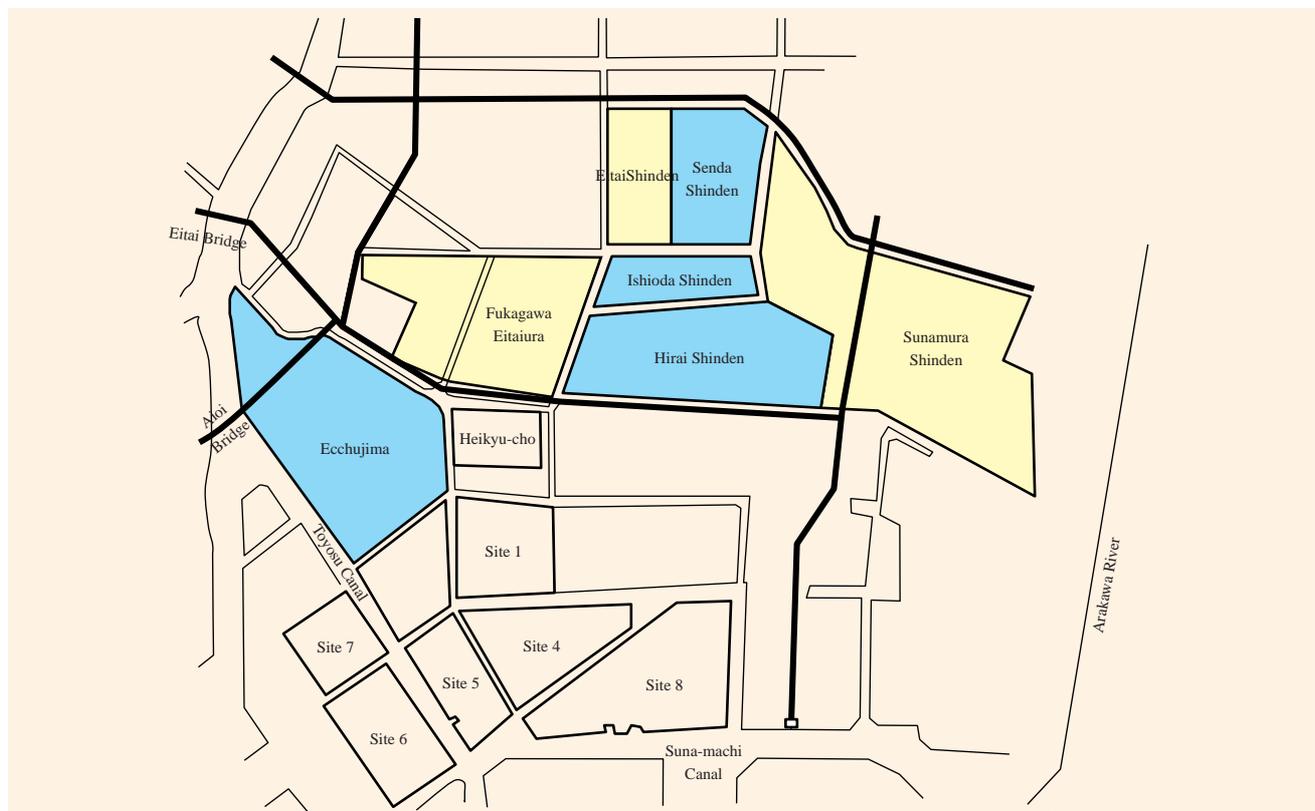
office issued an official town notice banning the dumping of waste in *kaisho-chi* in 1649 and designated a place named Fukagawa Eitaiura as a dumpsite in 1655. In 1662, disposal companies were designated, leading to the establishment of a mechanism in which wastes were gathered in designated places ready for disposal by these disposal companies. As a result of these efforts, the three key processes involved in waste management, namely collection, transport and disposal, were all successfully organized in Edo.

Policies such as these were adapted to people's real

lives at the time they were implemented. The town magistrate sometimes even consulted members of the public over the acceptability of an ordinance before issuing it. Edo citizens are said to have been very good at integrating government ordinances into their daily lives. This sort of "community wisdom" probably contributed to Edo's success in establishing an effective waste disposal system at such an early date.

There were also many ordinances banning the dumping of waste in non-designated areas. By about 1699, ordinances were in place that banned the dumping of waste in rivers

Figure 4-2-3 Major landfill sites in the Edo



Name	Current place name	Landfill period		Size of landfill	Notes
		Start	End		
Fukagawa Eitaiura	Around Tomioka, Fuyuki and Kiba, Koto Ward	Nov. 25, 1655	1724		Became the property of the shogunate in Dec. 1733.
Eitai Shinden (Eitaijima Shinden)	Around Ishijima and Sengoku, Koto Ward	Jun. 30, 1681	July 1730		
Sunamura Shinden	Around Minamisuna, Koto Ward	Jun. 30, 1681		495,900 m ²	
Senda Shinden (Juman-tsubo Tsukiji)	Around Senda, Sengoku and Kaihin, Koto Ward	1704	1711	330,600 m ²	Became the property of the shogunate in Dec. 1733.
Ishioda Shinden (Rokuman-tsubo Tsukiji)	Around Toyo, Koto Ward	1725		198,360 m ²	Same as above
Hirai Shinden	Around Toyo and Minamisuna, Koto Ward				
Fukagawa Ecchujima	Around Ecchujima, Botan and Furuishiba, Koto Ward	1730		495,900 m ²	

Source: Created by Ministry of the Environment, based on "Tokyo Seiso Jigyo Hyakunen Shi"

and required disposal companies to carry waste to disposal sites in an appropriate manner. Edo already had a responsible waste disposal mechanism that somewhat resembles today's measures used to prevent illegal dumping.

B Development of new agricultural land

The wastes carried to Eitaiura for final disposal were primarily household kitchen garbage and soil combined with the rubble removed from fire sites, all of which decomposed naturally in about a year. Since Eitaiura was originally a wetland, rubble and soil dumped there as waste eventually formed new land. The shogunate gov-

ernment, which was developing new farmland, found this reclaimed landfill site valuable and used it for agriculture.

Records show that, starting with the reclamation project in Fukagawa Eitaiura, the government reclaimed at least 10 sites, including Eitajima Shinden and Sunamura Shinden (49.5 hectares), during the Edo era.

By the late 18th century, over 380,000 tsubo (approximately 1,254,000 square meters) of land had been reclaimed (Figure4-2-3).

This section provides an overview of the history of Japan's responsible waste disposal activities, from the Meiji to Heisei eras(Figure4-2-4).

Figure 4-2-4 Japan's history of appropriate waste disposal

Legislation and policy formulation	Organizational change	Changes in systems and technology	Per capita GDP (in US dollars)	
			Year	GDP
1954 Public Cleansing Law			1960	477
1967 Basic Law for Environmental Pollution Control			1970	1,963
1970 Waste Management Law	1971 Environment Agency established	(1970) Improvement in hygiene	1980	9,170
1976 Amended Waste Management Law		(1980) Measures against hazardous substances	1985	11,381
1991 Amended Waste Management Law		(1990) Recycling	1990	24,815
1995 Containers and Packaging Recycling Law			1995	41,952
2000 Fundamental Law for Establishing a SMC Society	2001 Ministry of the Environment established (waste management administration transferred from Ministry of Health and Welfare)	(2000) 3Rs	2000	36,790
2003 1st Fundamental Plan for Establishing a SMC Society			2005	35,675
2008 2nd Fundamental Plan for Establishing a SMC Society				

Source: Ministry of the Environment.

Column “Kudaranai” and SMC blocks for local production for local consumption

Compared with high-grade sake transported from the Kamigata region, local sake in Edo was cheaper and therefore called “*kudaranai*” sake, literally meaning sake not brought down from Kamigata. Some believe that the expression “*kudaranai*” in the modern Japanese language, meaning worthless, is derived from this.

However, this word also demonstrates that products

from Kamigata had become easily available in Edo as a result of economic growth in areas around Edo. The fact that the word *kudaranai* and economic growth, two seemingly opposite elements, were actually more like two sides of the same coin suggests that things regarded as *kudaranai* today may have a more complex background than first thought and could actually be of some use.

Column

The Edo era and people's own efforts

People in the Edo era used their goods with care, in keeping with the spirit of *mottainai*. This is something that modern society can use as a guide in promoting new initiatives to establish a SMC. For example, as many as 1,000 organizations were engaged in recycling in the city of Edo and there were activities aimed at creating a SMC in all four classes of the population: warriors, farmers, artisans and tradesmen.

The expression “*shisso kenyaku*” (living a simple and frugal life), which also symbolizes the life of samurai, reflects the samurai’s lifestyle of not wasting things. *Keizai Zuihitsu* (An Essay on Economy), a book describing the rules of the samurai lifestyle in those days, introduces tips on how to practice *mottainai*: “When buying clothes, buy those with the same pattern for all family members so that they may later be used for patching each other’s clothes”; “Waste threads can be used as a wick”

One piece of literature that describes how samurai and their rulers fostered the *mottainai* spirit is *Seiryoki*, written by a medieval general in the Iyo-Uwajima region. This book explains how people in his fief made effective use of night soil.

Even castles were built in keeping with the *mottainai* spirit. The Hikone Castle used some recycled construction materials for the castle keep, turret and walls. Castles like this are well-preserved and still exist today.

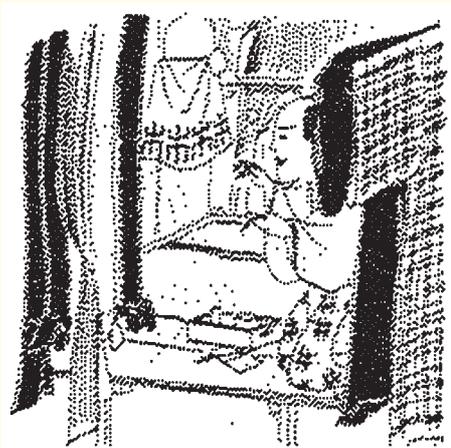
Since farmers in those times mostly cultivated rice, they used many common tools derived from rice cultivation. For example, rice straw left behind after harvest

(and still used as fertilizer and feed today), was a necessity in every aspect of life, including food, clothing and shelter. This straw had many uses. It was used to make clothing, such as woven hats, rain capes and zori sandals. It was used to make rice bags, fermentation packets for *natto* (fermented soybeans), and for livestock feed. It was also used for shelter, providing roofing and mats, as well as handicrafts to decorate the house for the New Year. Even when these household goods made from rice straw were no longer useful and were discarded, farmers still gathered them up and used them as fertilizer.

Artisans and tradesmen also worked in a way that saved resources.

The industrial products in the Edo era were all made manually by artisans. This manufacturing process, although requiring a great deal of time and labor, minimized the wastage of resources. For example, in the color plate-making and printing processes used to create *nishikie* colored woodprints, the surface of each used wood-block was shaved flat so that it could be reused. Artisans making metal products used iron scrap as a raw material because, in those days, the process of refining metals from ores required advanced technology and much energy.

Many tradesmen in the Edo era were engaged in businesses corresponding to today’s reuse and repair industries. For example, as “artisan-tradesmen,” they ran shops to repair broken bowls and other kinds of china (by gluing the pieces back together), pans and pots, wooden tubs and barrels (by rebinding them with



[Used clothes store]

Source: Edo Shokunin Uta-awase (Edo Artisan Poetry Contest)



[Waraji sandals dumped at the roadside]

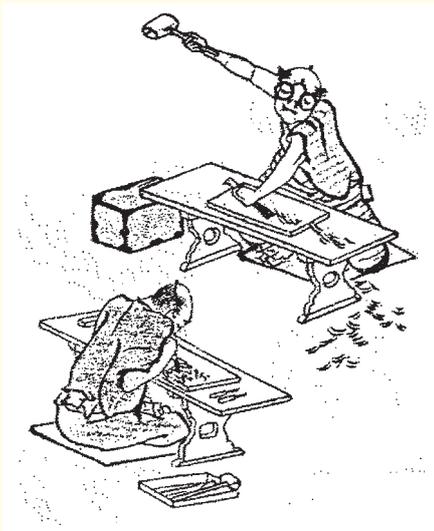
Source: Edo Meisho Zue (An Illustrated Book of the Sights of Edo)

new hoops), umbrellas and paper lanterns (by re-covering them). In addition, most kimonos, shoes and other sundry items were also reused. Tradesmen such as these are believed to have gone from door to door looking for business and are thought to have played an important role in supporting Edo's SMC. *Furoshiki*, the cloth wrappers that these peddlers used for carrying goods, have found new roles in today's modern Japan and are commonly used in many different ways.

Other tradesmen specialized in purchasing used metal products. They bought every kind of iron product, including old kitchen knives and pans that were no longer useful, and other metal products made of copper, brass and so forth in order to recycle them as raw materials. Ash from cooking stoves was collected by "ash men" for use as potash fertilizer by farmers (see Section 1. (1). B) as well as for papermaking, dyeing and many other useful purposes. Haiya Joeki, a wealthy merchant and a well-known man of culture in the Edo era (and the person on whom the leading character in the novel *Koshoku Ichidai Otoko*, written by Ihara Saikaku is thought to be based), was engaged in the ash recycling business. "Haiya," which literally means "the ash store," was his popular name. In the Edo era, ash from cooking stoves was collected in order to produce fertilizer or for use in indigo dyeing, sake brewing and papermaking. This shows that recycling activities had developed much momentum in these fields.

The book rental business also boomed during this period. Records from 1808 indicate that book rental shops formed regional groups (*kumi* or *gumi*) and that Edo had 12 such groups, including Nihonbashi Minami-gumi, Honmachi-gumi, and Kanda-gumi, consisting of approximately 650 members in total. Osaka also had about 300 people running book rental shops. A document titled *Edo Hanjoki* (A Sketch of Edo's Prosperity), written in the 1830s, states that there were 800 book rental shops in Edo, indicating the popularity of this business. A typical shop had a clientele of 170-180 households and Edo, alone, is assumed to have had as many as 100,000 readers of rented books.

Some other examples of cooperation and collaboration are found in the *nagaya* terrace houses in Edo, which, although small in size, were the focus of ordinary people's daily lives. For instance, each *nagaya* building had a shared well (*ido*), which was a key area for the residents. As represented by the word "*idobata*" (well-side), the residents gathered around the well to carry out kitchen chores. *Nagaya* also had a shared dumpsite and shared toilets (mentioned earlier) that were jointly maintained by the residents. Another example, this time in the field of child education, is that textbooks for the students of *terakoya* private elementary schools were shared among siblings and relatives, with some books used for over 100 years as they were passed on from one child to the next.



[Edo artisans]

Source: Hokusai Manga (Sketches by Hokusai)



[Edo artisans]

Source: Hokusai Manga (Sketches by Hokusai)

Section 2

Japan's history of responsible disposal of waste, from the Meiji to Heisei eras

(1) From the Meiji to early Showa eras

As Japan entered the Meiji era, with large-scale industries and urban areas starting to develop, the government clarified the methods of waste disposal to be used. Although waste disposal during this period was much the same as that in the Edo era, the *mottainai*-based lifestyle gradually changed as Western cultures were imported. People began throwing away goods that had once been effectively reused or recycled, resulting in an increase in both waste quality and quantity. It was about this time that the government began promoting the construction of large-scale waste disposal sites.

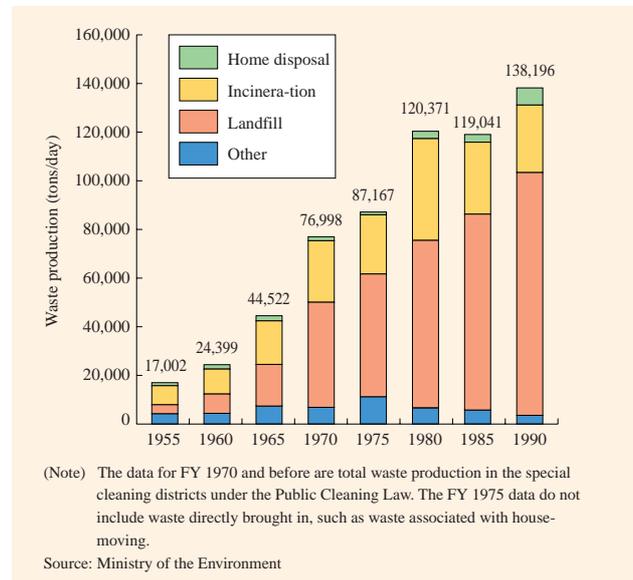
Also, as Japan's exchange with foreign countries increased, infectious diseases such as cholera and the plague were brought into Japan from overseas. The plague epidemic at the end of 1887 prompted the country to address the issue of waste and night soil disposal from the viewpoint of public hygiene. Consequently, the Unsanitary Substance Cleaning Law was instituted in 1900 in order to assign responsibility for waste disposal to municipal governments. In accordance with this law, the Tokyo City Government started collecting waste generated in central Tokyo. Records show that the daily amount of waste produced in Tokyo was approximately 800 tons, which translates into a per capita amount of approximately 290 grams, given that the population at that time was about 2.75 million.

(2) The Post-World War II period (before the period of high economic growth)

After World War II, farmers stopped using night soil as fertilizer because of the widespread availability of chemical fertilizer and because of the major changes in farm villages triggered by the process of agrarian reform. With the loss of the traditional disposal methods, night soil disposal posed a problem. Waste disposal became another serious problem as the Japanese economy entered the postwar recovery period, accelerating urban development. In those times, waste and night soil were dumped in the ocean or in landfills. Many landfill sites were unsanitary and bred large numbers of mosquitoes and flies (Figures 4-2-5).

Japan instituted the Public Cleansing Law in 1954. With the stipulated aim of improving public hygiene, this law was intended to enhance the waste disposal system by

Figure 4-2-5 Trends in waste disposal methods



making the municipal governments responsible for providing sanitation services and defining disposal zones through the establishment of a special sanitation zone system. In other words, following on from the concept of the Unsanitary Substance Cleaning Law, this new law defined waste and night soil as “unsanitary substances” and sought to dispose of them for public hygiene reasons so that a sanitary and comfortable living environment could be maintained.

In the Showa 30s (1955-1964), the production of chemical fertilizer increased as the economy grew. The widespread availability of chemical fertilizer throughout Japan led to falling demand for night soil on farms, forcing municipal governments in urban areas to address the problem of developing new waste and night soil disposal technologies. This was a time of great difficulty for the municipal administration for waste management because major changes in both the quantity and quality of waste produced during this period of rapid economic growth distorted the traditional frameworks that had previously been used for waste disposal.

In 1963, the government set up the First Five-Year Plan for Development of Living Environment Facilities, presenting the principles of its new urban waste disposal policy involving incineration, with residues disposed of in landfills. This prompted municipal governments in urban areas to construct incinerators. By defining incineration and residue landfill as the basic method for urban waste

disposal, the government aimed to both stabilize waste in a sanitary manner and reduce the volume of waste.

(3) The post-high economic growth period

As its economy grew, Japan faced problems such as increases in the amounts of waste generated by business activities and the amount of water pollution caused by

illegally dumped waste oil. During the so-called Pollution Diet session in 1970, the Public Cleansing Law was revised and renamed the Waste Management and Public Cleansing Law (Waste Management Law). This law defined the differences between municipal solid waste and industrial waste and, while holding municipal governments responsible for the disposal of municipal solid

Column

The history of composting

Since ancient times, Japanese farmers had been using waste as fertilizer, either incorporating kitchen garbage into the soil through plowing, for example, or distributing incineration ash over the fields. Even in the post-war era, urban waste was still used as fertilizer in rural farming villages until the Showa 30s (1955-1964) because only small amounts of plastic and metal were included in the waste in those days.

However, as more rapid changes occurred, such as the outgrowth of cities, the widespread use of chemical fertilizers, and the aging and exhaustion of farming villages, urban waste management reached a major turning point.

In Japan, a mountainous country with little spare land for landfill use and a climate often characterized by high temperature and high humidity, incineration became more common in the Showa 40s (1965-1974) for the sake of sanitation and to reduce the volume of waste. There was also a move by municipal governments towards the machine composting of kitchen garbage (a process also known as fast composting) so that the compost produced could again be used by rural farmers, as before. Many such composting facilities were built and operated by municipal governments in the Showa 40s to 50s (1965-1984).

However, composting projects involving urban waste, especially household waste, encountered several problems, as described below. As a result, no users could be found for the compost produced and it had to be eventually disposed of in landfills, forcing municipal governments to withdraw from those projects.

(i) Foreign substances

As living standards rapidly improved in the Showa 30s to 40s (1955-1974), consumers started to buy a wider variety of goods. This resulted in the inclusion of greater amounts of foreign substances in waste, such as glass from glass bottles, metals from cans, and plastics from containers and other sundry items. Since the idea of sorting wastes was not common in those days, com-

post made from waste inevitably contained foreign substances. Farmers noticed that a field fertilized with compost made from such waste glittered in the sunlight. As a result, farmers began to avoid using compost made from waste.

(ii) Odors

Since Japan has a hot, humid climate, kitchen garbage easily goes rotten. For this reason, composting requires that appropriate measures be taken to minimize odors. Since insufficient measures to control odors were taken at composting facilities during this era, local people often regarded these facilities as an annoyance.

(iii) Farmers' labor

The Showa 30s to 40s (1955-1974) was a period in which young workers moved from rural to urban areas, leaving behind an aging population of farmers. Although the farmers knew that organic fertilizer was needed for sustainable agriculture, they found it increasingly difficult to apply organic fertilizer because of the heavy workload required. Older farmers preferred to use chemical fertilizer because it was then easier to distribute only those substances actually needed.

There has been little promotion of composting since then, except by certain municipalities in rural farming regions, but composting again began attracting attention in recent years as a means of biomass use. In 2000, the Food Waste Recycling Law was instituted and recycling targets were set. In 2007, this law was amended, mainly to define exceptions in those cases where "a recycling loop" is created by all parties concerned. Supported by these frameworks, new efforts towards composting have now been launched in many regions. While solving the problems described in (i) and (ii), above, these projects are also attempting to address the problem described in (iii) by establishing a face-to-face relationship with farmers in order to encourage collaboration.

waste, as before, assigned the responsibility for the disposal of industrial waste to waste-generating businesses, based on the Polluter Pays Principle.

With respect to the disposal of hazardous industrial waste, particularly strict standards were imposed on the final disposal of sludge and slag containing mercury, cadmium and other harmful substances following the entry into effect of the Waste Management Law in 1971, aimed at safeguarding people's health.

Disposal facilities were also enhanced, following the institution of the Waste Management Law. On the other hand, negative effects of economic growth surfaced in connection with various waste disposal issues. One of these was the so-called Tokyo Waste War, a waste disposal dispute that started in 1971 between a municipal government and local residents over waste disposal. This became an issue of serious public concern. In those days, since the final disposal site within metropolitan Tokyo only had a limited incineration capacity, some domestic kitchen garbage was carried to a final disposal site in Koto Ward. Meanwhile, while Sugunami Ward had a plan to build new incineration facilities in order to reduce the volume of waste, it could not implement this plan because of community objections against the construction project. The Sugunami Ward Government had no other choice but to continue to carry waste to the final disposal site in Koto Ward. The Koto Ward Government, which regarded this act as forcing it to accept unwanted waste, began refusing

to accept waste from Sugunami Ward and this issue then developed into a serious public dispute. It is safe to say that this incident was the very first formative experience from which Japan learned valuable lessons on how to select a site for waste disposal facilities and how to cope with local residents opposing the project.

After overcoming the first and second oil crises, Japan achieved a level of economic growth driven by many technological innovations, leading to the production and consumption of a wide variety of products. This also brought about changes in the composition of urban waste and created concerns over the emission of hydrogen chloride and other hazardous substances from incinerators, an issue that attracted attention as an emerging environmental problem. This was the starting point for Japan's efforts to ensure that waste incineration facilities had adequate environmental conservation capability, including measures against dioxins. To address the problem of night soil disposal, an advanced system for sanitary night soil disposal was established for traditional Japanese vault toilets, while sewage systems and Johkasoh were made widely available in order to meet the needs of flush toilets. In particular, as a result of technological advances, new Johkasoh were developed which were small enough to be installed in homes yet still had the same capability for high-quality treatment as public sewage systems. These tanks are now widely used.

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Introduction of sorted waste collection (Hiroshima City)

In the postwar high economic growth period, Hiroshima City experienced a sudden increase in waste generation, as did many other cities throughout Japan. In Hiroshima City, kitchen garbage, categorized as "Hiroshima garbage", was once used for fertilizing farmland in islands and other rural areas of the city. However, demand fell as chemical fertilizers came into general use. The existing waste disposal system was abolished in 1960. With no other place to go, most of the waste in the city was disposed of in landfills in the Showa 30s to 40s (1955-1974), but the city government increasingly found it more and more difficult to secure enough landfill sites. At Hesaka Junior High School, which was built on a former landfill site, there was even an incident in which methane erupted from the school yard.

In response, the Hiroshima City Government declared a state of waste disposal emergency in 1975

and urged the public to consider the waste disposal issue as their own problem. In an effort to reduce waste generation, in the following year (1976) the city introduced the sorted collection of waste for the first time in Japan. In this collection system, everyone was required to separate their own garbage into five categories: (i) combustible waste, (ii) non-combustible waste, (iii) recyclable waste, (iv) large-sized waste, and (v) hazardous waste. Although people were confused at the beginning, the new collection system gradually became established and has since come to be widely known throughout Japan as "the Hiroshima system". This has now become a landmark in the history of waste disposal and a pioneering example demonstrating that even a big city like Hiroshima can operate a sorted waste collection system by gaining the understanding and support of its citizens.

(4) The Heisei period (from 1989 to the present)

A Amendment of the Waste Management Law and related efforts

The Japanese economy continued to grow, even after the high-growth period, creating a society with a high degree of material affluence. On the other hand, the country underwent social changes that led to the increased adoption of a lifestyle based on mass consumption and the throwaway principle. These changes resulted in an increase in the amount and the diversity of waste and made it harder to dispose waste appropriately. These developments have led to several phenomena and incidents such as municipal solid waste in the Kanto region being carried to the distant Tohoku region for disposal because of lack of incinerating facilities and the difficulty of securing final disposal sites; a large amount of industrial waste, primarily shredder dust, being illegally dumped in Teshima, Kagawa Prefecture; and a large amount of industrial waste, primarily waste oil, being illegally dumped in an abandoned mine in Fukushima Prefecture.

Since the beginning of the Heisei era, Japan has improved its framework for responsible waste disposal by amending the Waste Management Law and introducing a

range of other initiatives to cope with a situation in which the waste disposal issue needs to be addressed not only as an environmental conservation problem but also as the more fundamental problem of how to deal with the wastes that are produced each and every day.

In order to become a member of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Japan amended the Waste Management Law in 1992, in addition to enacting the Law for the Control of Export, Import and Others of Specified Hazardous Wastes and Other Wastes. This amended law stipulated that, in principle, all wastes should be disposed of within Japan, and imposed the necessary regulations on waste imports and exports (e.g., the introduction of an export confirmation system and an import permit system). Rules on the international movement of wastes were also established pursuant to this law.

There were other developments concerning measures to be taken against domestic hazardous substances as well. One of them concerned batteries containing mercury. In 1983, the *Kurashi no Techo* (A Note of the Life) magazine pointed out the risk of environmental pollution from the mercury contained in waste batteries. In the same year, the Tokyo Metropolitan Research Institute for

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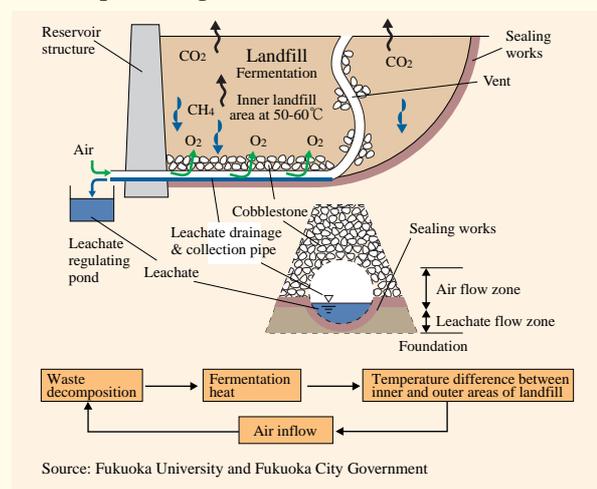
The semi-aerobic landfill structure (the Fukuoka method)

One of the landfill systems now used for final disposal sites is the semi-aerobic landfill structure (the Fukuoka method), which was first proposed in the second half of the Showa 40s (1970-1974) by Fukuoka University and the Fukuoka City Government. Because of its ease of construction and maintenance and its ability to quickly stabilize waste and improve the quality of the leachate, this landfill structure was adopted by the former Ministry of Welfare as the national standard and has been used by many municipal governments when constructing their landfill sites.

This structure uses large-diameter leachate collection and drainage pipes installed at the bottom of the landfill site in order to drain out the leachate and allow outside air to naturally flow into the inner landfill through these pipes via convection induced by the heat of waste decomposition. This design increases the decomposition capacity of the aerobic bacteria present and thereby improves the quality of the leachate. The ease of construction and maintenance is another advantage of this method, and there is no need to mechanically pump air into the landfill.

Since the semi-aerobic landfill structure allows cheaper construction and faster waste stabilization than the anaerobic landfill system promoted in the West, and since it can even restrict methane generation, it has recently attracted the attention of many developing countries as a sustainable technology and a suitable technology with which to help prevent global warming.

Conceptual image of the semi-aerobic landfill structure



Environmental Protection announced that waste batteries could cause environmental pollution in the process of incineration and landfill. This issue became a major public concern.

In order to improve the management of the mercury contained in batteries, the government subsequently promoted source-oriented measures and recycling in cooperation with all parties concerned.

One of these source-oriented measures was stopping the use of mercury for manganese batteries (April 1991) and alkaline batteries (January 1992) through joint efforts with the Battery Association of Japan. This has enabled significant reductions to be made in the amount of mercury used in batteries sold in Japan.

Japan has also established a collection and recycling system to prevent the mercury contained in household batteries, as well as the mercury in waste fluorescent lamps, from being released into the environment. Many municipal governments now participate in the Liaison

Meeting for the Amalgamated Treatment of Waste Batteries, etc., organized by the Japan Waste Management Association, and jointly collect waste batteries and fluorescent bulbs (by means of sorted collection) and then dispose of them (through mercury recovery and recycling).

As these examples show, one effective measure to minimize the release of the hazardous substances contained in these products is to establish a system for environmentally responsible recycling, in conjunction with other source-oriented approaches. It is also essential that countries with no appropriate disposal facilities at hand consider a wide-area recycling system in which hazardous wastes can be exported under the Basel Convention and then recycled overseas. (For example, Japan imports mercury-containing wastes from Thailand, the Philippines and other countries and recycles them.)

B Introduction of recycling laws

As shown above, the government set out specific poli-

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The hexavalent chromium problem and the amendment of the Waste Management Law

The Waste Management Law, enacted in 1970, provided a clear definition of industrial waste and positioned it within the legal framework. However, because of the lack of an appropriate mechanism to accurately keep track of activities concerning industrial waste disposal, the monitoring and directions provided by the authorities were incomplete, leading to problems such as the frequent occurrence of illegal dumping and other violations, along with failures by the waste-generating businesses in exercising their responsibility. In addition, as the shortage of final disposal sites worsened, a growing number of companies simply piled up their waste out in the open, within their factory premises.

In the summer of 1975, an inappropriate disposal site for slag containing hexavalent chromium was found at a Tokyo factory that manufactured hexavalent chromium compounds, such as bichromate of soda. Environmental pollution was also discovered in the area around this site, along with potential health hazards to local residents. This incident developed into an issue of major public concern since pollution from hexavalent chromium slag was identified in many other regions following this initial discovery.

In light of public concern over waste disposal problems, the government amended the Waste Management

Law in 1976. This amendment was mainly aimed at tightening regulation and supervision in order to ensure responsible final disposal.

Specifically, these amendments included redefining final disposal sites as waste disposal facilities, instituting a registration system, and introducing prior assessments based on technical standards. To enforce appropriate outsourcing practices concerning waste disposal, the amended law set up standards for the outsourcing of disposal work and banned companies from subcontracting any disposal work they have undertaken to another company. To keep track of industrial waste disposal activities and provide appropriate supervision and instructions, the amended law obliged enterprises and disposal companies to create and maintain disposal records, and added provisions on restoration orders to be issued in the event of any incident harmful to the conservation of the living environment.

This hexavalent chromium problem awakened Japan to the need to take environmental effects into consideration when addressing the final disposal of any waste, including industrial waste. It was also the starting point for efforts that have since led to Japan's success in reducing the amount of waste disposed of in final landfill sites by about 70% since the 1990s.

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Past initiatives

Prompted by the oil crises in the 1970s, pioneering initiatives such as recycling were started in many parts of Japan.

(1) Urban-Rural Environmental Connections Plan (URECs Plan)

In 1980, Toyohashi City started mandating its residents to separate their household garbage into five categories in order to facilitate the effective use of waste. In the same year, the following five plants were built on a single site to enable the integrated treatment of waste: (i) a waste incineration plant, (ii) a composting plant, (iii) a sorting and crushing plant, (iv) a chicken feces drying plant, and (v) a night soil disposal plant. The heat generated from the incineration of combustible waste and residues from the composting plant was used for heating in an adjacent greenhouse complex and for generating electricity for the internal facilities. The overall plan also involved the production of compost from combustible waste and night soil disposal sludge for use by local farmers to fertilize their farmland.

However, the usage of plastic by local residents increased year after year, eventually making it impossible to produce good-quality compost from combustible waste. Although Toyohashi was therefore unable to accomplish the plan's original goals, its attempt to construct a mechanism in which urban waste is used on rural farms while the food produced in rural farms is supplied to urban communities, in return, had something in common with today's concept of constructing a recycling loop under the Food Waste Recycling Law, and can be regarded as a pioneering attempt to establish SMC blocks.

(2) Stardust 80 Plan

In 1973-1980, to cope with the problems of urban waste disposal and the exhaustion of natural resources, the then Agency of Industrial Science and Technology, part of the Ministry of International Trade and Industry, working in cooperation with the Yokohama City Government, constructed and operated a research/demonstration plant for a resource recycling system centered on material recovery. In this system,

mixed waste was divided into three groups: (i) garbage, glass and rubble, (ii) paper, and (iii) plastic and metal, so that resources could be recovered from each group by using (i) fast composting equipment, (ii) purifying and pulping equipment, and (iii) thermal decomposition and gasification equipment. However, limitations in the capability of the machine sorting stage for mixed waste prevented the production of good-quality compost and pulp and increased costs. Although the system did not, therefore, come into general use, the project raised awareness of the importance of sorting by waste generators and contributed to the improvement of more appropriate technologies, including those for waste gasification.

(3) Vacuum transport system for waste

Garbage is usually collected by a sanitation truck, but this method involves problems such as foul odors and pests released from the exposed garbage, and the mess made on the streets. To counter such problems and to meet the growing needs of the public for a better living environment and amenities, some municipalities constructed a system that combined waste incineration facilities and vacuum transport pipelines for the waste.

This system provided benefits such as (i) allowing citizens to throw away garbage whenever they liked, (ii) preventing odors and therefore improving sanitation, (iii) not marring the street appearance, and (iv) requiring less labor for waste collection and transport. However, it also had disadvantages such as the need for huge initial investments, long transport distance, a lack of flexibility, and the fact that it made people less motivated to reduce waste because of the "invisibility" of the waste. This attempt served as an unsuccessful example from which the 21st century, "the century of the environment," can learn a great deal on how to plan and implement more eco-friendly approaches such as reduced waste generation, sorted collection and recycling.

Although the above projects all had to be closed down without delivering as good a result as initially expected, Japan has learned many lessons from them and has now developed new capabilities to convert its society into a SMC one.

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The PCB waste problem

Polychlorinated biphenyls (PCBs) are industrially synthesized compounds. Because they are resistant to heat, have high electrical insulation properties, and are chemically stable, they are often used as insulating oil in high-tension transformers, high-tension capacitors and voltage regulators, as well as the heating medium for heat exchangers. However, the Kanemi Oil Poisoning Incident in 1968 became a turning point, after which the toxicity of PCBs became widely recognized. In 1972, administrative guidance was given to PCB manufacturers to stop producing PCBs and collect them instead. In addition, the Law Concerning the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc., was enacted in 1974, principally to prohibit PCBs from being manufactured, imported and used from that year onward. Later, in 1976, standards for disposal by high-temperature incineration were introduced. However, some PCB wastes have been held in storage by domestic companies without being disposed of for over 30 years because of the opposition from neighbors, except for about 5,500 tons of liquid PCBs that were disposed of by high-tempera-

ture incineration at the Takasago plant of Kanegafuchi Kagaku Kogyo K.K. from 1987 to 1989. There was some concern that the negative legacy of these PCB wastes might cause environmental pollution in the event of loss or leakage during long-term storage.

In response, the government instituted the Law Concerning Special Measures against PCB Waste (PCB Special Measures Law) in July 2001 with the aim of ensuring and fostering the reliable and responsible disposal of the PCB wastes stored in Japan for long periods. The law stipulated the necessary regulations on PCB waste storage and disposal. In line with this law, the government took the initiative in constructing wide-area PCB waste disposal facilities to serve as key disposal centers, assisted by the Japan Environmental Safety Corporation (formerly Japan Environment Corporation), while the national and prefectural governments formed PCB waste disposal funds to reduce the financial burdens associated with disposal by small- and medium-sized enterprises. Through the use of these measures, Japan is striving to fundamentally eliminate the negative legacy posed by PCBs.

cies to address increasingly complex and serious waste disposal problems. However, the government also realized that it needed to address the situation in which a significant proportion of the ever-increasing amount of recyclable resources was being disposed of without being recycled. To meet this need, the Law for the Promotion of Utilization of Recycled Resources was enacted in 1991 to oblige manufacturers to promote the effective utilization of recyclable resources. On the other hand, municipal governments, especially big city governments, found it more and more difficult to secure sufficient final and other disposal facilities for solid waste, leading to the problem of “reverse-charging,” or paying fees in order to hand over certain wastes (as in the glass bottle recycling system, for example, which had previously worked well). This raised the need for further recycling of containers and packaging, which accounted for a large part of all municipal solid waste. To meet this need, the Containers and Packaging Recycling Law was enacted in 1995. This law mandated manufacturers to engage in recycling activities and obliged municipal governments to introduce well-planned efforts to foster sorted collection. This law, which can be regarded as an example of early adoption of

the concept now known as extended producer responsibility, has helped the development of full-fledged recycling systems by involving more members of the general public and attracting greater public attention.

In 1998, the Home Appliance Recycling Law was introduced, requiring home appliances to be disposed of by manufacturers, mainly by means of recycling. In 2000, the government also enacted the Construction Waste Recycling Law which obliges demolition companies that carry out demolition projects larger than the specified criteria to sort and recycle construction waste, and the Food Waste Recycling Law, which requires restaurant and distribution businesses to recycle food waste. To further enhance the legal framework for recycling, the End-of-life Vehicle Recycling Law was established in 2002, obliging automakers to collect and recycle shredder residues from end-of-life vehicles.

C The first year of the establishment of a SMC Society

Based on experience gained over the years, the government designated 2000 as the first year of the establishment of a SMC because this was the year when the Fundamental Law for Establishing a Sound Material-



[Open-air burning of waste in developing countries]
Source: Website of the Japan Industrial Waste Technology Center



Cycle Society (hereinafter referred to as “the Fundamental Law”), the Waste Management Law, the Law for the Promotion of Effective Utilities of Resources and a number of recycling laws were enacted or revised. This year, Japan took a large step toward establishing a SMC Society.

The Fundamental Law defines a SMC Society as one in which the consumption of natural resources is curbed and the burden on the environment is minimized, by means of:

- 1) Preventing products from becoming waste;
- 2) Promoting appropriate and cyclical use of CRs that have been generated; and
- 3) Ensuring that CRs which are not subject to cyclical use are disposed of appropriately.

In other words, a SMC Society is a sustainable development-oriented society in which the following concepts are adopted as the basic socioeconomic principles: socioeconomic activities and people’s lifestyles based on the 20th century model of mass-production, mass-consumption and mass-disposal are reviewed; resources are used efficiently; waste generation is minimized; unavoidable wastes are recycled as resources; and wastes for which no means of recycling can be found are responsibly disposed of.

D Suggestions to put Japan’s experience to good use

This chapter has described Japan’s path to a SMC by providing an overview of the systems used from the Edo era through to the present. Although Japan already had an established SMC Society in the Edo era, as it later opened itself to the world and tried to model the country upon Western nations, the Japanese way of thinking about goods and production styles changed. The country moved

towards a mass-production and mass-consumption society. A variety of products produced in and after the 1970s caused many waste disposal problems, but systems and technologies for the responsible disposal and effective use of wastes also developed gradually over the same period. Progress towards a SMC Society gained momentum through the amendment of the Waste Management Law and the establishment of recycling laws in the 1990s and, since 2000, Japan has been recognized as a world leader in forming a SMC Society.

Developing countries are now in the midst of economic growth just like that experienced by Japan during its period of high economic growth. The inappropriate disposal of waste is common in these countries, and this includes the open dumping of waste, often industrial waste, and the open-air burning of waste. Electrical and electronic appliances imported from overseas, nominally for the purpose of reusing and recycling them, are also often subject to inappropriate treatment, posing a threat to the local living environment.

With resource conservation programs in these rapidly developing cities still far from complete, developing countries are nowhere near being able to deal with issues of global concern, such as resource problems and global warming problems. Japan needs to help them by sharing its experience.

Japan’s accumulated experience must be of help in solving many of the problems these Asian countries are faced with. Bearing in mind the history of Japanese systems described in this chapter, Japan should expand its program of assistance to other countries, especially in Asia, and help promote the establishment of a SMC Society, worldwide.