



Tokyo Model (Overview)

Tokyo’s history and strength that have overcome the municipal waste problems

2018



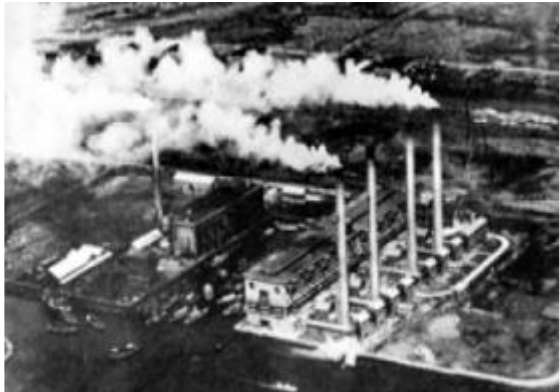


Historical background of the Tokyo Model



1910s
Open-air incineration

In Japan, the first law to control waste, was called the Feculence Cleansing Act, the incineration of waste was recommended for reasons of hygiene; however, the construction of incineration plant was delayed due to opposition movements, resulting in many hygienic issues, including emergence of flies and mosquitoes from the waste that was incinerated in open-air.



1929
Fukagawa Refuse Processing
Plant completed

Started to incinerate waste in fixed batches; however, due to waste separation inadequacies and excessive incineration, air pollution resulted from ash and soot.



1970s
Large-sized waste
disposed at landfills

Additional incineration plants were built during the 1960s and 70s; however, waste generation continued to grow beyond their processing capacity. Around this period, a war over waste between the local government and the residents occurred



1982
After 16 years from construction site announcement (the first generation) Sugunami Incineration Plant was completed.

What is “Tokyo Model” ?

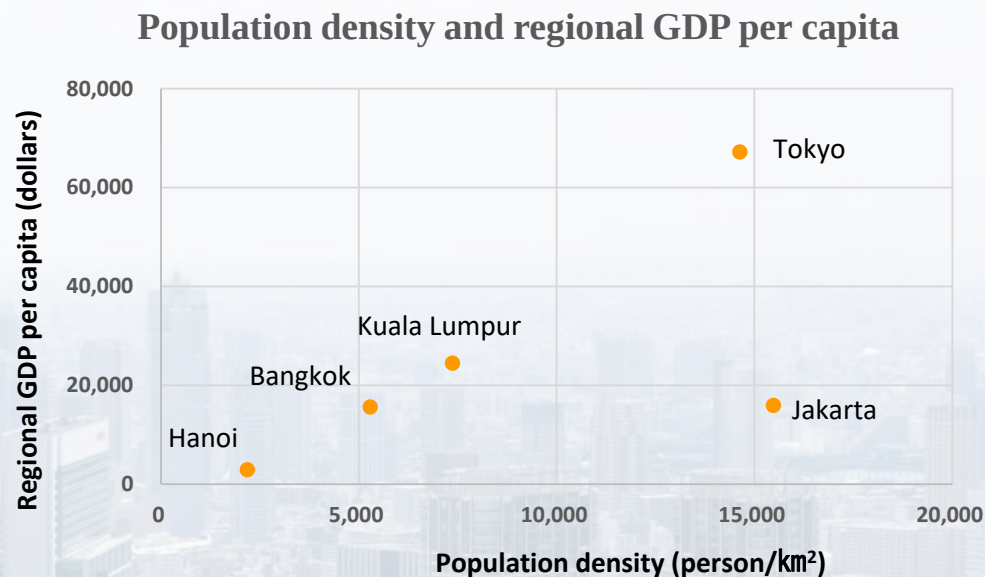
- The “23 Cities of Tokyo” refers to the 23 municipalities in the eastern region of Tokyo Metropolitan Area. It is the central area of Tokyo, in which the core functions of Japan’s politics, national administration, and economy are located.
- Tokyo Model is a systematic model of the municipal waste disposal system for Tokyo’s 23 Cities and of its strengths, prepared over the course of history overcoming many waste problems that had resulted from economic development and increased population density.
- Principal players in the municipal waste disposal system shown under the Tokyo Model are the 23 Cities of Tokyo, Clean Authority of TOKYO (hereinafter, CAT23), Tokyo Metropolitan Government (hereinafter, TMG), and our residents.



- 1. Introduction of TMG and 23 Cities of Tokyo**
- 2. History of waste treatment**
- 3. The strengths of the Tokyo Model**
- 4. International contribution utilizing Tokyo Model**

1. Introduction of TMG and 23 Cities of Tokyo

Population: Approx. 14M (2017)
 (9.3M in the 23 Cities)
 Area: 2,191 km² (23 Cities cover 627 km²)
 Scale of economy: 94.902 T Yen
 (TMG data, 2014)



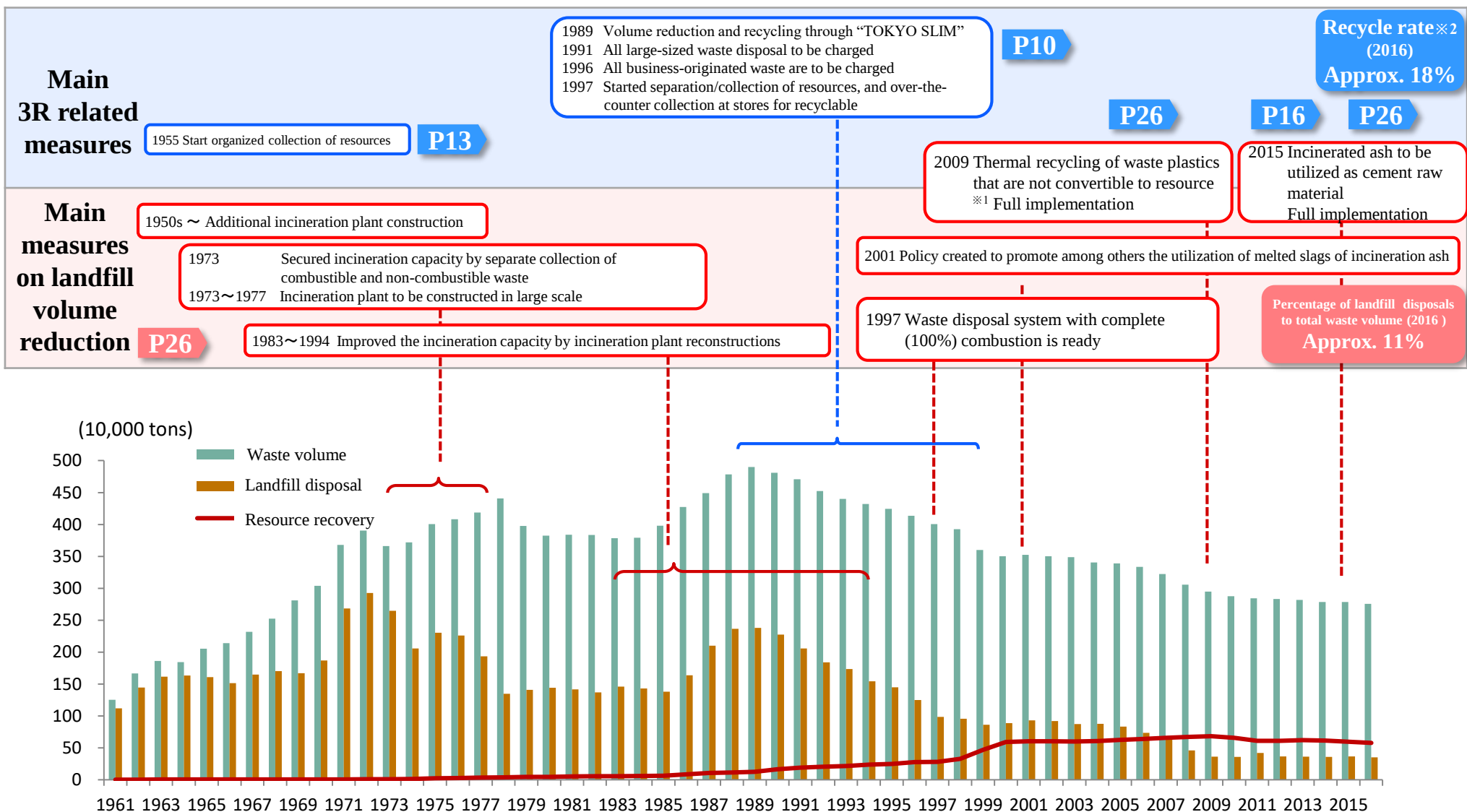
Rapid increase and growth in population and economic activities, not seen anywhere in the world created the uniqueness of the Tokyo Model

Source data for regional GDP per capita and population density		
	Population	Regional GDP
Tokyo	Tokyo 23 Cities, October 2014 (Tokyo Bureau of Statistics)	Metropolitan Tokyo, 2014 (Cabinet Office, total GDP of prefecture)
Jakarta	2016 (Statistik Indonesia 2017)	Same as to the left
Bangkok	2010 (Population and Housing Census)	2013 (Office of the National Economic and Social Development Board)
Kuala Lumpur	2016 (Department of Statistics Malaysia)	Same as to the left
Hanoi	2016 (General Statistics of Vietnam)	2016 (Hanoi Quarterly Knowledge Report by Colliers International Research)

Source: 1950-2017 National Census, Tokyo Statistical Data calculations (TMG2014), Cabinet Office Prefectural Economic Calculations (The calculation criteria for GDP was revised several times, and this criteria should not be related directly. Image of GDP trend is shown here.)

2. History of waste treatment

History of waste generation and landfill volume, and the measures on each



Source: “100 Years History of Waste Management in Tokyo Metropolis”, published in 2000 by Tokyo Environmental Public Service Corporation), Waste Disposal Management Annual Report (2016)

※1 To recover/utilize thermal energy generated from incineration

※2 Recycle rate = (resource waste volume + disposal process resource-conversion volume + community-based collection volume) / (government collection volume+ carried-in volume+ community-based collection volume)

2. History of waste treatment

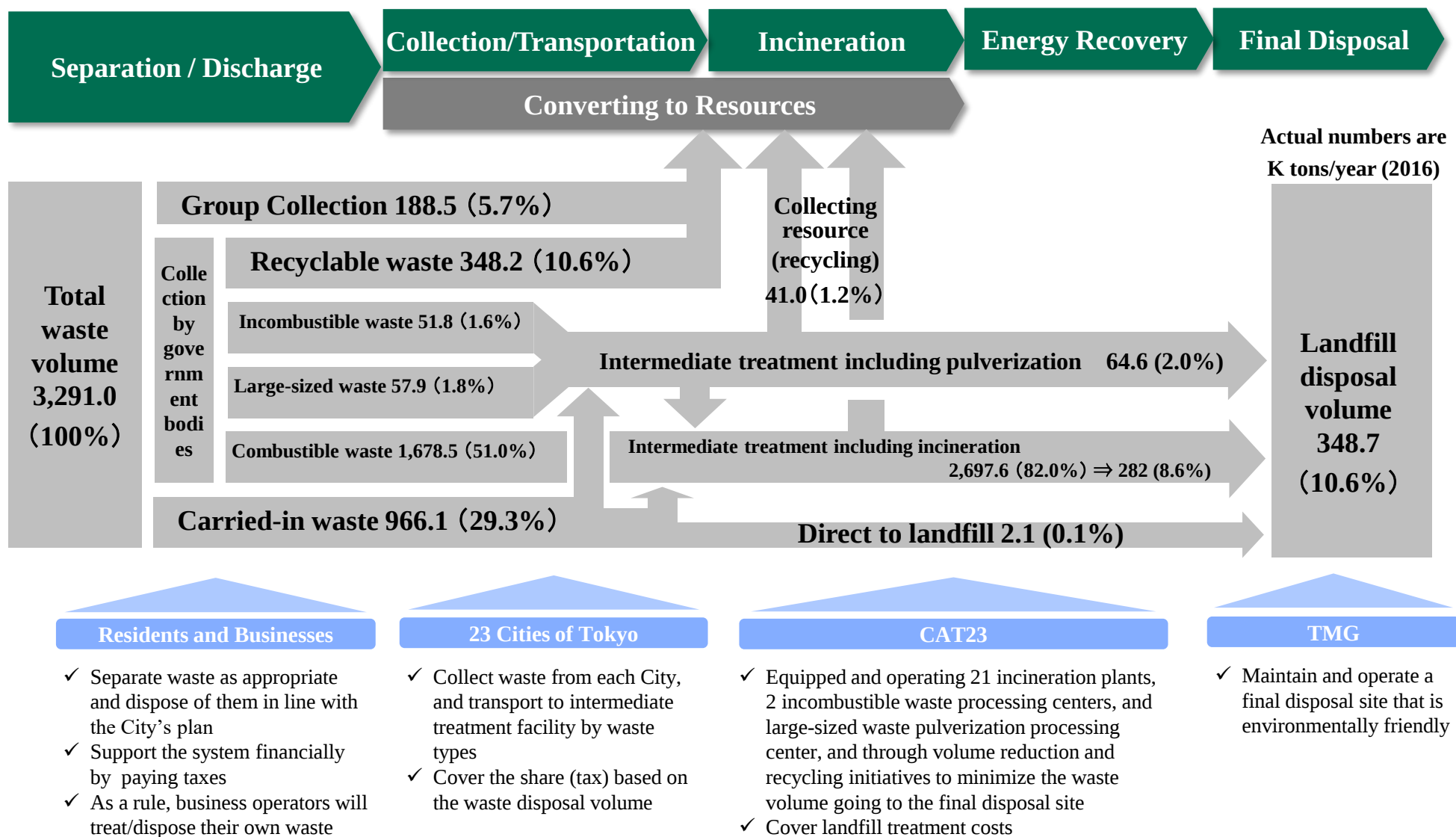
History of waste treatment and recycling in the 23 Cities of Tokyo

Stage	Issues	Action Taken
Early days of waste problems (1900-1955)	- Public health measures taken for dealing with epidemics of cholera and black plague throughout the world - Rapid increase in waste volume with urbanization	- Feculence Cleansing Act (1900) was promulgated, under which waste management became the responsibility of local governments, and local governments implemented the waste collection outsourcing system and supervised those vendors. - First ash and soot incineration site in Tokyo completed (Ohsaki) (1924) - City-run ash and soot treatment plant completed (Fukagawa) (1929) - Incineration plants began operation at 4 locations (1930)
Rapid economic growth, waste problems became apparent (1955-1973)	- Increasing necessity of fundamental waste measures due to drastic changes in the society and economic situations - Shortage of final disposal site due to mass production/mass disposal - Acceptance of waste containing high level of moisture to be incinerated - Tokyo Waste War (1971)	- TMG provisions and organizations were put in place after the enactment of the Cleaning Act (1954) - National government rolled out subsidy program to ready waste treatment facilities (1963) - Articles were amended under the legislation on incineration and treatment of waste (1970), and the importance of cooperation by residents and the duty of parties generating business waste were put into writing - Improved efficiency in waste collection and transportation - With developments in incineration technology and promotion of incineration disposal, 9 incineration plants were in operation (1973).
Stable growth period, dealt with environmental issues (1973-1985)	- Dealt with environmental issues - Increasing requirement for reuse of waste and converting it into resources	- Started full operation of the newest incineration plant equipped with facilities to prevent pollution - Started separation at source for combustible and incombustible waste in order to gain the required incineration capacity (1973) - Promoted recycling movements and group collection - Full dialog with the residents through briefings and council meetings - Waste incineration plant now operating at 13 sites (1985)
Significant increase in waste volume (1985-1990)	- Faster increase in waste volume - Diversification in waste types (creation of the PET bottle, etc.)	- Commencement of the TOKYO SLIM campaign, and a call was made to the public on reducing waste and recycling (1989) - Incineration plant now operating at 14 sites (1990) - Progress with waste volume reduction and recycling (3Rs) due to the amendment of Waste Management and Public Cleansing Act (1991)
Opening of 3R era (1990~present)	- Dealing with environmental issues (dioxins) - Promotion of a sound recycling-oriented society - Further landfill volume reduction	- Large-sized waste disposal to be charged (1991), and business generated waste disposal to be charged (1996) - New legislation was enacted to strongly promote recycling and reduce waste generation (1992) - Implemented reconstruction, upgrading, and modifying of the incineration plants to counter dioxins - Started collection of PET bottles and recyclable items at stores by local government bodies (1997) - Completed the current 21 incineration plant system (2001) - Promoted installation of gasification melting furnace and ash melting facilities (2002~2008) - Full implementation of thermal recycling of waste plastic that is not converted into resource (2009) - Full implementation of conversion of incinerated ash into cement (2015)

Sources: “White Paper on Biodiversity, Recycling Society, and Environment in Figures” (Ministry of Environment, 2011), “100 Years History of Waste Management in Tokyo Metropolis”, published in 2000 by Tokyo Environmental Public Service Corporation, and “Research Report on Feasibility of Waste Incineration Technology in Developing Nations and Analysis of Works by Japan and Many Advanced nations” (JICA, 2012)

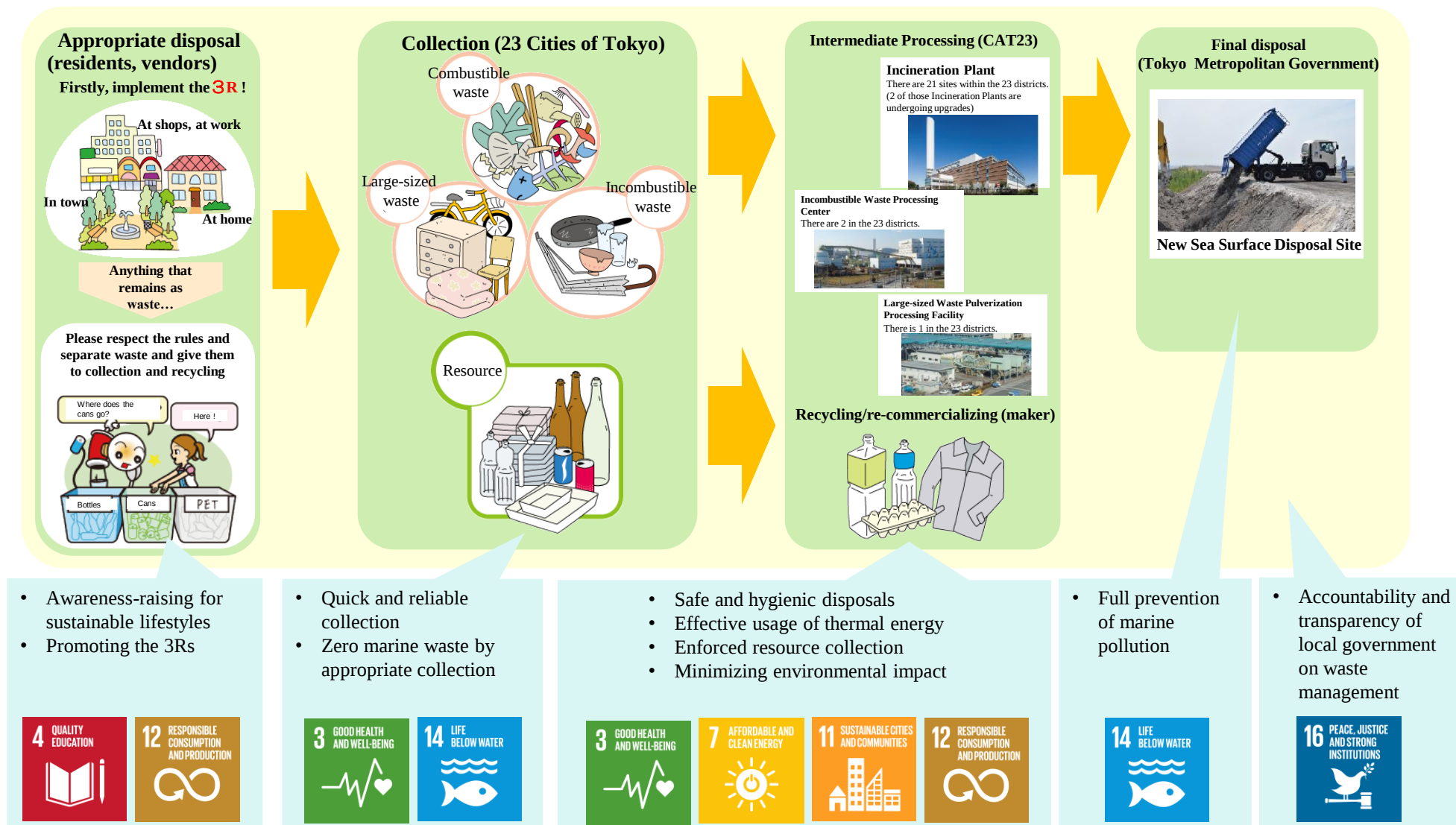
3. The strengths of the Tokyo Model

Recycling-oriented Waste Treatment System



3. The strengths of the Tokyo Model

Waste and resource flow diagrams for the 23 Cities of Tokyo: From SDGs※ standpoint



※ International targets between 2016 and 2030 under “Agenda 2030 for Sustainable Development” adopted at the UN Summit in September 2015

3. The strengths of the Tokyo Model

Separation / Discharge

Collection / Transportation

Incineration

Energy Recovery

Final Disposal

Recycling

Main measures on waste volume reduction and recycling based on the 3R concepts

Main measures on waste volume reduction and recycling taken since the end of Japanese bubble

1989

Started TOKYO SLIM Campaign

- ❑ Waste volume reduction and recycling were promoted through mainstream media
- ❑ “Tokyo Waste Meeting” was established participated by city residents, businesses, and local governments
- ❑ Onsite guidance for businesses to promote reutilization and reduction in generation of waste (Waste G-men)

Tokyo Waste Meeting which was held once a year from 1991 to 1998, gathered tens of thousands of participants each time, and this gathered the attention of society towards waste management

1991

Large-sized waste collection is to be charged

- ❑ Large-sized waste under 200 kg fee to be charged

Businesses now have to put out waste after placing a prepaid waste management fee sticker



1996

Started to charge all types of business related waste

- ❑ Business generated waste of less than 10 kg per day, is no longer free at approx. 560,000 businesses.

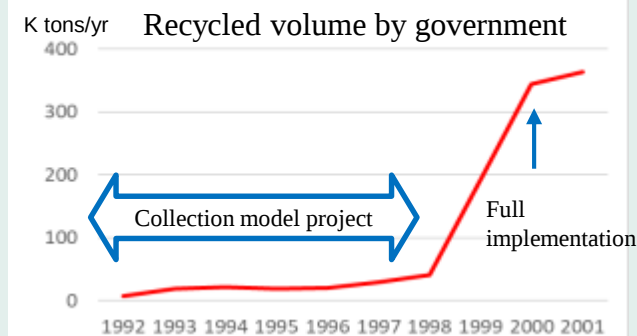
Tokyo Rules are implemented which state the division of roles and responsibilities of each participant

- ❑ Resource collection by local government once a week (Tokyo Rule I)
- ❑ Promoting self collection by manufacturers of containers and such (Tokyo Rule II)
- ❑ Collection at store fronts of rapidly popularized PET bottles (Tokyo Rule III)

2000

Full scale recycling project (used paper, bottles, cans)

- ❑ Combustible waste collection was reduced from 3 to 2 times a week, and, instead, a resource collection date was established (for used paper, bottles, cans) at once a week was added



3. The strengths of the Tokyo Model

Separation /
Discharge

Collection /
Transportation

Incineration

Energy Recovery

Final Disposal

Recycling

Full face-to-face communication and educating next generation's waste generators

Awareness raising for waste generators

**On
implementing
new waste
generation rules**

- Focus on face-to-face communication
 - Briefing at town halls and residential association meetings
 - Door-to-door legwork by waste management office staff
- Diverse awareness raising and education tools
 - Distribution of multilingual leaflets
 - Special issue on waste disposal in the City's public news media



In Suginami City, 83 briefings were held in a year on thermal recycling of waste plastic, and had dialogues with a total of about 3,500 residents

**Awareness
raising activities
for proper
waste
generation rules**

- Creating a system to fully inform residents
 - Established "Personal Guidance Team" at the local government side to provide guidance on waste
 - Established "Waste Reduction Promotions Staff" with volunteer residents.
 - Continuous PR activities (public relations publications, collection point bulletin boards, etc.)



Number of incineration plant tour participants

FY	Elementary and middle school students	Other	Total
2015	41,123	17,580	58,703
2016	41,901	19,153	61,054

Education for
the next generation

**Creating a
eco-friendly
mindset in
children**

- Provided education on waste management for the next generation waste generators
 - Receiving students at incineration plants (tours of on average about 100 students (elementary and middle school students alone) every day)
 - Teaching at local schools
 - Hold junior high school environment summits, and took up subjects on environment and energy issues

Have continued to educate and raise awareness over many years, and have been able create a mindset and habits within our residents.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION



Mobile app

Notification of waste collection dates by waste type

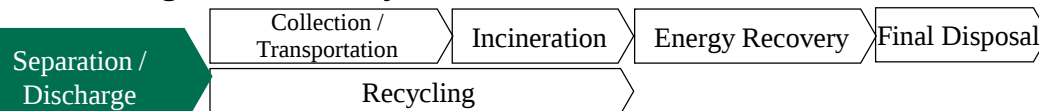
●●●●● docomo 3G 14:22 61%

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日	月	火	水	木	金	土
2017年11月						
			1	2	3	4
			📅	🔥		🌿
5	6	7	8	9	10	11
	🔥		📅	🔥		🌿
12	13	14	15	16	17	18
	🔥	🚫	📅	🔥		🌿
19	20	21	22	23	24	25
	🔥		📅	🔥		🌿
26	27	28	29	30		
	🔥	🚫	📅	🔥		

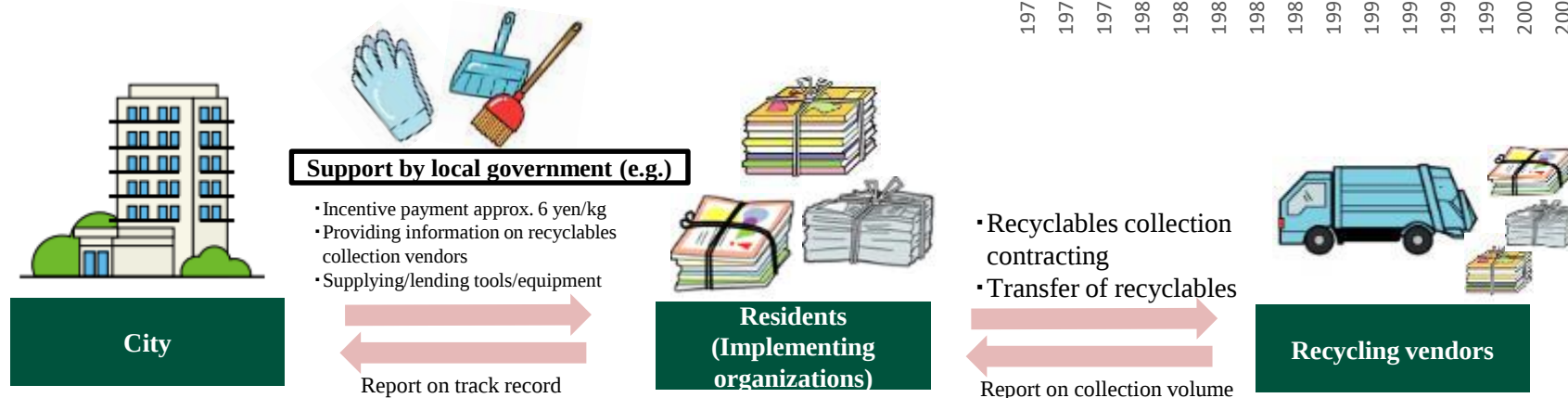
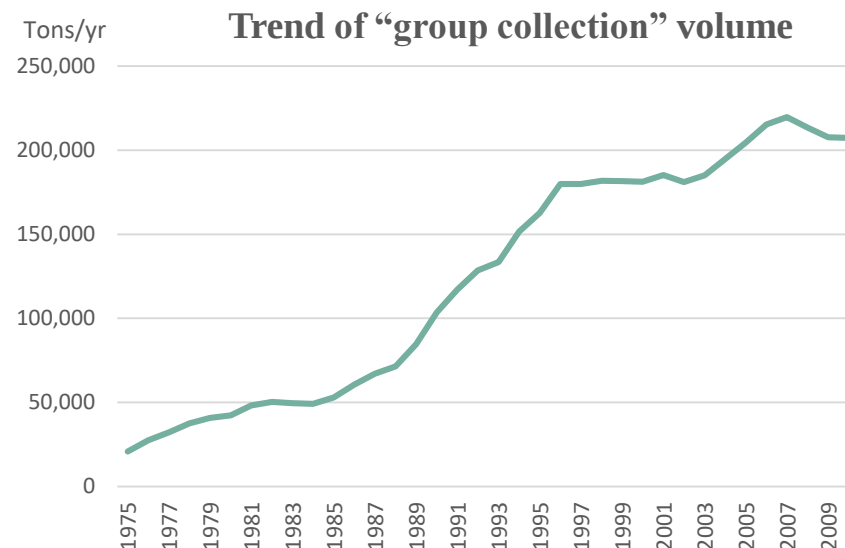
Resources

3. The strengths of the Tokyo Model



Recycling efforts by residents through “group collection” activities

- ✓ This is an activity where resident groups comprised of about 10 households voluntarily collect resources from homes, and take them to recycling vendors.
- ✓ In 1955 an initiative called “waste reduction and utilize as a valuable resources” started in Tokyo’s pilot districts.
- ✓ Each City support the activities through paying an incentive based on collection volume, providing recycling vendors information, and supplying and loaning equipment and tools necessary for the activity.



Recycling volume through group collection was approximately 35% of the total recycling volume of all 23 Cities. And, this also corresponds to approximately 8% of the total waste and recyclables discharged from homes (2016)

3. The strengths of the Tokyo Model



Measures that ensured a 100% collection

Collection and transportation work for 100% collection

Work Planning



Collection and transportation work planning

- Create work plans for distribution of vehicles and staff, and transportation routes implemented based on site situation and data such as demographics, waste management rules and waste volume projection.

Efficient Collection Work



Compaction level of waste collection vehicles

- More than approx. 1,500 waste collection vehicles collect waste from about 440,000 waste collection points.
- 70% of waste collection vehicles are Small Compaction Vehicles that can get around efficiently, and has a very high waste compression ratio.
- Stickers placed on collection bags conveying caution against waste that cannot be collected due to incorrect waste separation, and promote a proper separation.

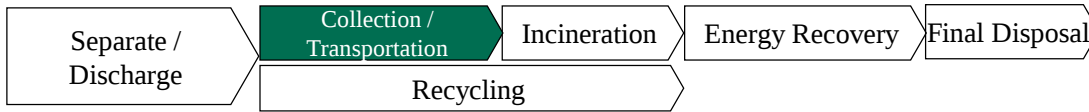
Door-to-door Collection



Door-to-door collection

- We visit individual homes of elderly and disabled residents who have difficulty bringing their waste to the collection points.

3. The strengths of the Tokyo Model



Safe and stable incineration treatment in central city areas

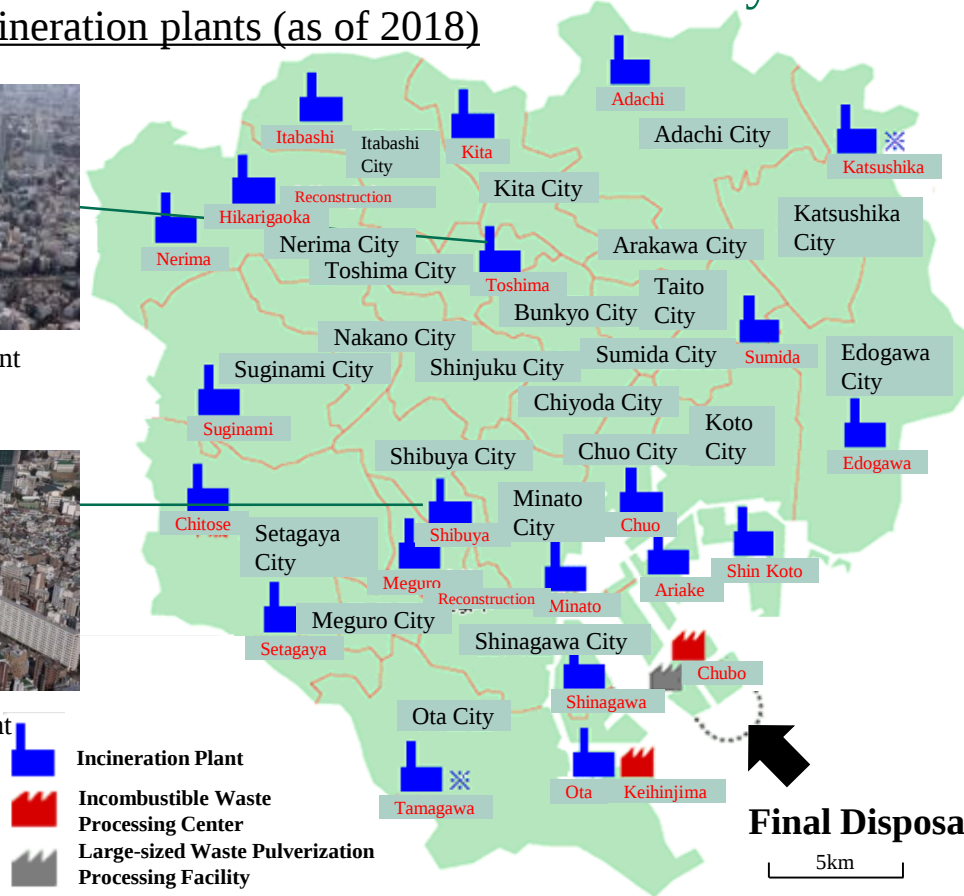
21 Incineration plants (as of 2018)



Toshima Incineration Plant



Shibuya Incineration Plant



✓ **Manage incineration treatment near where waste is generated**



✓ **Minimization of transportation volume to the final disposal site**
 ✓ **Reduction in traffic congestion**
 ✓ **Reduction in greenhouse gas**



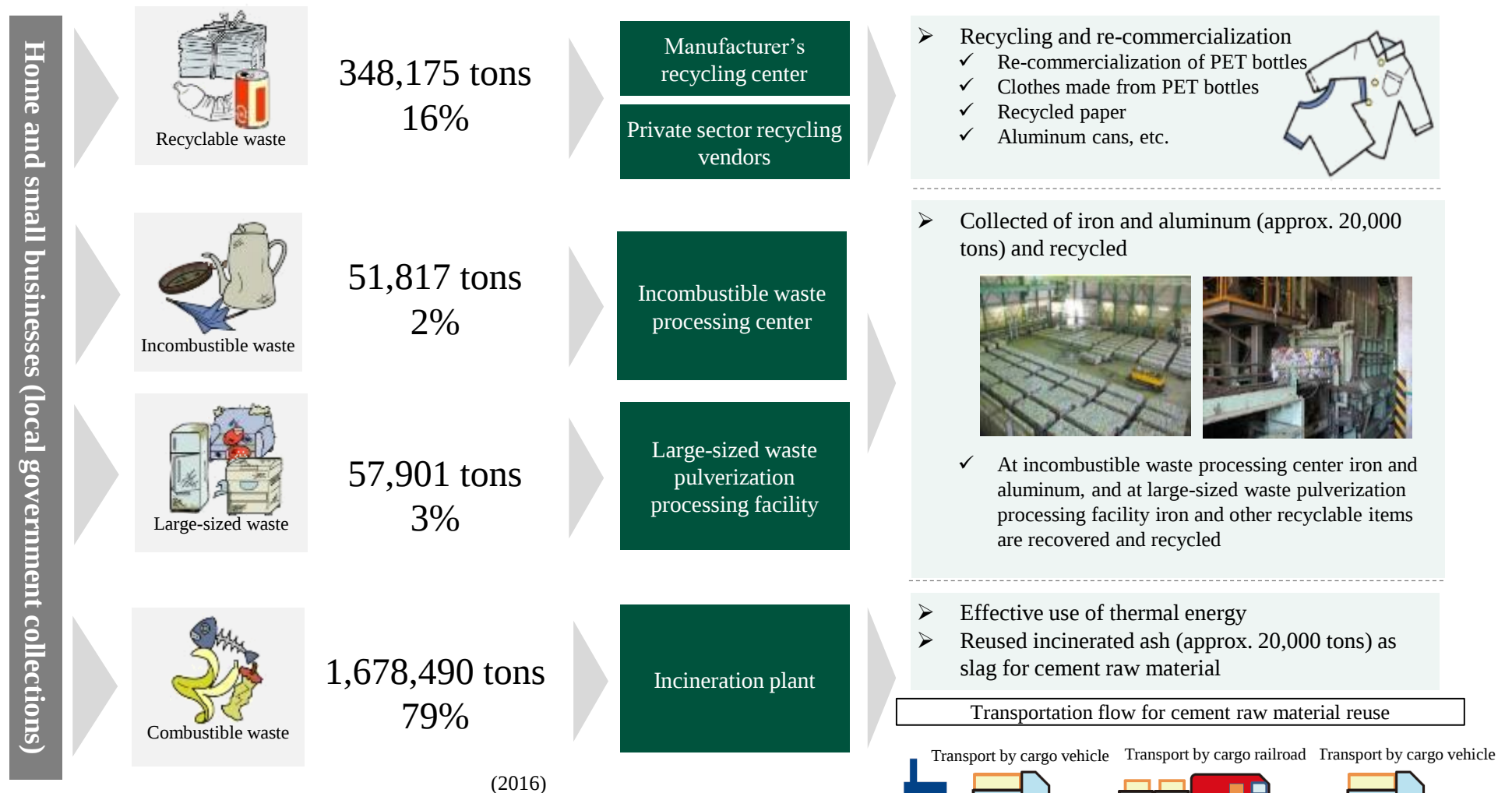
✓ **Improvement in cost efficiency**
 ✓ **Reduction on environmental impact**

For areas like the 23 Cities of Tokyo where its final disposal site is approaching its full capacity, with increasing concentration of population and economic activities, incineration treatment is the optimal and most efficient method to process waste quickly and hygienically.

3. The strengths of the Tokyo Model



Optimal recycling depending on the type of waste and processing stage (collection by government)



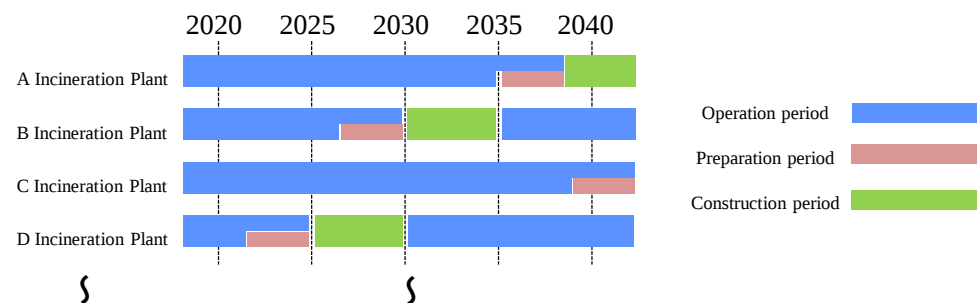
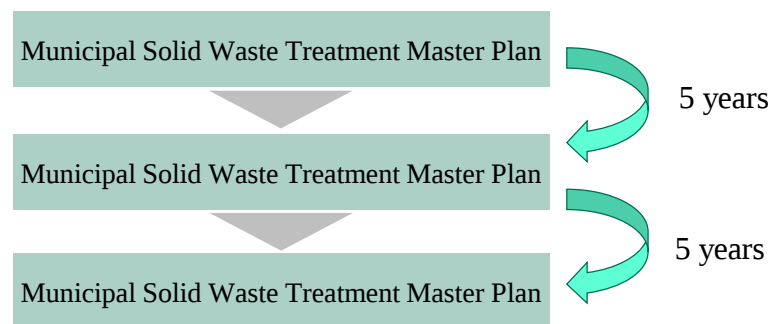
3. The strengths of the Tokyo Model

Incineration



Create plant reconstruction plan with emphasis on communication with residents

- Reconstruction plan is based on the Municipal Solid Waste Treatment Master Plan (15 year plan), which sets forth the reconstruction schedule of the 21 incineration plants in order to secure a consistent and complete incineration of combustible waste.
- Municipal Solid Waste Treatment Master Plan is revised every 5 years, after calling for opinion at public commenting sessions



Prior to creating a plan

- Before creating a reconstruction plan, hold **briefing sessions** with the neighborhood residents
- Call for opinion** on the reconstruction project



Preparation period (5 yrs)

Create a Reconstruction Plan

- Hold a **pre-briefing session**
- Hold a briefing session/call for views** from residents
- Decide on plan

Environmental Impact Assessment Procedure

- Call for opinion** on assessment plan
- Call for opinion** and **hold a briefing session** for residents regarding the draft assessment report
- Submit the assessment report

By communicating thoroughly with residents from the basic planning stage, it is possible to create a reconstruction plan that fully reflects the local opinion

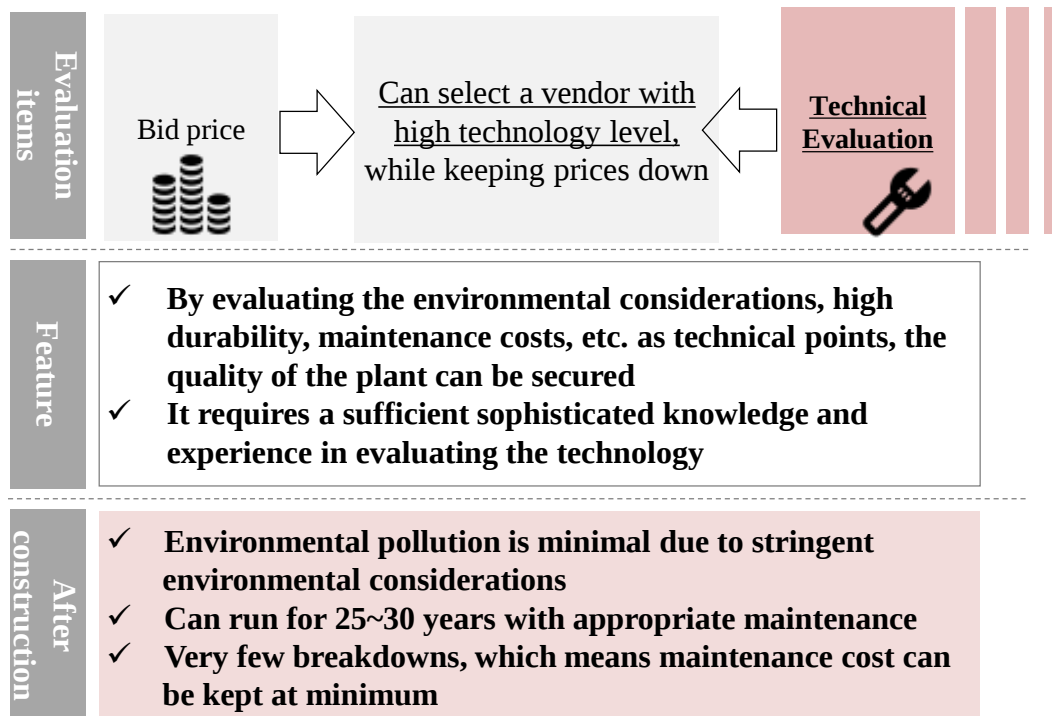
3. The strengths of the Tokyo Model

Incineration



Bidding system to evaluate both technology and price

Comprehensive Evaluation Bid Method



Technical Evaluation Items

Large items	Medium items	Small items
Items responding to demand by the society	Items on harmonization with regional environment	Landscape Greening Consideration for visitors Exhaust gas volume
	Items to prevent global warming and reduce impact on the environment	Measures to reduce power usage Global warming countermeasures for buildings CO2 output level from energy sources
	Items on safety and stability of plant and building	Measures for plant accidents and breakdown countermeasures Rating capacity range for waste quality Disposal capacity of the main facilities Building and stack safety and maintenance plan
Items on technology strength of companies	Items on design and construction	Facility and equipment setup plan Demolition works plan Construction works plan
	Items on breakdowns leading to incinerator shut down	Record of breakdowns
	Items on construction and aftercare preparedness of the construction company	Construction readiness Aftercare
Total cost reduction related items	Utility balance (income and expenditure)	Annual utility usage level Power balance (income and expenditure)
	Regular repair items (6 years) Main facilities repair items (10 years)	

For incineration plant reconstruction, Comprehensive Evaluation Bid Method is being used to select the construction companies, and this process has accumulated high levels of knowledge and experience in evaluating technology.

3. The strengths of the Tokyo Model

Incineration



Construction management of EPC Contractors and provision of construction progress information to residents

CAT23

Fulfillment
confirmation of
contract contents

Execution of
proposal and
ensure
performance

Publicize bid evaluation
results and information
provision

EPC Contractors

- Formulation of implementation plan
- Demolition works
- Building construction
- Stack construction
- Plant construction
- Periphery works and greening work
- Test runs



Safeguarding environment during reconstruction work

- ✓ Noise pollution/ vibrations prevention
- ✓ Dome-type tents are used during demolition works

Residents



Information desk set up at the construction site



Updating “Reconstruction Works Newsletter” by CAT23

3. The strengths of the Tokyo Model

Incineration



Operation and maintenance management for safe and stable plant

✓ Perform a comprehensive overhaul once a year

- ✓ Combustion gas temperature must be measured continuously
- ✓ Maintain at above 800°C
- ✓ Furnace temperature should be raised quickly using a combustion support device at start of operation such as after shut down
- ✓ Waste should be completely incinerated using a combustion support device when terminating operation for shut down.

✓ Continuous feeding of fixed quantity of uniformly mixed waste

✓ Analyze waste property 4 times a year

✓ Measure flue gas emission (soot and dust, SO_x, hydrogen chloride)

✓ Prevent scattering of cooling and cleaning water for gas

- ✓ Continuously measure soot and dust, NO_x, SO_x, hydrogen chloride, and mercury
- ✓ Measure dioxins once a year

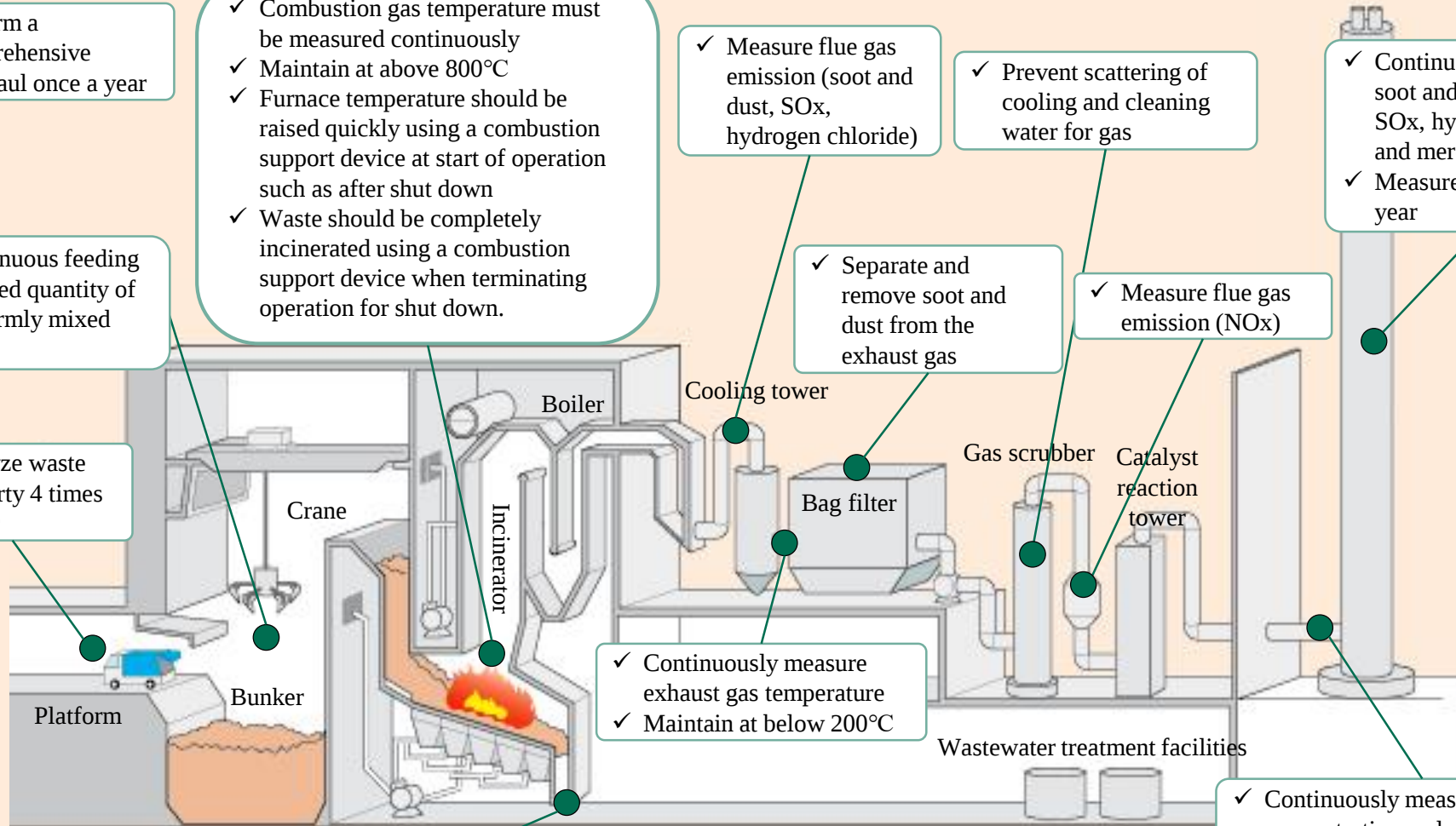
✓ Separate and remove soot and dust from the exhaust gas

✓ Measure flue gas emission (NO_x)

- ✓ Continuously measure exhaust gas temperature
- ✓ Maintain at below 200°C

- ✓ Continuously measure CO concentration and maintain this at no higher than 100 ppm (12% oxygen calculation)

✓ Ignition loss of ash to 10% or less



3. The strengths of the Tokyo Model

Incineration



Thorough maintenance management and active information disclosure

Long-term stable operation

- ✓ At bidding stage, evaluate for cost reduction technology throughout the plant lifecycle
- ✓ All furnaces are overhauled, once a year
- ✓ Key equipment focused works are applied after 15 years into operation

**Have realized operation period of 25-30 years.
We are also implementing works to prolong operations up to 40 years.**

Thorough maintenance and pollution control

- ✓ Stable operation is realized in light of maintenance management plan based on self-regulated values in alignment with the law
- ✓ Setup self-regulating values stricter than the regulatory values of Japan and Tokyo, and enforce prevention of pollution
- ✓ In order to maintain the environment of residents around the incineration plant, the number of waste collection vehicles bringing in waste and its route is being controlled.

Active information disclosure

Environment Measurement Results

- ✓ Measurements of waste gas, waste water, main properties of ash and soot, atmospheric environment around the incineration plant, and dioxin concentrations (exhaust gas, bottom ash, fly ash, wastewater, etc.) are all publicized on the website



Incineration plants display gas status on a display in real time (Setagaya Incineration Plant)

Continuous Measurements Results

- ✓ Publicize incineration room gas temperature, dust collector entry gas temperature, and CO concentration in exhaust gas through the website

Environment Report

- ✓ All incineration plants issue this report once a year. It covers the management policy, treatment process, various data, and plant tour participants data are publicized on the website

Operations Council

- ✓ Held regularly at the incineration plant. Operation status including breakdowns and incidents are reported.

Incineration Plant Newsletter

- ✓ All incineration plants issue a newsletter and it is publicized on the website



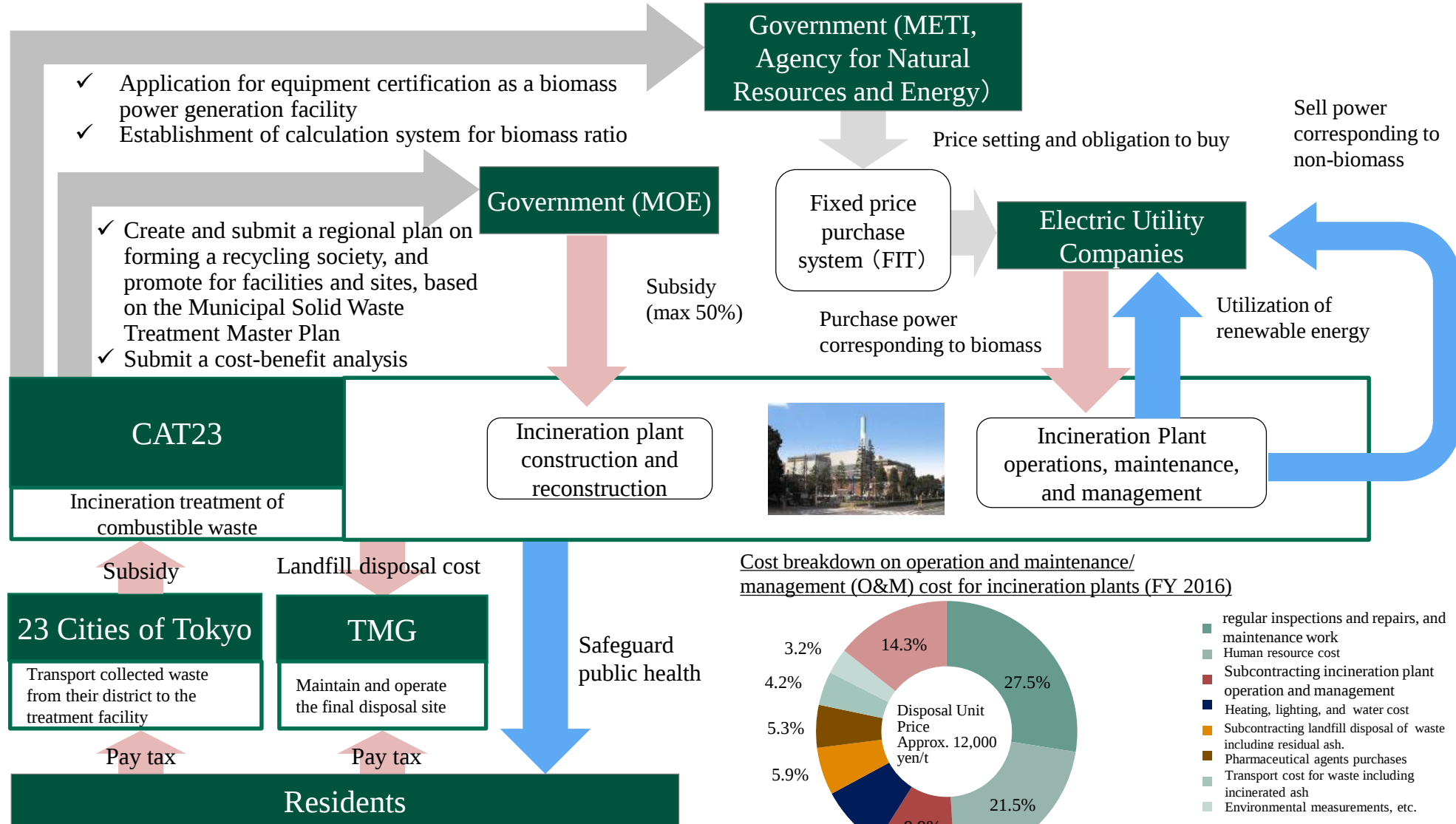
Environment Report 2016 (Ota Incineration Plant)

3. The strengths of the Tokyo Model

Incineration



Financing system supported by national/local governments, residents, and electric utility companies



3. The strengths of the Tokyo Model

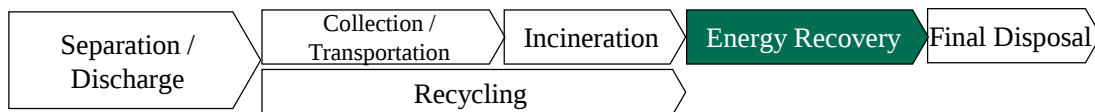
Incineration



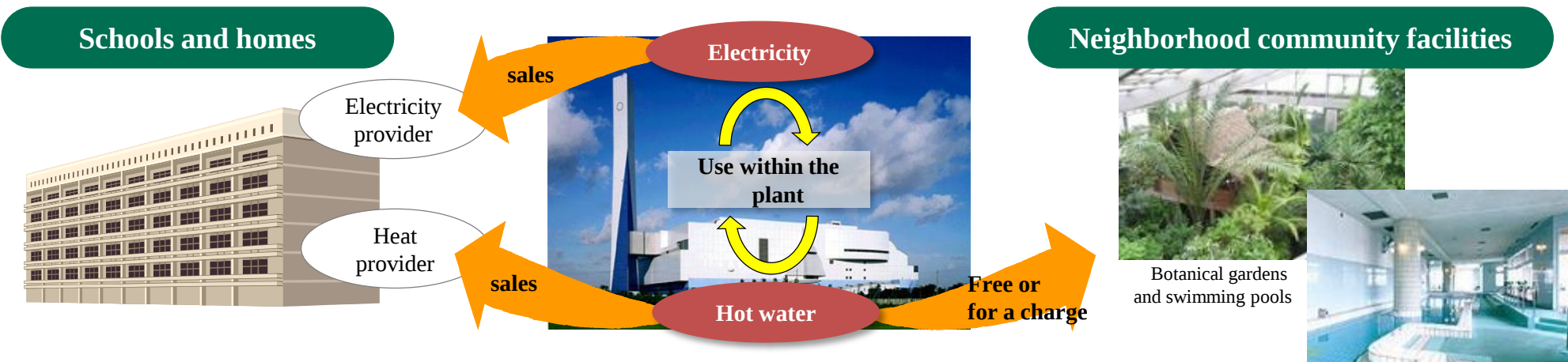
Various actions taken to resolve anxieties, distrust, and dissatisfaction of the local residents

Voice of residents		Actions taken	Ideal State
Anxieties	- We hear that incineration plants are dangerous facilities. Won't there be any problems? - Won't there be harmful substances in the exhaust smoke output that would be harmful for our health? - Wouldn't the increased vehicles have negative impact on our environment?	<u>Build assurance</u> - Effort to prevent pollution - Thorough information disclosure	
Distrust	- Aren't the local government and incineration plant hiding some negative information from us? - We cannot trust national /local governments because they make decisions without us.	<u>Build trust</u> - Hold briefings - Establish Councils	
Dissatis-faction	- Incineration plant construction will lead to poor image of our community - We now understand that the incineration plant is needed, but we emotionally cannot accept the fact that this will be built in our neighborhood	<u>Consideration for the community</u> - Facility design in harmony with the community - Supply heat and thereby giving back to the community	Assurance

3. The strengths of the Tokyo Model



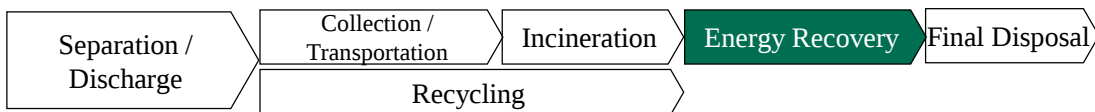
Effective use of recovered energy through sale and returning it to the community



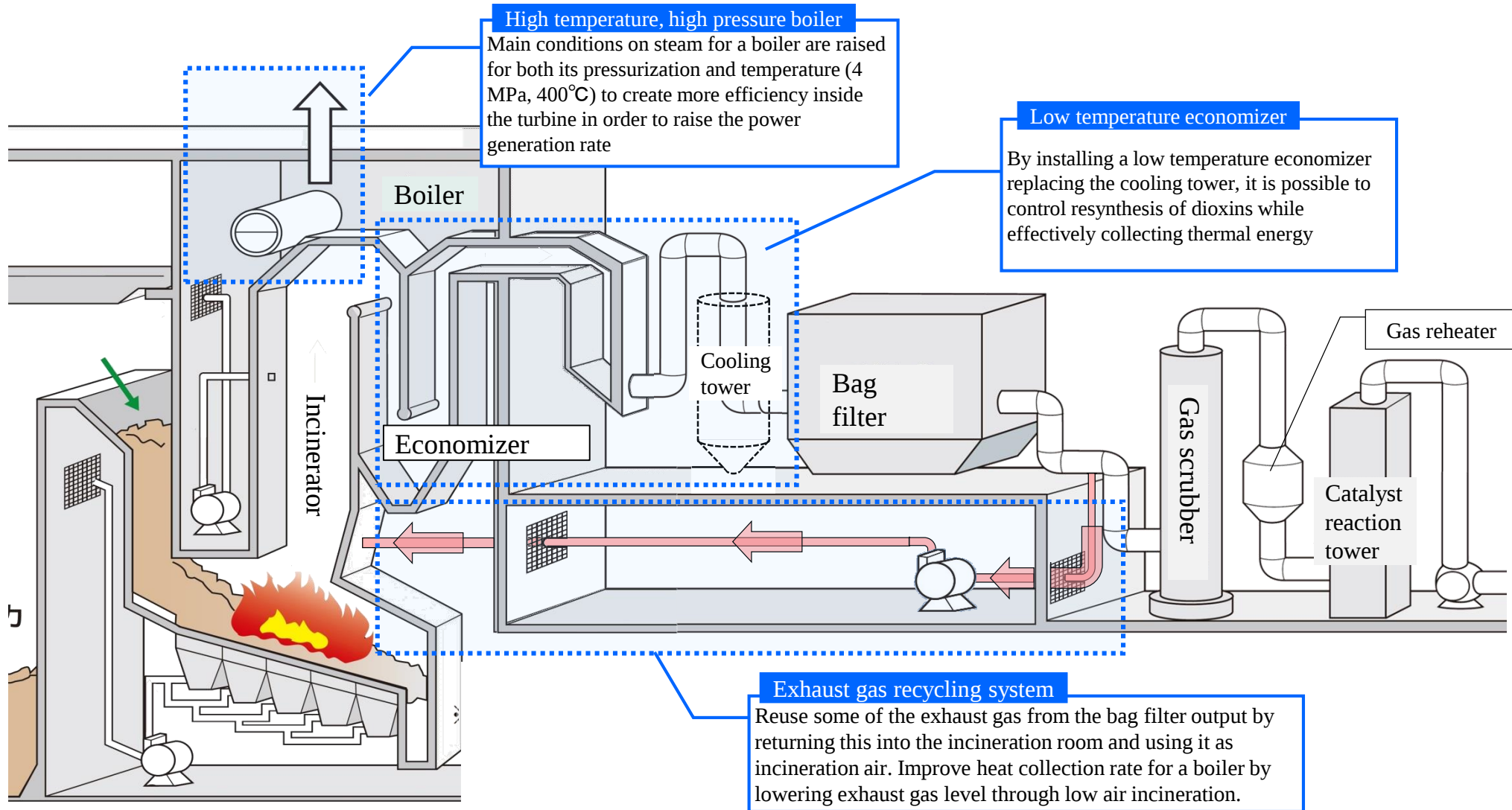
Power generation results (FY2016)	
Annual incinerated waste volume per annum	2,700,000 tons
Calorific heat quantity on average	11,223 kJ/kg
Total power generation	1,202,060,000kWh
Total power sold	689,960,000 kWh
Power generation rate (Nerima Incineration Plant)	23%
Revenue from power sold	9,801,900,000 Yen
Unit for generated power	449 kWh/waste ton

Track record of heat supplied (FY2016)	
Heat provided (at a cost)	415,000 GJ
Revenue from heat sold	185,820,000 Yen
Supplied to, at a cost	Local heat supply (Ariake Incineration Plant, Shingawa Incineration Plant), Municipal Yumenoshima Tropical Greenhouse Dome, Tokyo Tatsumi International Swimming Center, Tokyo Sports and Culture Center (Shin-Koto Incineration Plant), and Municipal Itabashi Special Needs Support (Disability) School (Itabashi Incineration Plant)

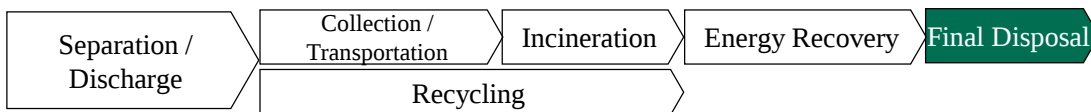
3. The strengths of the Tokyo Model



Installation of technology that enables waste power generation facility.



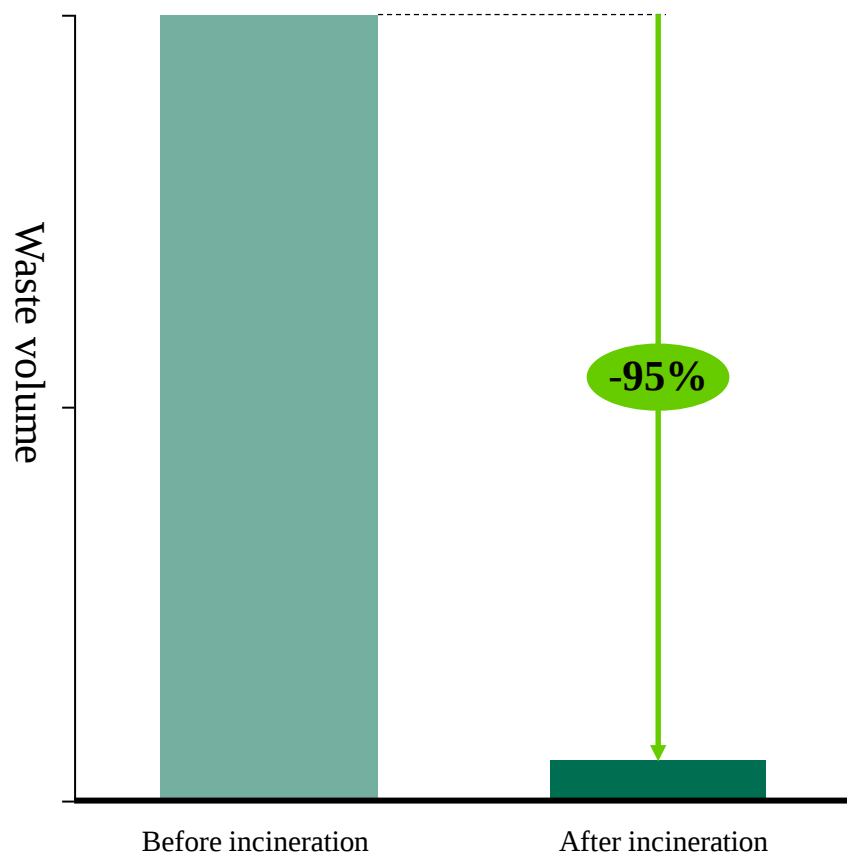
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Impact incineration disposal has on reduction landfill disposal volume

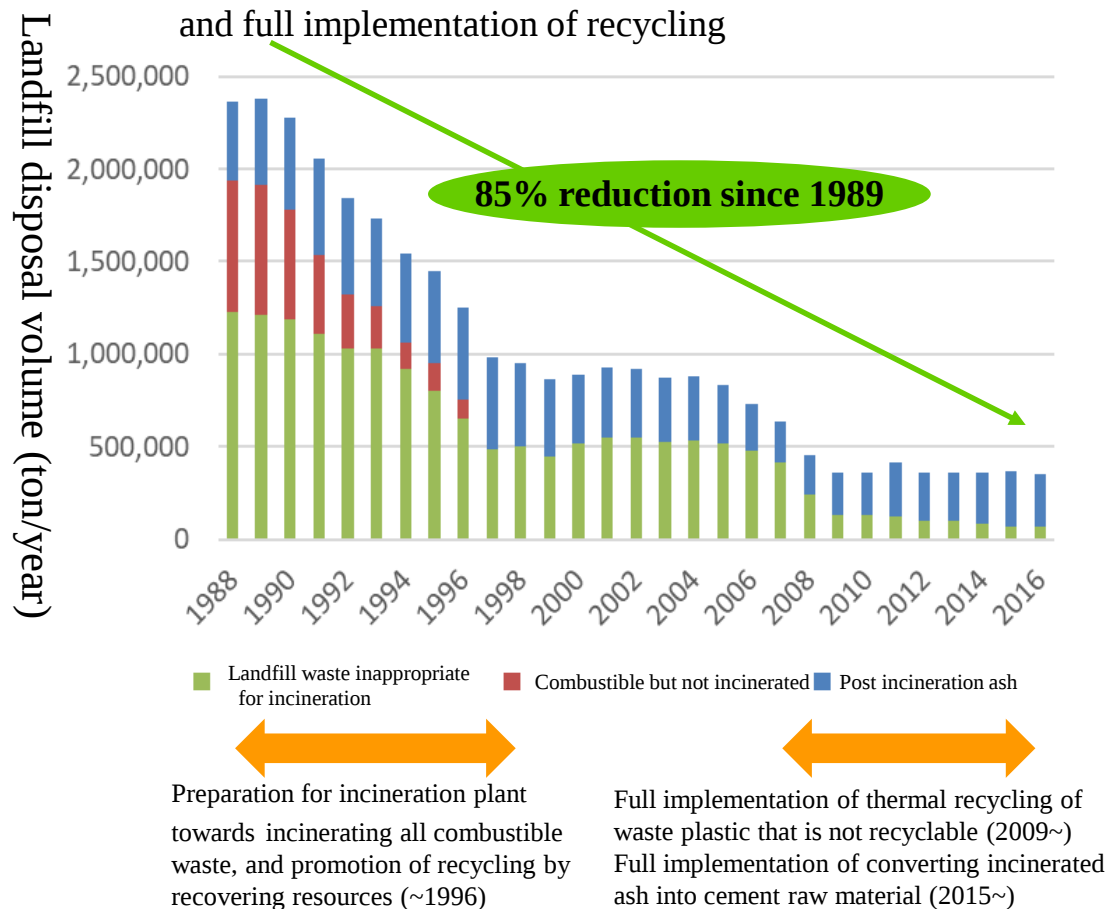
Volume reduction effect of waste incineration

- Can cut approx. 95% of waste volume, by incineration

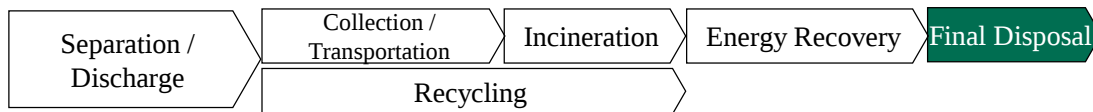


Trend in landfill disposal volume

- Landfill disposal volume has decreased 85% since 1989, as a result of reduction in volume through incineration and full implementation of recycling



3. The strengths of the Tokyo Model



Implementation of landfill disposal on sea surface with considerations for the environment



- From 1927 to today, 100 M tons will fill in a total of 7 sea surface disposal sites.
- Today, at the final disposal sites, landfill disposal of industrial waste from SMEs in the city is done in addition to intermediate processing of residues.
- As a result of reduction in landfill volume, it is said that these landfills can be used for more than 50 more years

Source: "Tokyo Waste Landfill Disposal Sites Description Pamphlet" (Tokyo Bureau of Environment), Metropolitan Tokyo website, and "Works of MLIT on Creation of a Recycling Society" (Ministry of Land, Infrastructure, and Tourism, 2000)



■ Final disposal sites built on sea surface

- Due to the difficulty of securing landfill sites in the inland area, have proactively established sea surface landfill technology

■ Developed an environmental friendly landfill

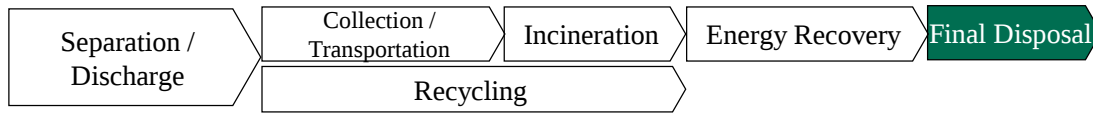
- Prevent marine pollution by appropriately implementing leachate treatment
- Greenhouse gas is reduced by implementing methane gas collection*
- Effort on extending life

* Stopped in 2017/1

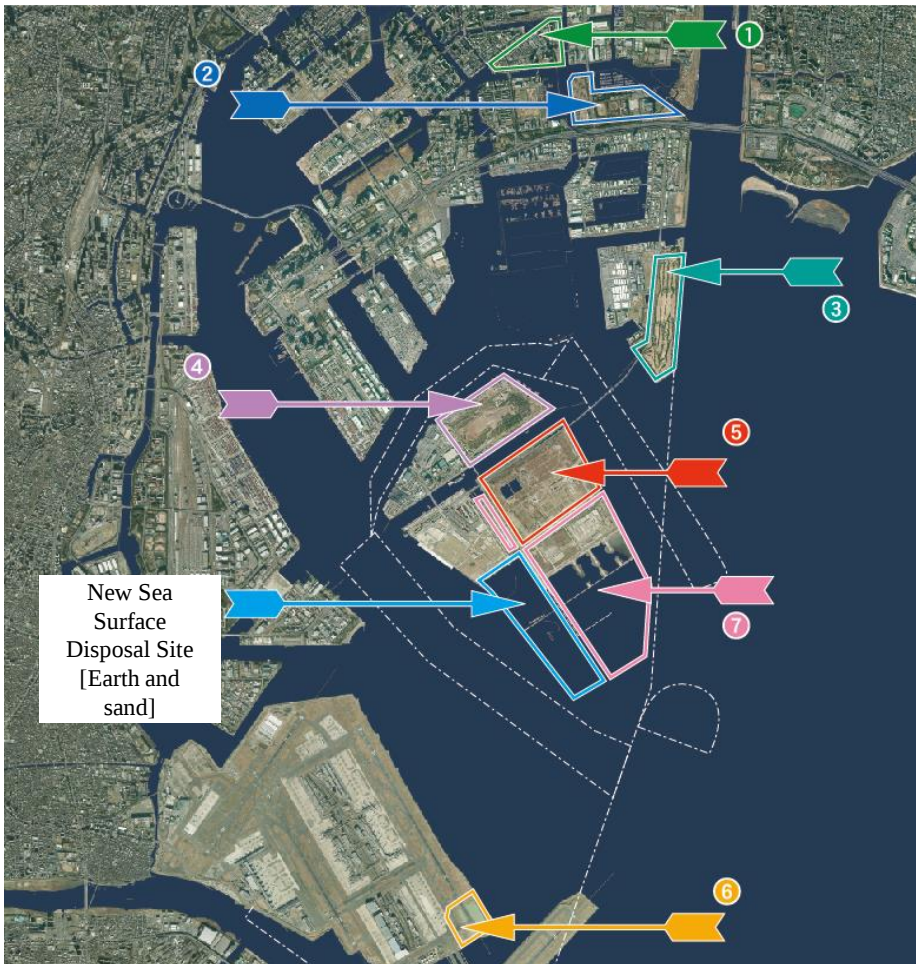
■ Actively accepting visitors

- Different courses with different tour duration based on audience from children to adults
- Anybody can participate at any time, and there also are many visitors from overseas

3. The strengths of the Tokyo Model



Various usages of former landfills for waste disposal



	Name of landfill site	Period in use as landfill (FY)	Area (ha)	Site used as:
①	Site No 8	1927-1962	36.4	Parks, general residential area, railroad station
②	Site No 14	1957-1966	45.0	Parks, tropical botanical garden, baseball stadium, incineration plant
③	Site No 15	1965-1974	71.2	Industrial sites, parks, camp sites
④	Inner Central Breakwater	1973-1986	78.0	Uminomori Park
⑤	Outer Central Breakwater	1977-present	199.0	Used as landfill
⑥	Haneda Offshore	1984-1991	12.4	Airport
⑦	New Sea Surface	1998-present	319.0	Used as landfill

At the 2020 Tokyo Olympics, these former landfill sites are to be used for various competitions such as archery and cross-country sports.

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4. International contribution utilizing Tokyo Model

International contribution towards achieving SDGs in other countries

