Asia-Pacific
Economic Cooperation

Reference

Guidebook for the Development of Sustainable Cities Focusing on Resource Circulation and Waste Management ~ A Methodology for Measuring and Realizing the Sustainability of Cities in the APEC region ~

SOM Friends of the Chair (FotC) on Urbanization

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Contents

1. Resource Circulation and Waste Management

1.1 Current-status Evaluation Input Sheet (Reference of "2.1 Method of present status evaluation" in the guidebook)

<Making entries>

- Make entries in according to criteria in Excel. Subjective evaluation is acceptable, depending on the evaluation item.

- Information should be inputted in the following matter:
  - Blank space: Enter figures.
  - ○: Select the best one option.
  - □: Check if applicable.

- Regarding legal system, please input specific names of legal systems established in your economy or city in order to understanding the development status of your economy or city. (Please refer to the attached excel sheets.)

- Regarding municipal waste and hazardous waste, please input the definitions in your city because every city has its own definitions. (Please refer to the attached excel sheets.)

- Regarding a collection rate of municipal waste, please input the definitions in your city because every city chooses its own denominator and numerator, and definitions. (Please refer to the attached excel sheets.)

- Regarding hazardous substances and other recycled substances, please input the definitions made in your city because every city has its own definitions. (Please refer to the attached excel sheets.)

<Evaluation stage on each axis>

- Evaluation should be made on four stages (score 3, score 2, score 1, score 0).
- Please note that the Current-status Evaluation of the Guidebook should not be used to compare with other cities. This is because cities have different definitions of waste that they evaluate, as well as some evaluation items need subjective judgement of individual cities and a strict quantitative evaluation is impossible for those. However, the Current-status Evaluation is useful for identifying an overall trend of the development status of a city and can be used for comparing trends of individual cities.

Evaluation axis		Evaluation item	Criteria	Check ※Subjective answers are acceptable.		Evaluation criteria and points (Not to be provided in the Guidebook)	
Major category	Minor category						
0.Governance		01.Legal system for waste management	011.Choose the most appropriate answer to the current status of member economy government and municipal laws on waste management. Waste in this column means not only municipal waste but all waste.	○	Laws on waste managemetn are in place on the whole.	Laws on waste managemetn are in place on the whole. : 2 points Laws on waste management are in place, but are insufficient: 1 points Laws on waste management are not in place: No point.	Evaluate by total score 14/13/12/11 points→Grade 3 10/9/8/7 points→Grade 2 6/5/4 points→Grade 1 3/2/1/No point→Grade 0
				○	Laws on waste management are in place, but are insufficient.		
				○	Laws on waste management are not in place.		
			012.If the relevant lawas in place, choose the most appropriate answer to the current status of enforcement of the member economy government and municipal laws on waste management.	○	Laws on waste management are enforced appropriately.	Laws on waste management are enforced appropriately: 1 point Laws on waste management are enforced but with problems.: No point	
				○	Laws on waste management are enforced but with problems.		
		02.Legal systems for efficient utilization of resources, promoting environmentally friendly design, and recycling waste (legal systems of 3R (Reduce, Reuse, Recycle))	021.Choose the most appropriate answer to the current status of member economy government and municipal laws on the efficient use of materials, the promotion of environmentally friendly designing, and the recycling of waste.	○	Laws on 3R (Reduce-Reuse-Recycle) are in place.	Laws on 3R (Reduce-Reuse-Recycle) are in place : 2 points Laws on 3R (Reduce-Reuse-Recycle) are in place, but are insufficient: 1 points Laws on 3R (Reduce-Reuse-Recycle) are not in place: No point.	
				○	Laws on 3R (Reduce-Reuse-Recycle) are in place, but are insufficient.		
				○	Laws on 3R (Reduce-Reuse-Recycle) are not in place.		
			022.If relevant laws are in place, choose the most appropriate answer to the current status of enforcement of the member economy government and municipal laws on the efficient use of materials, the promotion of environmentally friendly designing, and the recycling of waste.	○	Laws on 3R (Reduce-Reuse-Recycle) are enforced appropriately.	Laws on 3R (Reduce-Reuse-Recycle) are enforced appropriately: 1 point Laws on 3R (Reduce-Reuse-Recycle) are enforced but with problems: No point	
				○	Laws on 3R (Reduce-Reuse-Recycle) are enforced but with problems.		
		03.Data on waste generation from all sources	031.Choose the percentage of sources available for monitoring.	○	95% or more	95% or more: 2 points; 50% or more: 1 point; Almost no sources are monitored: No point	
				○	50% or more		
				○	Almost no sources are monitored for data collection.		
		04.Civil activities, such as waste management and 3R (Reduce, Reuse, Recycle)	041.Check the most appropriate answer regarding the current status of waste management and treatment and 3R (Reduce-Reuse-Recycle) activities of your citizens	□	The waste management and treatment and 3R (Reduce-Reuse-Recycle) activities of citizens are sufficiently communicated.	If checked: 2 point	
				□	Communities are sufficiently developed for waste management and treatment and 3R (Reduce-Reuse-Recycle) activities of citizens.	If checked: 2 point	
				□	The waste management and treatment and 3R (Reduce-Reuse-Recycle) activities of citizens are sufficiently contributing to reductions in administrative costs.	If checked: 2 point	
Municipal waste (Waste that the city is responsible for management)	1.Generation	11.Amount of waste generated	111.If data are available regarding annual amount of waste generated per citizen, please enter the amount of waste generated (kg/person per annum). Annual amount of municipal waste generated per citizen = total annual amount of waste generated per citizen / population of the city ※Please describe the definition of "Municipal waste" in a separate sheet.	If the annual amount of waste generated per citizen is known, then enter the amount of waste (kg/person per annum)		Economy with a per-capita GDP of less than USD10,000 Less than 200 kg/person per annum: 3 points; 200-400 kg/person per annum: 2 points; More than 400kg/person per annum: 1 point Economy with a per-capita GDP of USD10,000 or more Less than 400kg/person per annum: 3 points; 400-600 kg/person per annum: 2 points; 600kg/person per annum: 1 point	3 points→Grade 3 2 points→Grade 2 1 point→Grade 1
				Per-capita GDP of the city (in tens of thousands of dollars)(The economy's GDP is acceptable)			
				Enter the amount of waste (kg/person per annum)			
			112.If data are NOT available regarding annual amount of waste generated per citizen, please the most representative answer. *Please note that this Guidebook (Resource Circulation and Waste Management) excludes sewage sludge and septic tank sludge, and therefore you cannot review related solutions. Sewage sludge and septic tank sludge will be included in the Guidebook (Water) which will be prepared in the future. ※This Guidebook (Resource Circulation and Waste Management) exclude sewage sludge and septic tank sludge.	○	The waste amount generated is not known but the waste amount collected is known (for all areas and total waste amount).	The waste amount generated is not known, but the waste amount collected is known (for all areas and total waste amount): 2 points; The waste amount generated is not known, but the waste amount collected is known (for some parts or part of total waste amount) : 1 point; Data are not available regarding waste amounts generated and collected: No point	Evaluate by total score 2 points→Grade 2 1 point→Grade 1 No point→Grade 0
				○	The waste amount generated is not known but the waste amount collected is known (for some areas or part of total waste amount).		
				○	Data are not collected regarding the amount of waste generated and collected		
				Please input collected waste amount (kg/person/year)		–	
	2.Collection and transport	21.Collection rate for municipal waste	211.Choose the waste collection rate that best represents your city. The rate may be calculated based on population, land area, and so forth. ※Please describe the definition of "Municipal waste collection rate" in a separate sheet.	○	95% or more	95% or more: 3 points; 70% or more: 2 points; 30% or more: 1 point; Nearly no waste is collected: No point	Evaluate by total score 5 points→Grade 3 4/3 points→Grade 2 2/1 points→Grade 1 No point→Grade 0
				○	70% or more		
				○	30% or more		
				○	Nearly no waste is collected		
		22.Efficient waste collection and transport	221.Check if compaction trucks are used for more than 50% of municipal waste collected.	□	Compaction trucks are used	If checked: 1 point	
			222.Check the box if you have transfer stations in place for efficient municipal waste collection.	□	Transfer stations are in place for efficient municipal waste collection.	If checked: 1 point	
	3.Sorting	31.Segregated collection at source	311.Choose the percentage of segregated collection at source that best represents your city. The rate may be calculated based on waste amount, population, land area, and so forth. ※Please describe the definition of "Rate of separate collection at source" in a separate sheet.	○	95% or more	95% or more: 3 points; 70% or more: 2 points; 30% or more: 1 point; Almost no waste is segregated at collection sites: No point	Select the higher score in segregated collection or sorting 3/4 points→Grade 3 2 points→Grade 2 1 point→Grade 1 No point→Grade 0
				○	70% or more		
				○	30% or more		
				○	Almost no waste is segregated at collection sites		
		32.Sorting at treatment facilities	321.Choose the percentage of sorting at treatment facilities that best represents your city. The rate may be calculated based on waste amount, population, land area, and so forth. ※Please describe the definition of "Rate of sorting after collection" in a separate sheet.	○	95% or more	95% or more: 3 points; 70% or more: 2 points; 30% or more: 1 point; No waste is sorted at treatment facilities : No point	
				○	70% or more		
				○	30% or more		
				○	No waste is sorted at treatment facilities		
		33.Advanced and efficient sorting at source as well as sorting after collection	331.Check if the system of separate collection at source and the advanced and efficient system of sorting after collection are conducted.	□	The system of separate collection at source and the advanced and efficient system of sorting after collection are sufficiently conducted	If checked: 1 point	

Evaluation axis		Evaluation item		Criteria	Check ※Subjective answers are acceptable.		Evaluation criteria and points (Not to be provided in the Guidebook)	
Major category	Minor category							
Municipal waste (Waste that the city is responsible for collecting and management)	4.Appropriate treatment and recycling	41.Biological treatment	Implementation of biological treatment	411.Choose the percentage of biologically treatment of waste that best represents your city. Biological treatment includes aerobic compost and anaerobic digestion.	○	95% or more	95% or more: 3 points; 70% or more: 2 points; 30% or more: 1 point; No waste undergoes biological treatment : No point	Add remaining score (for material recycling and fuelization) to biological treatment or incineration treatment, whichever has higher score. 13/12/11 points→Grade 3 10/9/8/7 points→Grade 2 6/5/4 points→Grade 1 3/2/1/0 points→Grade 0
					○	70% or more		
					○	30% or more		
					○	No waste undergoes biological treatment		
			Recycling of residue	412.Check if residue from biological treatment is recycled.	☐	Residue from biological treatment is recycled.	If checked: 1 point	
			Energy recovery	413.Check if more than 50% of your biological treatment facilities perform energy recovery.	☐	Energy is recovered at biological treatment facilities	If checked: 1 point	
		42.Incineration	Implementation of incineration	421.Choose the percentage of incineration that best represents your city.	○	95% or more	95% or more: 3 points; 70% or more: 2 points; 30% or more: 1 point; Almost no waste is incinerated: No point	
					○	70% or more		
					○	30% or more		
					○	Almost no waste is incinerated		
			Recycling of incineration ashes	422.Check if more than 50% of your incineration facilities are recycling incineration ashes. Incineration ashes may be recycled for melting, baking, making raw material for cement. Also includes recovery of metals and other resources from ash.	☐	Incineration ashes generated at incineration facilities are recycled.	If checked: 1 point	
			Energy recovery	423.Check if more than 50% of incineration facilities perform energy recovery.	☐	Energy is recovered at incineration facilities	If checked: 1 point	
		43.Appropriate material recycling		431.Check if a recycling system is in place. Such a system may be without any legal ground, including collection of material based on a market principle.	☐	Metals contained in municipal waste is recycled sufficiently and appropriately in the environment	If checked: 2 points	
				432.Check if a recycling system is in place. Such a system may be without any legal ground, including collection of material based on a market principle.	☐	Plastics contained in municipal waste is recycled sufficiently and appropriately in the environment	If checked: 2 points	
				433.Check if a recycling system is in place. Such a system may be without any legal ground, including collection of material based on a market principle.	☐	Other materials contained in municipal waste are recycled sufficiently and appropriately in the environment	If checked: 2 points	
		44.Production of fuel		441.Check if municipal waste that cannot be recycled as a resource is sufficiently utilized as solidified refuse-derived fuels (including RDF and RPF)	☐	Municipal waste that cannot be recycled as a resource is sufficiently utilized as solidified refuse-derived fuels (including RDF and RPF)	If checked: 1 point	
		45.Acceptance of waste from other cities		451.Check if waste is accepted from other cities.	☐	Waste is accepted from other cities, and it is treated and recycled appropriately.	If checked: 1 point	
	5.Landfill (Final dispose)	51.Disposal at a managed landfill site		511.Check the most appropriate answer about the percentage of disposal at a managed landfill site. (Please answer the landfill site which your city utilizes. If your city uses a private landfill site, your city can regard itself as "implementing," provided that it understands the situation of such a disposal site.)	○	95% or more	95% or more: 2 points; 70% or more: 1 points; The service is little implemented: No point	Evaluate by total score. 6/5 points→Grade 3 4/3 points→Grade 2 2/1 point→Grade 1 No point→Grade 0
					○	50% or more		
					○	The service is little implemented.		
		52.Residual life of the landfill site		521.Enter the residual life of the landfill site used by your city. (Such landfill site may be in your city or another) Residual life of the landfill site = residual capacity / annual landfill amount	Enter the residual life (in years) of the landfill site.		More than 20 years: 2 points; 10-20 years; Less than 10 years: No point	
					Enter the residual life (in years) of the landfill site.			
		53.Construction of landfill sites		531.Check if the construction of new landfill sites is being planned.	☐	New landfill sites are being constructed.	if checked: 1 point	
		54.Acceptance of waste from other cities		541.Check if your city accepts waste from other cities	☐	Waste is accepted from other cities and undergoes landfill.	If checked: 1 point	
6.Hazardous waste (Including hazardous waste which the city is not responsible for management)		61.Segregated collection of hazardous waste		611.Choose the most representative percentage of segregated collection of hazardous waste. Hazardous waste is containing substances those are dangerous or harmful to human health and the environment, including Mercury, Lead, and other substances specified in domestic laws or international treaties such as the Basel Convention.	○	95% or more	95% or more: 2 points; 50% or more: 1 point; Nearly no hazardous waste is collected: No point	Evaluate by total score. 4 points→Grade 3 3 points→Grade 2 2/1 point→Grade 1 No point→Grade 0
					○	50% or more		
					○	Nearly no hazardous waste is collected		
		62.Sorting		621.Check if hazardous waste is sorted after collection.	☐	Hazardous substances are sorted.	If checked: 1 point	
		63.Appropriate treatment		631.Check if hazardous waste is treated appropriately.	☐	Hazardous waste are disposed of at managed landfill. Otherwise, they are detoxified.	If checked: 1 point	

Evaluation axis		Evaluation item	Criteria	Check ※Subjective answers are acceptable.		Evaluation criteria and points (Not to be provided in the Guidebook)	
Major category	Minor category						
7.E-Waste (Including E-Waste that the city is not responsible for management)		71.Segregated collection of E-waste	711.Choose the most representative percentage of segregated collection of E-waste. Such a system may be without any legal ground, including collection based on a market principle. If the percentage fluctuates according to changes in the market, choose the lowest percentage. (Percentage of segregated collection = amount of E-waste generated. If quantitative figures are not available, provide an approximate figure.)	○	95% or more	95% or more: 2 points; 50% or more: 1 point; Nearly no e-waste is collected: No point	Evaluate by total score. 9/8/7→Grade 3 6/5/4→Grade 2 3/2 points→Grade 1 1/0→Grade 0
				○	50% or more		
				○	Nearly no e-waste is collected		
		72.System to ensure the safety of reusable items	721.Check if a scheme is in place to ensure the safety of reusable items.	□	A scheme is in place to ensure the safety of reusable items.	If checked: 1 point	
		73.Appropriate management of waste till it is made into reusable items	731.Check if there are guidelines or other schemes in place for inspection, repair, and management of used products till they are made into reusable items.	□	A scheme is in place to manage waste until it is made into a reusable item.	If checked: 1 point	
		74.Appropriate management of non-reusable products	741.Check if unusable items are treated properly.	□	Unreusable items are treated appropriately.	If checked: 1 point	
		75.Appropriate treatment of hazardous substances	751.Check if the appropriate treatment is being implemented.	□	E-Waste hazardous substances (please specify in a separate sheet) are treated appropriately	If checked: 1 point	
		76.Appropriate recycling	761.Check if the recycling is implemented.	□	Metals are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			762.Check if the recycling is implemented.	□	Plastics are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			763.Check if the recycling is implemented.	□	Other materials are recycled sufficiently and appropriately in the environment	If checked: 1 point	
8.Motor vehicles (including vehicles that the city is not responsible for management)		81.Segregated collection of motor vehicles	811.Choose the most representative percentage of collection of motor vehicles. Such a collection system may be without any legal ground, including collection based on a market principle. If the percentage fluctuates according to changes in the market, choose the lowest percentage. (Percentage of segregated collection = amount of end of life automobiles generated. If quantitative figures are not available, provide an approximate figure.)	○	95% or more	95% or more: 2 points; 50% or more: 1 point; Nearly no automobiles is collected: No point	Evaluate by total score. 10/9/8 points→Grade 3 7/6/5 points→Grade 2 4/3/2 points→Grade 1 1/0 point→Grade 0
				○	50% or more		
				○	Nearly no automobiles is collected		
		82.System to ensure the safety of reusable items	821.Check if a scheme is place to ensure the safety of reusable items	□	A scheme is in place to ensure the safety of reusable items.	If checked: 1 point	
		83.Appropriate management till reusable item is completed	831.Check if there are guidelines or other schemes in place for inspection, repair, and management of used products till they are made into reusable items.	□	A scheme is in place to manage waste until it is made into a reusable item.	If checked: 1 point	
		84.Appropriate management of non-reusable products	841.Check if un-reusable items are treated appropriately.	□	Unreusable items are treated appropriately.	If checked: 1 point	
		85.Appropriate treatment of hazardous substances	851.Check if the appropriate treatment is being implemented.	□	Vehicle-derived hazardous substances (please specify in a separate sheet) are treated appropriately	If checked: 1 point	
		86.Appropriate recycling	861.Check if the recycling is implemented.	□	Metals are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			862.Check if the recycling is implemented.	□	Plastics are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			863.Check if the recycling is implemented.	□	Glass is recycled sufficiently and appropriately in the environment	If checked: 1 point	
			864.Check if the recycling is implemented.	□	Other materials are recycled sufficiently and appropriately in the environment	If checked: 1 point	
9.Construction waste (including construction and demolition waste that the city is not responsible for management)		91.Sorting and collection of construction waste at demolition	911.Choose the most appropriate percentage of collection of construction and demolition waste generated in your city. Such a collection system may be without any legal ground, including collection based on a market principle. If the percentage fluctuates according to changes in the market, choose the lowest percentage. (Percentage of segregated collection = amount of construction waste generated. If quantitative figures are not available, provide an approximate figure.)	○	95% or more	95% or more: 2 points; 50% or more: 1 point; The service is little implemented: No point	Evaluate by total score. 7/6 points→Grade 3 5/4 points→Grade 2 3/2 points→Grade 1 1/0 point→Grade 0
				○	50% or more		
				○	Nearly no construction waste is collected		
		92.Approval treatment of hazardous substances	921.Check if the appropriate treatment is being implemented.	□	Hazardous substances from construction and demolition waste (please specify in a separate sheet) are treated appropriately	If checked: 1 point	
		93.Appropriate recycling	931.Check if the recycling is implemented.	□	Asphalt and cement concrete is recycled sufficiently and appropriately in the environment	If checked: 1 point	
			932.Check if the recycling is implemented.	□	Metals are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			933.Check if the recycling is implemented.	□	Bricks are recycled sufficiently and appropriately in the environment	If checked: 1 point	
			934.Check if the recycling is implemented.	□	Other materials (including wood dust, glass, and plastics) are recycled sufficiently and appropriately in the environment	If checked: 1 point	

Legal system sheet

Type of legal system	Name of legal system
Legal system for waste management	
Legal system for efficient utilization of resources (e.g. recycling)	

*Please add more lines as needed.

Waste definition sheet

Type of waste	Definition
Municipal waste	
Hazardous waste	
E-Waste	
Motor vehicle	
Construction waste	

*Please add more lines as needed.

Calculation Formula Definition Sheet

Category	Definition
Collection rate of municipal waste	
Rate of separate collection at source	
Rate of sorting after collection	

Definition Sheet for Hazardous and Other Substances

Category	Definition
E-Waste:Definition of hazardous substance	
E-Waste: Definition of recycling of other than metals and plastics	
Vehicle: Definition of hazardous substance	
Vehicle: Definition of recycling of other than metals, plastics and glass	
Vehicle: Definition of hazardous substance	
Construction waste: Definition of recycling of other than asphalt, cement concrete, metals, bricks.	

1.2 An outline of solutions (Reference of "3.2.1 Resource circulation and waste management sector" in the Guidebook）

Here are compiled data of an outline of solutions in the resource circulation and waste management sector. Please refer to the below data when you determine a solution.

a. Policy packages

Individual policy packages in the resource circulation and waste management sector are shown below with its outline, responsible entities, expected effects, points to consider in implementation, related technologies and systems, and introduction examples.

Cross-sectional items		a. Establishing a legal system for waste management (p.44) b. Establishing a legal system for efficient utilization of g resources (including environmentally friendly design) (p.45 c. Developing a system for promoting collection and recycling (p.45) d. Supporting for technology development (p.46) e. Developing an incentive system (e.g. public procurement, group collections, and preferential treatment) (p.47) f. Education and awareness raising (p.49) g. Establishing Eco-Towns (p.50) h. Risk communication (p.51) i. Waste information sharing (p.52)
Municipal waste	**1. Generation**	a. Promoting a waste charging system (p.53) b. Establishing rules of segregated collection (p.54)
	2. Collection and transport	a. An approval and license system for collection and transport operators (p.55) b. Developing collection methods (p.56) c. Transfer stations (p.58)
	3. Sorting	a. Implementing segregated collection (p.59) b. Installing a sorting center (p.60)
	4. Appropriate treatment and recycling	a. Facilitating development of appropriate treatment and recycling technologies (p.60)
	5. Landfill (Final disposal)	a. Constructing a managed landfill site (p.61) b. Promoting technology for reducing amount of waste landfilled (p.63)
6. Hazardous waste		a. Developing a scheme for collecting hazardous substances (p.63) b. Mandatory appropriate treatment of hazardous substances (p.64)
7. E-waste		a. Mandatory recycling (p.65) b. A system for promoting reuse of electrical and electronic equipment (p.66) c. Second hand market (p.67)
8. Motor vehicles		a. Mandatory recycling (p.68) b. A system for promoting reuse of vehicles and the parts (p.69) c. Vehicle inspection and registration system (p.70)
9. Construction waste		a. Mandatory recycling (p.71) b. Promoting long life buildings (p.71)

ア）0. Cross-sectional items

Policy	**a. Establishing a legal system for waste management**
Outline	A legal system defines waste, waste treatment operators, waste treatment facilities and standards of waste treatment in order to secure living environment through preventing waste, as well as managing generated contaminants and hazardous substances and treating them in an environmental appropriate manner. It stipulates individual roles of various entities such as a member economy government, local governments, waste generators, citizens, and a scheme for appropriate waste collection and treatment. Many legal systems stipulate that household waste should be managed by local governments, and industrial waste should be managed by waste generators. They also designate hazardous waste. Legal systems generally stipulate that the hazardous waste should strictly be managed.
Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Securing appropriate waste collection and treatment
Points to consider in implementation	● It is preferable to clearly define entities that take responsibility of waste collection and treatment by properties and types of waste. ● If waste is not appropriately treated, it may seriously harm human health and environment. It is preferable to introduce penalties for violating a legal system and ensure enforcement. ● Appropriate implementation of legal systems requires a member economy government or a local government to improve its capability to give guidance and monitor. (It requires capacity building and human resource development.)
Related technologies and systems	● All the technologies and systems in the resource circulation and waste management Sector
Introduction examples	● In Japan, the Waste Management and Public Cleansing Law stipulates that municipal waste should be treated by local governments, and industrial waste should be treated by waste generators. In addition, the law requires special management of hazardous waste. If they violate the law, they will be punished by either imprisonment with labor or a fine.

Policy	**b. Establishing a legal system for efficient utilization of resources (including environmentally friendly design)**
Outline	Since there are issues for environmental and resource constraints while we try to achieve sustainable development, we should shift from the economic system of mass production and mass disposal to a recycling-oriented economic system. To this end, a legal system defines standards and individual roles in recovering and recycling of products, controlling waste generation by using resource saving and longer-lasting products, and reusing products and parts from recovered products. It stipulates individual roles of various entities such as a member economy government, business operators, and local governments, and a scheme for utilizing resources efficiently. You should consider a legal system based on current situations and legal systems of waste management and treatment in individual economies.
Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Using resources efficiently ● Prevention of waste
Points to consider in implementation	● It is preferable to consider an available scheme based on current situations and legal systems of waste management. ● It is preferable to consider planning a scheme for reducing and reusing products such as environmentally friendly designing and reusing as well as for recovering and recycling.
Related technologies and systems	● All the technologies and systems in the resource circulation and waste management sector
Introduction examples	In Japan, the Act on the Promotion of Effective Utilization of Resources (the Law for the Promotion of Effective Utilization of Resources) carries out the following measures: 1) recycling measures such as recovering and reusing products by business operators; 2) measures for controlling waste generation by using resource saving and longer-lasting products; and 3) measures for reusing products such as parts from recovered products.

Policy	**c. Developing a system for promoting collection and recycling**
Outline	This is a system for stipulating standards and individual roles of entities to address a shortage of landfill sites and promote the collection and recycling

	of designated waste for facilitating the efficient utilization of resources. Systems are often considered depending on properties of individual products, such as containers and packaging, electrical and electronic equipment, and vehicles, based on situations of waste generation, management, and treatment in each economy. In many cases, Extended Producer Responsibility (EPR) is applied to manufacturers of the products. In addition to the EPR, there is an idea that places the responsibility on waste generators as well.
Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Using resources efficiently ● Prevention of waste
Points to consider in implementation	● It is preferable to consider target products and an available scheme based on current situations and legal systems of waste management. ● You should carefully consider individual roles of responsible entities and cost burden.
Related technologies and systems	● All the technologies and systems for both 2. Collection and transport and 4. Appropriate treatment and recycling in the resource circulation and waste management sector
Introduction examples	In Japan, recycling systems are established for individual products with the aim of dealing with a shortage of landfill sites and facilitating the efficient utilization of resources. For example, the systems are the Containers and Packaging Recycling Law, the Home Appliance Recycling Law, the End-of-Life Vehicles Recycling Law, the Construction Material Recycling Law, the Food Recycling Law, and the Small Home Appliance Recycling Law. Those laws specify individual roles of entities and cost burden based on properties of individual products.

Policy	**d. Supporting for technology development**
Outline	This is necessary support provided by a member economy government or a local government for the practical use of waste management and recycling technologies that public entities or private companies are developing. Supporters are a member economy government, local governments, or other institutions that serve as proxy for a member economy government, or local governments. Entities receiving support are public entities or private

	companies that have waste treatment and recycling technologies, and capabilities to conduct pilot projects. The selected entities will receive necessary financial support, carry out pilot projects, develop technologies, and report the results in order to promote technologies.
Responsible entities	● Public entities or business operators that have waste treatment and recycling technologies
Expected effects	● Improving waste treatment and recycling technologies ● Promoting waste treatment and recycling technologies, and developing awareness
Points to consider in implementation	● It is preferable to hold a committee consisting of experts in order to fairly select entities that have a technology applicable for technology development support. ● It is preferable to consider the promotion possibility and promotion measures of the developed technologies at the same time.
Related technologies and systems	● All the technologies and systems in the resource circulation and waste management sector
Introduction examples	In Japan, New Energy and Industrial Technology Development Organization (NEDO) supports waste management and recycling technology development. One of NEDO's recent technology development support is Solar Power Recycling Technology Development Project (2014 - 2018) including survey on low cost removal, sorting, recovery and disposal technologies of solar power generation system and feasibility study on low cost dismantling and treatment technology for solar cells.

Policy	**e. Developing an incentive system (e.g. public procurement, collection by civil group, and preferential treatment)**
Outline	This system offers related entities incentives to proper waste management as well as promotion of the efficient utilization of resources. Examples of incentive system are public procurement, group collection, and preferential treatment (e.g. tax reduction and exemption for recycling facilities).
Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Conducting appropriate collection and treatment of waste ● Promoting efficient use of resources

Points to consider in implementation	● When you establish public procurement criteria, you should fully consider the fairness of market competition. ● Funding for incentives needs to be continuously secured.
Related technologies and systems	-
Introduction examples	Please refer to the below.

Specific policy	**e. Developing an incentive system－(A) Public procurement**
Outline	This intends to promote a shift of demand by establishing public procurement criteria and promoting public procurement of products and services which contribute to reducing negative impact to the environment. There are some examples of a system which stipulates member economy government's activities as well as responsibility of local governments, business operators, and citizens.
Advantages	● Establishing public procurement criteria can promote products and services which contribute to reducing negative impact to the environment. ● For business operators, developing products and services which meet public procurement criteria is their incentives.
Points to consider	● You should fully consider fair market competition before establishing public procurement criteria.
Introduction examples	In Japan, the Green Purchasing Law stipulates public procurement criteria. In accordance with the criteria, a member economy government and local governments procure products and services contributing to reducing negative impact to the environment.

Specific policy	**e. Developing an incentive system－(B) Collection by civil group**
Outline	This is a voluntary recycling activity. Citizens can decide collection time and date, places, and types of waste, and then take recyclable waste out of their houses, which is collected by recycling operators. Depending on the amount of waste to be recycled, the residents can receive reward from a local government.
Advantages	● Civil activities can reduce administrative costs of waste collection and transport. ● A civil group can receive reward for its collection activity
Points to consider	● Funds for incentives continuously need to be secured.
Introduction examples	In Japan, local governments support collection by civil groups. For example, a civil group applies for a registered group of a local government, and it then reports the result of collection to the local government. The local government provides reward with the civil group several times a year.

Specific policy	**e. Developing an incentive system－(C) Preferential treatment**
Outline	This is a system for providing tax relief to facilities or business operators which meet certain criteria in order to promote appropriate waste management as well as efficient use of resources.
Advantages	● Establishing criteria for providing tax relief can promote appropriate waste management as well as efficient use of resources.

	● For business operators, developing facilities which meet the criteria is their incentives.
Points to consider	● Funds for incentives continuously need to be secured.
Introduction examples	In the past of Japan, when you introduced recycling facilities (e.g. plastic recycling facilities or recycled paper manufacturing facilities), there was a system for applicants who satisfy certain requirements to receive special depreciation for the facilities, reduction of real property tax, business facility tax and other taxes.

Policy	**f. Education and awareness-raising**
Outline	Appropriate management of household waste and promotion of efficient use of resources need citizens to understand the necessity of appropriate waste management and recycling. To this end, a member economy government or local governments provide citizens with education and awareness-raising. Only developing systems is not enough. Effective waste management and recycling can be carried out only after obtaining understanding and cooperation of citizens. More specifically, if you tell citizens how to separate waste and what the separated waste is recycled into, citizens deepen their understanding, thereby facilitating public cooperation. In addition to citizens, business operators who currently deal with waste treatment and recycling as well as individuals also need to know appropriate waste treatment and recycling methods. In the long run, accurate knowledge and experience that business operators who currently engage in waste treatment and recycling as well as individuals will make appropriate waste treatment and recycling possible, and lead to protection of environment as well as the health of people engaging in waste treatment and recycling. Examples of education and awareness raising are distribution of reference materials and explanation at meetings with stakeholders. You can also consider development of a licensing system. In some cities, the range of individual works of municipal staff is unclear or there is no budget for their work, so that activities in the resource circulation and waste management sector may not be carried out. In that case, you should recognize the necessity and importance of activities in the sector, and conduct activities for improving job performance. Examples of education and awareness raising are distribution of reference materials and participation in training offered by international organization or other economies. When some economies have insufficient education in the resource circulation and waste management sector, you should start establishing a system for basic and higher education.

Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Conducting appropriate collection and treatment of waste ● Promoting efficient use of resources
Points to consider in implementation	● Securing funding needed for providing education and awareness-raising ● A member economy government and local governments provide education and awareness-raising. In addition, school education and collaboration with NGOs are also considered.
Related technologies and systems	-
Introduction examples	In Japan, there are examples that education and awareness raising activities utilize an original character to draw attention of citizens. In this case, if a member economy government or a local government invites entries for character design to the public, it provides them for opportunities to consider waste appropriate management as well as promotion of efficient resource utilization. For instance, Kitakyushu city in Fukuoka prefecture of Japan publishes comprehensive environmental education text books targeting different age groups from infants to junior high school students, as well as shares environmental information.

Policy	**g. Establishing Eco-Towns**
Outline	This is a project of local governments for supporting the development of advanced environmentally friendly towns in collaboration with citizens and local industries. The project aims to establish a recycling based society by regional developments through promotion of environmental industry utilizing local industrial experiences, as well as preventing waste promoting recycling based on regional identities. Establishing Eco-Town is development of recycling industrial clusters, industrial symbiosis, and collaboration activities with citizens.
Responsible entities	● A member economy government ● Local governments ● Business operators ● Citizens
Expected effects	● Reducing amount of waste landfilled

	● Improving rate of material recycling ● Reducing utilization of natural resources
Points to consider in implementation	● Securing raw materials needed for material circulation in an Eco-Town ● Securing a market for recycled products in a region ● Less cost-effectiveness due to the advanced treatment ● Considering advanced heat and energy supply system utilizing waste as energy source through not only gathering waste management industry and recycling industry, but also adjacency with the manufacturing industry or heat utilization facilities (e.g. power generation plants)
Related technologies and systems	● All the technologies and systems in the resource circulation and waste management sector
Introduction examples	As an example of Eco-Town projects in Japan, Kitakyushu Eco-Town consists of three areas: comprehensive environmental industrial complex; practical research area; and Hibiki recycling area. The comprehensive environmental industrial complex gathers waste recycling plants in coastal area, or Hibiki-nada, to establish a waste and energy recycling system. The practical research area gathers recycling and waste treatment research institutions. There are research institutions of universities and R&D facilities of companies. The Hibiki recycling area gathers SME (small and medium-sized enterprise) of waste management industry to promote recycling appropriately and efficiently as well as foster recycling venture companies.

Policy	**h. Risk communication**
Outline	This is a measure for all stakeholders such as citizens, business operators, and local governments to share information on risks and take measures against problems through mutual communication. It includes efforts to achieve the transparency of information on facility maintenance and management and to get understanding of the construction of waste management facilities from surrounding residents so that risks of waste management can be appropriately evaluated.
Responsible entities	● Local governments ● Business operators ● Citizens
Expected effects	● Facilitating waste management ● Promoting appropriate management and the efficient use of resources

Points to consider in implementation	● For carrying out risk communication, you should accurately understand the stakeholders. ● For carrying out risk communication, you should refer to examples in waste management or related sectors.
Related technologies and systems	-
Introduction examples	In Tokyo Japan during the period of high economic growth, while the amount of waste increased rapidly, the construction of waste incineration facilities remained hampered by protest movements of surrounding residents. As a result, a large amount of waste was landfilled, which degraded the environment around the landfill sites. In particular, in Koto Ward, which accepted most of the waste generated in the 23 wards of Tokyo, landfills threatened the living environment of surrounding residents. For example, odor, a large number of flies and mosquitos were generated from landfills, and garbage trucks fouled residential roads. In such a situation, Koto Ward made a decision to protest against carried-in waste. Also, Koto Ward rejected carried-in waste from Suginami Ward because there was an active protest movement against a construction plan of a waste incineration facility in Suginami Ward at the same time. Having a strong sense of crisis, in September 1971, the Governor of Tokyo declared “garbage war,” saying that the impending crisis of waste was threatening the lives of the citizens of Tokyo, and asserted that he would take thorough measures managing waste including promoting the construction of incineration plants and landfills. As a result of their practice, the situation became under control. The garbage war raised awareness among people that waste is a very important issue in daily lives. They recognized the importance of the cooperation of the government and residents to promote cleaning and waste management. At the same time, the improvement of treatment facilities which are friendly to the surrounding environment was promoted.

Policy	**i. Waste information sharing**
Outline	Some waste contains something which can be effectively reused as a resource by other business operators. This is an effort to promote the reuse of such waste by collecting information on waste and provide it widely to business operators and help them find the waste they want. It includes matching of business operators who are capable of appropriate waste management and the efficient use of resources, and certification and disclosure of such business operators.

Responsible entities	● Local governments ● Business operators
Expected effects	● Facilitating waste management ● Promoting appropriate management and the efficient use of resources
Points to consider in implementation	● For sharing information on business operators, local governments need to be responsible for collecting and integrating information from business operators and providing it. ● It is necessary to pay attention to ensure the accuracy and reliability of information.
Related technologies and systems	-
Introduction examples	Local governments in Japan (e.g. Kanagawa Prefecture) have a waste information sharing system on industrial waste generated from business operators, whereby they carry out information sharing and matching on waste to achieve the efficient use of waste.

イ）1. Generation

Policy	**a. Promoting a waste charging system**
Outline	This is a charging system on waste generation for increasing incentives to prevent waste and contributing to waste management cost. There are a variety of fee systems. One example is a fee system that waste generators pay fees depending on waste generated or the frequency of collection. Other examples are a multistage fee system, including a partial free-of-charge stage, and a fee system for imposing large waste generators extra charges for their huge amount of waste. More specifically, there is a system for designating bags for waste collection and charging a certain amount of fee for every bag.
Responsible entities	● Citizens (when household waste is charged) ● Business operators (when industrial waste is charged)
Expected effects	● Prevention of waste ● Raising awareness of citizens ● Making citizens' expenses fair (waste generators pay expenses) ● Reducing expenses of waste management

Points to consider in implementation	● If household waste is charged, there is a probability that a lot of waste will be brought in garbage boxes of public places such as stations, parks, and stores. ● System design may provide less effects of preventing waste because their shares of expenses are lower, or may not reduce burdens because complicated administrative procedures required more expenses for managing a system.
Related technologies and systems	● Waste reduction technology at sources (e.g. dehydration and drying of food residue) (resource circulation and waste management sector 1-a)
Introduction examples	In Singapore, household waste is collected by a fee charging system. How to dispose and how much the fee to pay differs depending on the type of residence: apartment/condominium or house. In Japan, waste collection at fixed time and using designated translucent garbage bags enable a local government to easily monitor whether residents comply with rules. As a result, the waste charging system is promoted. In addition, a fee for recyclable waste is often discounted.

Policy	**b. Establishing rules of segregated collection**
Outline	This is introducing a collection system for separating waste by type to promote appropriate waste management and make waste collection and transport efficient. A door-to-door collection area should adopt a “source separation system,” while a station collection area should adopt a “separation at stations system.” In order to promote waste separation by citizens, it is effective way to distribute waste separation containers to individual households. When you introduce a separate collection system, you need to set rules of separate collection based on the result of basic survey in a city. After that, you need to obtain people’s understanding beforehand. You should explain objectives of introducing a separate collection system, and comment on its merits and demerits to achieve consensus. Following the consensus achievement, you should hold meetings for residents to promote and share rules of separate collection before introduction. After the separate collection is started, it is preferable to conduct a survey of actual situations, and review the result of the survey.
Responsible entities	● Local governments ● Citizens
Expected effects	● Promoting appropriate waste treatment

	● Reducing waste management costs ● Increasing the efficiency of waste collection and transport ● Making waste pretreatment process efficient ● Promoting efficient utilization of resources
Points to consider in implementation	● You should develop a recycling system after separation, as well as separate classification corresponding to waste treatment technologies. ● You should apply a separate classification acceptable to citizens. ● You should set model collection areas to review the introduction of a separate collection system, and then promote it into all the area, rather than introducing the system to all city at one time. ● There is a risk for mixing different types of waste due to improper separation by citizens. After introduction, citizens who do not engage in separate collection, you should consider imposing fines on them.
Related technologies and systems	-
Introduction examples	The City of Liverpool in Australia distributes three types of colored tins to individual households and promotes separate collection at a household. The city stipulates that a yellow tin is used for recyclable waste, a green tin is used for garden waste, and a red tin is used for rest municipal waste. Marikina City of Philippines requires residents to use ribbons or bags with different colors in order to separate waste. The residents use green ribbons or bags for food waste. In addition, they use pink ribbons or bags for waste other than food waste.

ウ）2. Collection and transport

Policy	**a. An approval and license system for collection and transport operators**
Outline	This is an authentication system for only waste collection and transport operators who have capabilities to collect and transport waste in order to prevent deterioration of public health through inappropriate waste collection and transport as well as inappropriate treatment. One of criteria for waste collection and transport operators is whether they have facilities not to fly and leak waste as well as emit odor.
Responsible entities	● Business operators (collection and transport operators) ● Local governments
Expected effects	● Improving environmental hygiene

	● Promoting appropriate waste treatment
Points to consider in implementation	● When you have a facility to transship and store waste, you need to take measures concerning the facility not to fly and leak waste, as well as spread and emit odor.
Related technologies and systems	● Compaction trucks (resource circulation and waste management sector 2-a) ● A vehicle dispatching system (resource circulation and waste management sector 2-b)
Introduction examples	Singapore has a licensing system and collection and transport operators of municipal waste are selected through government bids. The bidding system is introduced into nine regions. Selected operators collect municipal waste and transport it to incineration facilities. Recycling resources are also collected, separated, and then transported to a recycling center. The Waste and Resource Management Department invites bids and manages operators. The contract term is seven years.

Policy	**b. Developing collection methods**
Outline	This is a policy for developing a household waste collection system to appropriately manage waste and improve the efficiency of waste collection and transport for recycling. Collection methods are basically classified into door-to-door collection or collection at a station.
Responsible entities	● Citizens ● Waste collection operators
Expected effects	● Increasing a collection rate ● Enhancing an aesthetic of roads and improving environmental hygiene ● Reducing collection cost and time
Points to consider in implementation	● Advantages and disadvantages of door-to-door collection and collection at a station are inextricably linked each other. A collection system needs to be developed depending on a situation of a target area. When you place importance on the reduction of time and effort of residents and environmental hygiene, you should select door-to-door collection. On the other hand, when you place importance on the efficiency of collection, you should select collection at a station. ● Waste collection and transport costs generally account for a larger proportion of the overall cost of waste treatment. You should therefore consider the development of a collection system taking into account actual cost of waste collection and transport.

Related technologies and systems	● Compaction trucks (resource circulation and waste management sector 2-a) ● A vehicle dispatching system (resource circulation and waste management sector 2-b)
Introduction examples	● In Singapore, under the National Recycling Program, government-approved waste collectors need to provide a recycling bin per household for recyclable waste. Residents can put cans, glass bottles and containers, plastic containers such as hangers and CDs, paper and cardboard, and used cloth into the recycling bins.

Specific policy	**b. Developing collection methods －(A) Door-to-door collection**
Outline	This is a system for placing household waste in front of individual doors. The waste is collected by a small vehicle, such as a handcart, a tricycle with a bell, and a light vehicles, and then brought in a parked collection vehicle.
Advantages	● Improving environmental hygiene of roads by removing waste containers from roads. ● Reducing residents' time and effort for placing waste and increasing a waste collection rate ● Identifying waste generators and dealing with bad manners
Points to consider	● Waste collection takes time and cost. It is comparatively inefficient. ● Some cases of waste collection on narrow roads are difficult because of types of collection vehicles.
Introduction examples	Chennai city of India abolished a waste collection system using waste containers (boxes and bunkers) on roads, and instead introduced door-to-door collection in May 2003, in order to improve environmental hygiene. Collection is conducted by a tricycle, a type of bicycle towing a cart. The number of waste containers on roads was reduced from 14,000 to 1,300 by November, 2004.

Specific policy	**b. Developing collection methods —(B) Collection at a station**
Outline	This is a system for placing municipal waste and recyclable waste from individual houses to a designated station. Waste at a designated station is collected by a collection vehicle. There are two types of collection at a station: installing waste containers; or instead of installing waste containers, putting garbage into garbage bins or plastic bags and placing them at a station.
Advantages	● Improving collection efficiency compared to door-to-door collection and reducing time and cost

Points to consider	● This system does not identify waste generators, so that violation of rules and bad manners are likely to cause. Dealing with such acts is difficult. ● In an area where an interpersonal relationship is poor, troubles with a station designation often occur. ● A station is damaged by animals, thereby worse environmental hygiene.
Introduction examples	After the 1960s in Japan, collection at a station is a major system, adopted by 80% or more of local governments. This system improves collection efficiency.

Policy	**c. Transfer stations**
Outline	This is a transfer system for using transfer stations when collected waste should be transported into the end point which is far from the collection site. The transfer stations are used as places where the collected waste from collection vehicles is loaded into larger container vehicles. This system often improves transport efficiency and leads to cost reduction. In some transfer systems, waste is compressed at transfer stations, thereby reducing the volume of waste by reducing water contained in waste.
Responsible entities	● Business operators (waste collection operators)
Expected effects	● Waste collection and transport operations ● Decreasing the number of waste collection vehicles ● Reducing transport cost ● Transporting a large amount of waste at one time reduces the number of waste collection vehicles and transportation distance of individual collection vehicles, thereby controlling air pollution caused by traffic jams and exhaust gases as well as CO_2 emissions.
Points to consider in implementation	● If a destination is not far enough to transport, this system may lead to inefficiency. ● Since transport vehicles may cause a traffic jam, you should consider conditions of transport pathways and road maintenance in order to facilitate smooth transportation.
Related technologies and systems	● Compaction trucks (resource circulation and waste management sector 2-a) ● A vehicle dispatching system (resource circulation and waste management sector 2-b)
Introduction examples	Ho Chi Minh City sets up transfer stations at two places in order to efficient transport of household waste. Municipal waste in a city are firstly collected by an environment public corporation or unofficial private organizations with using handcarts. The waste is stored into a 660-liter container with a cover, and transported by a handcart, a tricycle, a tricycle scooter, and a 2 to 4-ton compactor collection vehicle. After that, the waste is transport into designated

	storing bases and transfer stations.

エ）3. Sorting

Policy	**a. Implementing segregated collection**
Outline	This is introducing a collection system for separating waste by type to promote appropriate waste management and make waste collection and transport efficient. A door-to-door collection area should adopt a "source separation system," while a station collection area should adopt a "separation at stations system." In order to promote waste separation by citizens, it is effective way to distribute waste separation containers to individual households. When you introduce a separate collection system, you need to set rules of separate collection based on the result of basic survey in a city. After that, you need to obtain people's understanding beforehand. You should explain objectives of introducing a separate collection system, and comment on its merits and demerits to achieve consensus. Following the consensus achievement, you should hold meetings for residents to promote and share rules of separate collection before introduction. After the separate collection is started, it is preferable to conduct a survey of actual situations, and review the result of the survey.
Responsible entities	● Local governments ● Citizens
Expected effects	● Promoting appropriate waste treatment ● Reducing waste management costs ● Increasing the efficiency of waste collection and transport ● Making waste pretreatment process efficient ● Promoting efficient utilization of resources
Points to consider in implementation	● You should develop a recycling system after separation, as well as separate classification corresponding to waste treatment technologies. ● You should apply a separate classification acceptable to citizens. ● You should set model collection areas to review the introduction of a separate collection system, and then promote it into all the area, rather than introducing the system to all the city at one time. ● There is a risk for mixing different types of waste due to improper separation by citizens. After introduction, citizens who do not engage in separate collection, you should consider imposing fines on them.
Related technologies and systems	● Sorting technology (resource circulation and waste management sector 3-a)
Introduction examples	The City of Liverpool in Australia distributes three types of colored tins to individual households and promotes separate collection at a household. The city stipulates that a yellow tin is used for recyclable waste, a green tin is used

	for garden waste, and a red tin is used for rest municipal waste. Marikina City of Philippines requires residents to use ribbons or bags with different colors in order to separate waste. The residents use green ribbons or bags for food waste. In addition, they use pink ribbons or bags for waste other than food waste.

Policy	**b. Installing a sorting center**
Outline	After the waste collection process, this policy is to install a sorting center for separating waste by types of material before treatment. This takes less time and effort of separation by waste generators and improves services for citizens, while it prevents risks caused by improper separation of citizens. Combining this policy with separate collection greatly increases a level of sorting.
Responsible entities	● Business operators (Waste collection operators)
Expected effects	● Reducing waste management cost ● Increasing appropriate treatment rate of hazardous waste ● Increasing a recycling rate of valuable resources ● Preventing waste contamination by improper separation
Points to consider in implementation	● A sorting technology should be introduced, corresponding with a waste treatment technology as well as a recycling system after the sorting process. ● Maintenance and management costs of a center should be considered. ● Compared to waste sorting at source, this policy needs less involvement of citizens at the time of municipal waste disposal. You should consider the possibility that citizens may be less interested in preventing waste and appropriate waste management.
Related technologies and systems	● Sorting technology (resource circulation and waste management sector 3-a)
Introduction examples	In Singapore, waste is separated into municipal waste and recyclable waste before collection. Recyclable waste is brought in a recycling center. The recyclables are gone through a sorting process by machines of facilities, sorted into paper, plastics, glass bottles, and metals, and then individually recycled.

オ）4. Appropriate treatment and recycling

Policy	**a. Facilitating development of appropriate treatment and recycling technologies**

Outline	A member economy government provides necessary support for the practical use of appropriate treatment and recycling technologies that public entities or private companies are developing. Supporters are a member economy government, local governments, or other institutions that serve as proxy for a member economy government, or local governments. Entities receiving support are public entities or private companies that have a waste treatment technology, and capabilities to conduct pilot projects. The selected entities will receive necessary financial support, carry out pilot projects, develop technologies, and report the results in order to promote technologies.
Responsible entities	● Business operators (public entities or business operators that have appropriate treatment and recycling technologies)
Expected effects	● Improving appropriate treatment and recycling technologies ● Promoting appropriate treatment and recycling technologies and raising awareness
Points to consider in implementation	● It is preferable to hold a committee consisting of experts in order to fairly select an entity that has a technology applicable for this policy. ● At the same time, it is preferable to consider possibilities of promoting developed technologies and promotion measures as well.
Related technologies and systems	● All the technologies and systems for 4. appropriate treatment and recycling in the resource circulation and waste management sector ● Recovering valuable substances from wastewater (relevant items in other sectors 4-d)
Introduction examples	In Japan, New Energy and Industrial Technology Development Organization (NEDO) supports waste management and recycling technology development. One of NEDO's recent technology development supports is Solar Power Recycling Technology Development Project (2014 - 2018) including survey on low cost removal, sorting, recovery and disposal technologies of solar power generation system and feasibility study on low cost dismantling and treatment technology for solar cells.

カ）5. Landfill (Final disposal)

Policy	**a. Constructing a managed landfill site**
Outline	This is developing a landfill site for controlling appropriate hygienic conditions. After being landfilled, many of waste are gradually decomposed to generate hazardous substances or contaminants, thereby often resulting in

	environmental pollution around a landfill site. Construction and appropriate management of a landfill site allowing you to properly control hygiene conditions, prevent environmental pollution
Responsible entities	● Administrators of landfilled waste ● Local governments and other entities which construct a landfill site
Expected effects	● Reducing environmental pollution in a landfill site
Points to consider in implementation	● Even if an appropriate landfill site is constructed, there is a probability of generating environmental pollution by contamination of hazardous substances. ● Funding construction and management and securing land are required. ● Developing an appropriate managed landfill site reduces water pollution caused by waste. ● Developing an appropriate managed landfill site reduces soil contamination caused by waste, because soil contamination could be a big issue after the closure of the landfill site. ● Administrators should improve their capabilities in order to appropriately manage a landfill site. (e.g. capacity building or human resource development) ● In order to develop a landfill site, you should consider measures to bring about efficient waste management including road maintenance for transporting waste to a landfill site. ● It is important to take measures against greenhouse gases (e.g. methane) emitted from a landfill site.
Related technologies and systems	● Technology for designing and constructing landfill sites (resource circulation and waste management sector 5-a) ● Landfill site management technology (resource circulation and waste management sector 5-b) ● Technology for managing a hazardous waste landfill site (resource circulation and waste management sector 6-b)
Introduction examples	In Japan, the Ordinance Specifying Technical Standards Pertaining to General Waste Disposal Plants and Industrial Waste Disposal Plants stipulated structural standards and maintenance management criteria of landfill sites, and it requires prior notification of a new constructed landfill site. After the revision of the ordinance in 1998, it improved seepage design criteria by types of landfill sites, such as municipal waste, controlled, shield type, and stable type landfill sites. As a result, reservoir and storage were

	being valued as functions of landfill sites. Now, waste is landfilled depending on the quality of waste (stability and safety).

Policy	**b. Promoting technology for reducing amount of waste landfilled**
Outline	This is a policy for promoting a technology of reducing amount of landfilled waste. In terms of sustainability of waste management, we should make efforts for reducing amount of waste landfilled in order to use a landfill site as long as possible. Approaches for reducing amount of waste landfilled are preventing waste, promoting reuse, recycling, and separate treatment depending on type of waste. Since there are many kinds of waste, industrial waste should be approached by industry sector, and household waste should be approached by type of waste. Administrators need individual entities to take measures based on each goal.
Responsible entities	● Industrial waste generators ● Waste treatment operators ● A member economy government, local governments ● Citizens
Expected effects	● Reducing amount of waste landfilled volume makes longer use of a landfill site ● Promoting appropriate treatment ● Mitigating water pollution and soil contamination caused by waste through the reduction of amount of landfilled waste
Points to consider in implementation	● Various approaches are considered. Considering current amount of waste landfilled and probabilities of reducing amount, you need to select a cost-effective measure.
Related technologies and systems	● All the technologies and systems for 4. appropriate treatment and recycling in the resource circulation and waste management sector
Introduction examples	In Australia, under the “National Waste Policy: Less Waste, More Resources,” the Department of the Environment and Energy aims at promoting a technology for reducing amount of waste landfilled and provides an Alternative Waste Treatment Fund which subsidizes project development using anaerobic digestion treatment technology, and composting technology.

キ）6. Hazardous waste

Policy	**a. Developing a scheme for collecting hazardous substances**
Outline	This is a policy for developing a scheme for recovering hazardous substances to mitigate health damage caused by hazardous substances. Hazardous substances could endanger human health and living environment, so that they should be managed throughout the lifecycle. At a recovery stage, establishing a management system can prevent them from damaging. Target substances are heavy metals including Mercury, Lead, and Cadmium. Management measures, which should be mandatory, are establishing an approval system of treating waste containing hazardous substances, assigning a designated administrator for generating waste containing hazardous substances, and preparing hazardous waste information.
Responsible entities	● Waste treatment operators (in particular, business operators treating hazardous substances) ● Business operators (Generators of waste containing hazardous substances)
Expected effects	● Mitigating health damage caused by hazardous substances ● Mitigating environmental pollution (water pollution, soil contamination, and air pollution) through the development of an appropriate system
Points to consider in implementation	● It is preferable for managing hazardous substances during each stage of the lifecycle as well as a recovery stage.
Related technologies and systems	● Hazardous waste treatment technology (resource circulation and waste management sector 6-a) ● Technology for managing a hazardous waste landfill site (resource circulation and waste management sector 6-b)
Introduction examples	In Singapore, the handling, treatment, and disposal of hazardous substances are controlled under the Environmental Public Health (Toxic Industrial Waste) Regulations 1988. Under the regulations, all the hazardous substance collectors must be licensed.

Policy	**b. Mandatory appropriate treatment of hazardous substances**
Outline	This is a policy for developing a scheme for recovering hazardous substances to mitigate health damage caused by hazardous substances. Hazardous substances could endanger human health and living environment, so that they should be treated appropriately to prevent them from being emitted to the environment. Therefore, you should identify

	hazardous substances, and obligate treatment operators appropriately treat them depending on their properties. When you select hazardous substances, you should consider their explosive and poisonous natures and infectivity that might endanger human health and living environment. For example, the substances are mercury, smoke and dust, waste oil, waste alkali, and other industrial waste which might be infectious.
Responsible entities	● A member economy government ● Local governments ● Waste management operators (in particular, business operators treating hazardous substances) ● Business operators (e.g. manufacturers of products containing hazardous substances and generators of waste containing hazardous substances)
Expected effects	● Mitigating damage to human health and living environment caused by hazardous substances ● Mitigating environmental pollution (water environment pollution, soil contamination, and air pollution) through the development of an appropriate system
Points to consider in implementation	● Individual hazardous substances widely vary in properties and sources, so that they should appropriately be treated depending on substances.
Related technologies and systems	● Hazardous waste treatment technology (resource circulation and waste management sector 6-a)
Introduction examples	Victoria State of Australia stipulates rules of treatment of hazardous waste under the Environment Protection (Industrial Waste Resource) Regulations 2009.

ク）7. E-waste

Policy	**a. Mandatory recycling**
Outline	Inappropriate treatment and recycling of E-Waste (WEEE) (e-waste: Electrical and electronic waste) may cause environmental pollution and health damage. In addition, the e-waste is a large volume of waste, so that you may face a shortage of landfill sites. Therefore, the e-waste should effectively and efficiently be treated and recycled. In order to address these issues, recycling of e-waste is mandatory under a recycling system.

	Recycling of e-waste is mandatory in Japan, Europe, South Korea, China, and other economies. Target products and ways of making it mandatory vary depending on systems of individual economies.
Responsible entities	● Business operators (manufacturers and importers of electrical and electronic equipment and retailers) ● Consumers
Expected effects	● Preventing waste and promoting appropriate treatment ● Promoting efficient use of resources
Points to consider in implementation	● Entities which are obligated to recycle and actual content of the obligation should be decided based on individual economies. ● When you consider this policy, please refer to the existing systems in each economy.
Related technologies and systems	● E-Waste recycling technology (resource circulation and waste management sector 7-a) ● CFC recovery and treatment technology (resource circulation and waste management sector 7-b) ● Compression and shredding treatment (resource circulation and waste management sector 7-c) ● Advanced sorting (resource circulation and waste management sector 7-d)
Introduction examples	When consumers in Japan dispose of specified electrical home appliances (air-conditioners, televisions, refrigerators and freezers, and washers and dryers), they should appropriately be treated in accordance with the Home Appliance Recycling Law. Roles of retailers and manufacturers are defined as collection, transport, and recycling of these waste based on the standards defined the law.

Policy	**b. A system for promoting reuse of electrical and electronic equipment**
Outline	This is a system for promoting reuse of electrical and electronic equipment. Reusing usable products of used ones lead to preventing waste and prevent you from consuming resources and increasing environmental burdens at the time of manufacture and disposal. In addition, it improves the quality of life of low-income earners. To this end, you should consider measures, such as setting performance goals of reuse and establishing a system keeping reuse business in mind. On the other hand, administrators should prevent from buying and selling of stolen items and secure appropriate treatment of unsold items. When an approval system of waste collection is introduced,

	you should distinguish clearly collection of waste from collection of reusable items, such as paying attention to prevent evasion of the law and secure the quality of distributed products.
Responsible entities	● A member economy government ● Local governments ● Manufacturers, importers, and retailers of electrical and electronic equipment ● Providers of reuse services ● Consumers
Expected effects	● Preventing waste ● Reducing environmental burdens ● Improving the quality of life of low-income earners ● Reducing energy required at the times of manufacturing and disposal
Points to consider in implementation	● You should manage a system, paying attention to prevent evasion of the law. ● You should avoid distribution of bad quality products including broken and unusable products.
Related technologies and systems	● Burn-in test and repair technology for used electrical and electronic equipment (resource circulation and waste management sector 7-e)
Introduction examples	In Australia, a scheme organized by the Australian member economy government and local governments promotes reuse and recycling of e-waste in collaboration with charity shops under the Product Stewardship Scheme Act 2011.

Policy	**c. Second hand market**
Outline	This is a market for citizens to bring unnecessary household goods and engage in Consumer-to-consumer (C-to-C) commerce. Promoting reuse leads to the reduction of waste amount. It is held as an event, and sometimes e-commerce on the internet. Organizers are not only administrative bodies but also citizens' groups. The second hand market contributes to waste prevention and efficient use of resources, while we should pay attention to risks of trading license-required products without a license, or trading low quality products.
Responsible entities	● Local governments ● Citizens
Expected effects	● Preventing waste

	● Utilizing resources efficiently
Points to consider in implementation	● When an administrative body is not involved in organizing a second hand market, a certain level of rules should be defined in order to prevent illegal trading.
Related technologies and systems	-
Introduction examples	In Japan, local governments or citizens' groups often hold second hand markets. There are various kinds of traded items, including cloth, toys, daily commodities, and books.

ケ）8. Motor vehicles

Policy	**a. Mandatory recycling**
Outline	Waste from vehicles are a large volume of waste generation, so that you may face a shortage of landfill sites. In addition, when you treat and recycle them, rising treatment cost will be issues as a result of a drop-in resource prices. When treatment cost rises, illegal dumping, inappropriate treatment, and increasing abandoned products might become issues. To address these issues, a recycling system should obligate you to recycle waste from vehicles. Recycling of waste from vehicles is mandatory in Japan, Europe, South Korea, and other economies.
Responsible entities	● Business operators (manufacturers and importers of vehicles, and retailers) ● Consumers
Expected effects	● Preventing waste and promoting appropriate treatment ● Promoting efficient use of resources
Points to consider in implementation	● Entities which are obligated to recycle and actual content of the obligation should be decided based on individual economies. ● When you consider this policy, please refer to the existing systems of each economy.
Related technologies and systems	● Material recycling of ASR (Automobile Shredder Residue) (resource circulation and waste management sector 8-a) ● Thermal recovery of ASR (resource circulation and waste management sector 8-b) ● Material recycling of plastics (resource circulation and waste management sector 8-c)

	● CFC recovery and treatment technology (resource circulation and waste management sector 8-d) ● Compression and shredding treatment (resource circulation and waste management sector 8-e) ● Advanced sorting (resource circulation and waste management sector 8-f)
Introduction examples	As above mentioned, in Japan, the End-of-Life Vehicle (ELV) Recycling Law requires manufacturers and importers of vehicles to recover and recycle shredder residue, an airbag, and CFC. The treatment cost collected as a recycling fee is paid by an owner of the vehicle. This recycling fee is strictly managed by an asset management agency before being end-of-life vehicles.

Policy	**b. A system for promoting reuse of vehicles and the parts**
Outline	This is a system for promoting reuse of vehicles and the parts. Reusing usable products of used ones leads to preventing waste volume and prevent you from consuming resources and increasing environmental burdens at the time of manufacture and disposal. In addition, it improves the quality of life of low-income earners. To this end, you should consider measures, such as setting performance goals of reuse and establishing a system keeping reuse business in mind. On the other hand, administrators should prevent stolen items from being bought and sold and secure appropriate treatment of unsold items. When an approval system of waste collection is introduced, you should distinguish clearly waste collection from collection of reusable items, such as paying attention to prevent evasion of the law and secure the quality of distributed products.
Responsible entities	● A member economy government ● Local governments ● Manufacturers, importers, and retailers of vehicles ● Providers of reuse services ● Consumers
Expected effects	● Preventing waste ● Reducing environmental burdens ● Improving the quality of life of low-income earners ● Reducing energy required at the times of manufacturing and disposal
Points to consider in implementation	● You should manage a system, paying attention to prevent evasion of the law.

	● You should avoid distribution of bad quality products including broken and unusable products.
Related technologies and systems	● Inspection and assembly technology of reused parts of vehicles (resource circulation and waste management sector 8-g)
Introduction examples	-

Policy	**c. Vehicle inspection and registration system**
Outline	This is a system to inspect and register vehicles for the safety of vehicles, pollution prevention. This makes it possible to identify individual vehicles and institutionally understand the status of the ownership and use of each vehicle. Also, it cancels registration as deregistration of end-of-life vehicles when the use of vehicles is discontinued temporarily, when vehicles have already been scrapped, or when vehicles are not available due to a theft or a disaster. The cancellation of registration makes it clear that the vehicles are no longer used. Thus, it contributes to facilitating the introduction of other systems including a vehicle recycling system.
Responsible entities	● A member economy government ● Citizens ● Business operators
Expected effects	● Ensuring the safety of vehicles ● Prevention of pollution caused by vehicles ● The registration system makes it possible to confirm which vehicles are no longer used. Thus, it contributes to facilitating the introduction of other systems including a vehicle recycling system.
Points to consider in implementation	● The introduction of both the registration system and the inspection system makes it possible to achieve objectives including ensuring safety.
Related technologies and systems	-
Introduction examples	In the vehicle inspection and registration system in Japan, vehicles are registered so that the Ministry of Land, Infrastructure, Transport and Tourism can carry out periodical inspections of vehicles to see if they meet the safety standard and notarize the ownerships of vehicles. Also, because vehicles have been managed under the vehicle inspection and registration system (in

	particular, end-of-life vehicles can be confirmed by deregistration), easy introduction of the vehicle recycling system was easily introduced.

ヨ）9. Construction waste

Policy	**a. Mandatory recycling**
Outline	Construction waste is a large volume of waste generation, so that you may face a shortage of landfill sites. In addition, some economies and cities might concern about increasing construction waste depending on time of renewal. In such cases, illegal dumping and inappropriate treatment might become issues. To address these issues, a recycling system should obligate you to recycle construction waste. Recycling of construction waste is mandatory in Japan, South Korea, and other economies. Target waste and ways of making it mandatory vary depending on systems of individual economies.
Responsible entities	● Business operators (e.g. construction contractors and construction waste generators)
Expected effects	● Preventing waste and promoting appropriate treatment ● Promoting efficient use of resources
Points to consider in implementation	● Entities which are obligated to recycle and actual content of the obligation should be decided based on individual economies. ● When you consider this policy, please refer to the existing systems of each economies.
Related technologies and systems	● Concrete and asphalt recycling technology (resource circulation and waste management sector 9-a) ● Wood recycling technology (resource circulation and waste management sector 9-b) ● Construction sludge recycling technology (resource circulation and waste management sector 9-c) ● Compression and shredding treatment (resource circulation and waste management sector 9-d)
Introduction examples	In Japan, the Construction Material Recycling Law requires contractors to sort out and recycle waste generated in demolition work or building construction above a certain scale where the specified construction materials such as concrete (including precast concrete panels), asphalt/concrete, and wooden building materials are used.

Policy	b. Promoting long life buildings
Outline	This is a policy to promote the improvement of durability of building materials in order to achieve long life buildings. Specifically, the policy includes subsidies for exceptional projects which introduce advanced materials, technologies, and systems proposed and selected by open calls, and development of standards related to technological matters necessary to achieve greener buildings such as long life buildings with the aim of promoting environment protection measures in government buildings. Besides, it refers to incentive policies and compulsory policies to achieve the long life buildings and infrastructure. Specifically, the policies include setting public procurement criteria for pioneering products and infrastructure that will lead to long life and requiring manufacturers to develop long life design.
Responsible entities	● Business operators ● A member economy government ● Local governments
Expected effects	● Longer life buildings ● Preventing waste
Points to consider in implementation	● Since building materials used differ economy by economy, it is necessary to develop a standard which is consistent with the situation of each economy. ● Work is needed in conjunction with promoting collection and recycling of construction and demolition wastes ● In stipulating duties of public procurement standards and duties of product design, due consideration should be given to fair market competition. ● Because longer life may lead to an increase in the amount of the resources used for products and an increase in energy consumption (when new energy-saving equipment is developed, it may lead to an increase in energy compared to the new equipment), attention should be paid to a trade off with other elements. ● Longer life leads to an extended period of the use of products. When new energy-saving equipment is developed, it will cause an increase in energy compared to the new equipment.
Related technologies and systems	-

Introduction examples	In Japan, the population has shown a declining trend after peaking in 2005 and the quantitative sufficiency of housing has been achieved. As a result, the housing policy started to be based on stock and, in 2006, the Basic Act for Housing and the Basic Plan for Housing (National Plan) were established. Based on these, the member economy government declared a policy to promote the long life of housing in Innovation 25, which is a long-term strategic principle up to 2025, and in the Basic Policy on Economic and Financial Reform. Besides, other related policies, standards and principles have been actively established.

b. Technologies and systems

Technologies and systems in the resource circulation and waste management sector are shown below with its outline, selection of technology, expected effects, points to consider in introduction, and related policy packages.

In addition, in the 4.Individual technical sheets, an information collection sheet used for collecting data of technologies and systems from a business operator is attached. Please use the sheet when you ask a business operator about information on technologies and systems.

Municipal waste	**1. Generation**	a. Waste reduction technology at sources (e.g. dehydration and drying of food residue) (p.75) b. Home composting (p.75)
	2. Collection and transport	a. Compaction trucks (p.76) b. A vehicle dispatching system (p.77)
	3. Sorting	a. Sorting technology (p.78)
	4. Appropriate treatment and recycling	a. Incineration and recovery of incineration residue (p.81) b. Methane fermentation (p.84) c. Composting (p.85) d. Feed producing technology (p.86) e. Recycling technology (e.g. metal, glass, plastic, and paper) (p.87) f. Fuel producing technology (e.g. carbonization, RDF, and plastic oil) (p.88) g. Compression treatment (p.89) h. Shredding treatment (p.90)
	5. Landfill (Final disposal)	a. Technology for designing and constructing landfill sites (p.91) b. Landfill site management technology (p.92)
6. Hazardous waste		a. Hazardous waste treatment technology (p.93) b. Technology for managing a hazardous waste landfill site (p.94)
7. E-waste		a. E-Waste recycling technology (p.94) b. CFC recovery and treatment technology (p.95) c. Compression and shredding treatment (p.96) d. Advanced sorting (p.97) e. Burn-in test and repair technology for reused electrical and electronic equipment (p.98)
8. Motor vehicles		a. Material recycling of ASR* (p.99) b. Thermal recovery of ASR (p.100) c. Material recycling of plastics (p.101) d. CFC recovery and treatment technology (p.102 e. Compression and shredding treatment (p.103) f. Advanced sorting (p.104) g. Inspection and assembly technology of reused parts of vehicles (p.105)
9. Construction waste		a. Concrete and asphalt recycling technology (p.106) b. Wood recycling technology (p.107) c. Construction sludge recycling technology (p.108) d. Compression and shredding treatment (p.110)

*ASR means an abbreviation of Automobile Shredder Residue.

ア）1. Generation

Technology	**a. Waste reduction technology at sources (e.g. dehydration and drying of food residue)**
Outline	This is a technology for significantly reducing waste volume at sources by dehydration and drying liquid waste or waste with high moisture content such as food residue, thereby improving treatment efficiency. Equipment using dehydration technology is a centrifugal separator, a press machine, and a heating evaporator. Equipment using drying technology is a food residue dryer, and a heat pump Vacuum Compact Disc dryer.
Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Waste type whose volume should be reduced ➢ Capabilities of reducing waste volume ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume ● Improving efficiency of collection and transport as well as pretreatment
Points to consider in introduction	● When you consider reducing waste volume, you should check the details of the following processes of pretreatment, recycling and landfill, and then introduce a technology contributing to improving efficiency of the processes. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Promoting a waste charging system (resource circulation and waste management sector 1-a)

Technology	**b. Home composting**
Outline	This is a technology for converting kitchen waste into useful compost by microbial activity. There are some methods depending on types of fermenters and recently disposers of home food waste are also sold. In addition, there is a comprehensive example that citizens and NPOs promote waste composting and separation in a local community, and conduct awareness building and environmental education in order to achieve preventing waste.

Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management and the like) ➢ Costs (initial cost and running cost) ➢ Places where compost should be used
Expected effects	● Preventing waste volume ● Recycling of food waste
Points to consider in introduction	● You should select a composting method which you engage in comfortably and continuously at home.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c)

イ）2. Collection and transport

Technology	**a. Compaction trucks**
Outline	Compaction trucks are waste collection vehicles with rear loaders for waste collection and transport. An example is a Rotary Press vehicle with a rotating plate at the entrance of waste container in order not to disperse waste water and stuck. After the plate rotates and pulls waste, a compression board inside reduces its volume. Another is a Press Loader vehicle with the functionality of compression, which compresses waste and reduce its volume. Some compaction trucks mount a sewage tank for treating water from food waste.
Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Types of target collected waste ➢ Capability of reducing waste volume ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume ● Improving efficiency of collection and transport as well as pretreatment
Points to consider in introduction	● When you consider introducing compaction trucks, you should select the most efficient technology after checking improvements in the efficiency of waste collection and transport as well as methods used for

	the following processes of pretreatment, recycling and final disposal. (For example, when waste is too compressed in compaction trucks and cannot be sorted in the following process, there is concern about decreasing a recycling rate.) ● Since transport vehicles may cause a traffic jam, you should consider conditions of transport pathways and road maintenance in order to facilitate smooth transportation. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● An approval and license system for collection and transport operators (resource circulation and waste management sector 2-a) ● Developing collection methods (resource circulation and waste management sector 2-b) ● Transfer stations (resource circulation and waste management sector 2-c)

Technology	**b. A vehicle dispatching system**
Outline	This is a system for controlling efficient dispatches of vehicles depending on drivers and waste collection vehicles at the time of waste collection and transport. If you designate a collection route and instruct drivers and collection vehicles, collection and transport processes become more efficient. As a result, you can easily manage performance of waste collection and transport volume.
Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Types and frequency of target collected waste ➢ Items to be managed ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a rate of waste collection and transport
Points to consider in introduction	● You should fully consider the efficiency of systemization as well as cost-effectiveness of introduction of the system. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● An approval and license system for collection and transport operators (resource circulation and waste management sector 2-a)

	● Developing collection methods (resource circulation and waste management sector 2-b) ● Transfer stations (resource circulation and waste management sector 2-c)

ウ）3. Sorting

Technology	**a. Sorting technology**
Outline	This is a technology for sorting recyclable waste collected at one time by types of waste in facilities, and sorting the waste into bulky and non-combustible waste. The technology utilizes physical nature of targeted waste and properties of material. Representative types of sorting technology are introduced as follows. Combining those technologies sorts recyclable and shredded solid waste by type of waste. A) Waste screener B) Gravity separators (dry type and wind power sorting) C) Magnetic separators D) Eddy current separators E) Optical separators
Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Type of targeted waste to be sorted out ➢ Accuracy of sorting ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Separation and recovery of valuable resources ● Improving efficiency of pretreatment and landfilling
Points to consider in introduction	● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Implementing segregated collection (resource circulation and waste management sector 3-a) ● Installing a sorting center (resource circulation and waste management sector 3-b)

Specific technology	a. Sorting technology —(A) Waste screener
Outline	This technology is a screening method of utilizing a difference in particle size. Targeted waste is passed through a screen with different sizes of holes and then separated. The system is mainly classified into vibrating and rotary (trammel) screens, depending on screening mechanisms. Since a larger difference in particle sizes is more effective, it is important that you should in advance adopt a shredding which makes waste various physical sizes of particles. In general, this technology is widely used for removal of inappropriate waste and primary selection of shredded particles.
Advantages	● This technology is widely utilized because of easiness of operation. ● Sorting combustible waste from non-combustible waste shows good performance.
Points to consider	● Due to the low accuracy of sorting, it is mainly used as a primary screener. ● Adhesive materials and wires often clog a mesh of a screen, and hinder emissions. ● Accuracy of sorting bulky shredded waste is low.

Specific technology	a. Sorting technology —(B) Gravity separators
Outline	This technology is used for separating waste utilizing a difference of specific gravity, and mainly classified into dry and wet types. In general, waste sorting uses a dry type wind power sorting. Wind power sorting is classified into horizontal and vertical machines depending on the wind direction. These are adopted for sorting plastic bottles and aluminum cans, and glass bottles. (Horizontal) While air is blown horizontally, target waste is dropped there. Differences of fall velocities of target waste provide different travel distances, and then waste is sorted. (Vertical) While air is blown from the bottom of a vertical duct, target waste is dropped in the middle of the duct. Lighter waste is levitated, whereas heavier waste is dropped into a heavy waste hopper.
Advantages	● If difference of specific gravity is big, accuracy of sorting is considerable.
Points to consider	● This may cause noise and dust particles. ● Moisture of waste samples should be controlled. ● A horizontal machine dose not achieve higher accuracy of sorting than a vertical one, because fall velocity depends on shape as well as specific gravity. ● A vertical machine can only sort waste into two types: light and heavy

	waste.

Specific technology	**b. Sorting technology —(C) Magnetic separators**
Outline	This technology is used for separating iron from other materials. Equipment incorporating permanent magnet and electromagnet, attracts magnetic materials (iron) from mixed waste and separate iron from other materials. The equipment is classified into magnetic pulley, magnetic drum, and magnetic belt types depending on an arrangement of magnets in the equipment, and a mechanism for separating waste.
Advantages	● You can easily introduce a magnetic separator because it has simple principles.
Points to consider	● This machine is only used for separating magnetic materials from others.

Specific technology	**c. Sorting technology —(D) Eddy current separators**
Outline	This technology utilizes a force generated by the interaction between a magnetic field and eddy current produced in nonferrous metal moving in the magnetic field. The technology is classified into orthogonal belt conveyor, rotary drum, and rotating magnet methods. Among them, rotating magnet type equipment is generally used. This method uses a high-speed rotation drum incorporating magnets, pass conductive materials through the drum, dash the conductive materials forward by the interaction between eddy current and a magnetic field, and separates target waste from other materials. This technology is used for separating iron, nonferrous metals (copper, aluminum, and others) and nonmetals (plastics and others).
Advantages	● Rotating magnet type equipment uses permanent magnet, thereby reducing operating costs. ● The equipment deals with not only separation between metals and nonmetals, but also mutual separation between metals and other metals.
Points to consider	● Operating costs for an electromagnet type equipment is higher.

Specific technology	**c. Sorting technology —(E) Optical separators**
Outline	This is a technology for sensing reflected visible light or transmitted light using a sensing device, recognizing the difference of lightness, chromaticness, hue, size, and geometric forms of target waste, and separating them, or alternatively for detecting waste with a spectroscope, recognizing the difference of spectrum and transmittance and separating. The technology is used for separating glass bottles and cullet; colored metals and gray metals; and different colored minerals.

Advantages	● Optical separators can remove things that a waste screener or wind power cannot remove through sorting by its size, shape and gravity.
Points to consider	● If target waste overlaps, optical separators cannot sort waste perfectly.

エ）4. Appropriate treatment and recycling

Technology	**a. Incineration and recovery of incineration residue**
Outline	This is a technology for incinerating waste and recovery of ashes generated from incineration such as dissolving. This technology contributes to reducing waste volume, detoxification, and recycling, whereas you should be careful that the improper introduction of the technology may cause pollution problems. Major incineration facilities are introduced below. They are basically classified into incinerators which burn waste, and melting furnaces which melt waste at a high temperature. Another technology is a combination of these technologies. (A) Stoker-type incinerators (B) Fluidized-bed incinerators (C) Kiln-type incinerator (D) Pyrolysis gasification furnace and gasification melting furnace (E) Direct melting furnace
Selection of technology	When you select a specific technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Recycling of metal waste ➢ Operating systems (continuous, batch processing) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume ● Detoxification and keeping environmental hygiene ● Recycling of incinerated ashes and thermal recycling ● Utilizing energy efficiently
Points to consider in introduction	● Selection and pretreatment of an inappropriate technology could cause air pollution and generate dioxins. ● You should get a full understanding of residents before constructing incineration facilities, because people could protest against it because

	they concern the deterioration of environmental (air pollution, water pollution, soil contamination) around the facilities. ● Even if waste is incinerated, landfill is still needed for incineration ashes and sludge. You should require treatment of incineration ash and slag, such as recycling or landfill. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Facilitating development of appropriate treatment and recycling technologies (resource circulation and waste management sector 4-a)

Specific technology	**a. Incineration and recovery of incineration residue —(A) Stoker-type incinerators**
Outline	This is an incinerator for treating waste over the stoker which is a tiered fire grate. At the end of the process, ashes are emitted. Dissolving ashes requires to separately install an ash melting furnace.
Advantages	● This mature technology has a high degree of reliability. ● Combustion is stable, thereby easily automating and managing operation. ● Pretreatment of waste is not required. ● The technology is already established and it reduces emissions of dioxins to some extent.
Points to consider	● Dissolving of incineration ashes requires separate installation of an ash melting furnace. ● Emitted iron is oxidized, so that the resource value is low. Aluminum is also dissolved and thus cannot be recovered. ● A combustion process required time.

Specific technology	**a. Incineration and recovery of incineration residue —(B) Fluidized-bed incinerators**
Outline	This is an incinerator for dropping waste into a fluidized-bed incinerator, which is a furnace that quantity of air blows up the filled sand and causing it to behave like a fluid, and thermally decomposing non-combustible waste with utilizing heat of combustion. This technology is often used for gasification melting furnaces.
Advantages	● It is a space-saving technology. ● A combustion process requires a short time.
Points to consider	● As a pretreatment, facilities for shredding are required.

Specific technology	a. Incineration and recovery of incineration residue —(C) Kiln-type incinerator
Outline	This is an incinerator for putting shredded waste into a kiln (a rotating drum), steaming and burning it at around 450 degrees in a vacuum, and then decomposing it into pyrolysis gases and pyrolysis carbon. It is often used for a pretreatment process of gasification melting.
Advantages	● When you treat waste which has a certain heating value, it is possible to decompose waste with the heating value only. (Other kinds of fuels are not necessary.) ● Recovering unoxidized iron and aluminum from a residue is possible.
Points to consider	● Controlling the speed of thermal decomposition is technically difficult. (reliability)

Specific technology	a. Incineration and recovery of incineration residue —(D)Pyrolysis gasification furnace and gasification melting furnace
Outline	This is a technology for thermally decomposing waste at about 450 to 600 degrees under a reduced oxygen condition, combusting flammable gas and char particles (coal shaped unburned matter) subjected to higher heat (at or over 1200 to 1300 degrees), and melting ash content and non-combustible waste with the heat of combustion. There are various types of technologies such as a kiln type and a fluidized-bed type.
Advantages	● This technology controls emissions of dioxins. ● Combustion and treatment of the residue are conducted as one process.
Points to consider	● Incomplete combustion could generate hazardous substances.

Specific technology	a. Incineration and recovery of incineration residue —(E) Direct melting furnace
Outline	This technology is for decomposing and recycling a wide variety of waste—not only combustible waste but non-combustible waste, incineration residue, sludge, landfill waste, and CFC— at one time. No pretreatment is required. It can be used for all the processes of drying, thermal decomposition, and melting.
Advantages	● A wide variety of waste is decomposed and recycled at one time. ● No pretreatment is required. ● Power generation utilizing exhaust heat is possible.
Points to consider	● Heat sources are required. ● In particular, a technology using coke emits CO_2. ● Generation of flammable gas under high temperature and pressure should carefully be treated.

Specific technology	a. Incineration and recovery of incineration residue —(F) Ash melting furnace
Outline	This is a furnace for melting and reducing incineration ashes generated in an incinerator. It melts incineration ashes at or over 1300 degrees and compress it into slag which is a raw material for concrete. Methods are classified into electrical method, burner method, self-burning melting method, subsidiary materials method, and a calcining furnace, depending on melting methods.
Advantages	● The furnace can detoxify hazardous waste. ● Volume of incineration ashes is reduced almost by half. ● Reusing recovered slag as concrete aggregates or materials for asphalt roads leads to reducing a large volume of landfill waste.
Points to consider	● A large amount of fuel for treatment is needed, thereby resulting in emission of GHGs (Greenhouse Gas). ● Advanced technology for treatment is needed and it might cause pollution (air, soil, the quality of water). ● Efficient use of slag needs technology and treatment.

Technology	b. Methane fermentation
Outline	This is a technology for decomposing organic matter in an anaerobic environment and extracting biogas that is predominantly composed of methane gas. After removing foreign matter inapplicable to methane fermentation in pretreatment, you should decompose organic waste mainly composed of kitchen waste. After fermentation, biogas and fermentation residue are extracted. The biogas is used as fuel, and fermentation residue is dehydrated and then incinerated or utilized as compost. Treatment methods are classified into the below types. ➢ Wet type method / dry type method (a difference in solid concentration of target waste) ➢ Medium temperature method / high temperature method (a difference in fermentation temperature)
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Operating systems (continuous, batch processing) ➢ Places where generated gas and compost should be used ➢ Securing operation and maintenance equipment, as well as human resources

Expected effects	● Reducing waste volume ● Recycling methane gas and fermentation residue ● Utilizing energy efficiently (reusing methane generated through fermentation treatment as fuel)
Points to consider in introduction	● Implementation of normal methane fermentation treatment requires appropriate separation and pretreatment. ● A technology is required for separately and appropriately treating removed non-fermentable substance, generated biogas, organic dehydration filtrate, and organic dehydration residue. ● Countermeasures for an odor generated in a fermentation process should be taken. ● Hydrogen sulfide contained in biogas as well as inappropriate treatment of dehydration filtrate could cause air pollution, water pollution, or soil contamination. ● Use, markets, and users of products need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Facilitating development of appropriate treatment and recycling technologies (resource circulation and waste management sector 4-a)

Technology	**c. Composting**
Outline	This is a system for fermenting organic waste such as municipal waste, sewage sludge, livestock excreta, and wood waste by microorganisms in an aerobic environment into compost, and reusing it as fertilizer and ameliorants for agriculture. Compositing has two methods: one is a method of storing waste outside and turning it into compost on its own; and another is a method utilizing high-speed compositing technology for speeding up composting reaction by mechanically agitating and ventilating waste.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Operating systems (continuous, batch processing) ➢ Places where compost should be used ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume

	● Recycling compost
Points to consider in introduction	● Appropriate sorting is needed because the quality of compost depends on the quality of waste. ● Since compost is made from waste and gives a negative impression, it is often difficult to secure places for which compost is used. ● Use, markets, and users of products need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

Technology	**d. Feed producing technology**
Outline	This is a technology for drying and processing organic waste including kitchen waste into powder, and producing feed for animals. There are various types of methods such as an oil temperature decompression drying method and a fermentation drying method. Produced feed can be utilized for stock farming.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Operating systems (continuous, batch processing) ➢ Places where feed should be used ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume ● Recycling feed
Points to consider in introduction	● Appropriate sorting is needed because the quality of feed depends on the quality of waste. ● Use, markets, and users of feed need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c)

	● Supporting for technology development (resource circulation and waste management sector 0-d)

Technology	**e. Recycling technology (e.g. metal, glass, plastic, and paper)**
Outline	This is a technology for recycling resource waste. Appropriate technologies vary by material. <Metal> A major metal recycling technology is material recycling technology for reusing the same kind of metal. After recyclable waste is sorted into a single material, ferrous metal is recycled in an electrical furnace while nonferrous metal is recycled in a smelter. <Glass> A technology for recycling glass bottles are mainly classified into the below two types. ● Bottle to Bottle Glass is used as raw materials for producing bottles and reused as glass bottles. ● Multiple use Glass is reused as heat insulating materials (glass fiber), bricks, base course materials, and backfilling materials. <Plastic> Many methods utilizing plastic recycling technology are practically used. Recycling methods are mainly classified into the below three types. ● Material recycling (mechanical recycling) Reproduction ● Feedstock recycling Raw material or monomer, blast furnace reduction agent, chemical materials for coke oven ● Thermal recycling (energy recovery) Cement manufacturing process, waste power generation system, RPF, RDF, gasification, and liquefaction (conversion of waste plastics into oil resources) <Paper> A major paper recycling technology is material recycling for reusing paper. Recycled paper individually needs different types of waste paper, and thus accurate sorting is indispensable in efficiently using waste paper.

Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ● Manageability (automation, operation management) ● Costs (initial cost and running cost) ● Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing waste volume ● Using resources efficiently
Points to consider in introduction	● In consideration of target waste composition and current situation, it is important to select a well-balanced combination of methods to make a social cost lower and reduce environmental burdens. ● Use, markets, and users of products need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

Technology	**f. Fuel producing technology (e.g. carbonization, RDF, and plastic oil)**
Outline	This is a technology for converting waste into fuel and reusing the fuel as energy. There are multiple technologies as follows: <Carbonization> Organic substances are thermally decomposed at 450 to 600 degrees in an oxygen-free or a low carbon reducing atmosphere, and separated into carbide, liquid component, and gas component. A technology aiming at extracting the carbide is called carbonization. Produced carbide is industrially used for a wide variety of applications, such as an alternative to coke in a steelmaking plant, activator agent for culture soil, soil improvement agent, and snow-melting agent. <RDF> RDF is an abbreviation for Refuse Derived Fuel, which means fuel produced from waste. <Plastic liquefaction (conversion of waste plastics into oil resources)> A technology for breaking a carbon-to-carbon bonded chain and turning waste plastic into a low-molecular-weight hydrocarbon is called plastic

	liquefaction. More specifically, it is a technology for sorting plastic from waste, thermally decomposing and converting it into fuel.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost) ● Utilizing energy efficiently through the reuse of waste as fuel
Points to consider in introduction	● You should select appropriate technology depending on waste properties. ● Use, markets, and users of products need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

Technology	**g. Compression treatment**
Outline	This is a compression treatment device or facilities for reducing waste volume. Compression treatment of collected waste achieves increased transport efficiency. Mechanization of waste compression and transshipment operations reduces waste spills and conducts hygienic transport and treatment.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources

Expected effects	● Improving efficiency of collection, transport, and treatment by reducing waste volume ● Carrying out hygienic waste collection, transport, and treatment
Points to consider in introduction	● Compression treatment achieves reducing waste volume. However, waste is often landfilled after the compression treatment. Therefore, you should consider other treatment methods with less environmental burden in addition to this compression treatment. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

Technology	**h. Shredding treatment**
Outline	This is a shredding treatment for reducing bulk, separating a compound, speeding up reaction such as combustion by enlarging surface area. For example, if untreated waste requires a large space, the shredding treatment reduces the volume of waste, and achieves increased efficiency of landfill. In addition, products composed of metals, plastics, and other raw materials are shredded into each component, and thereby being easily recovered. There are various types of shredding machines, which are basically classified into shear shredder (horizontal and vertical) and rotary shredder (low-speed and high-speed rotation).
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.

Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

オ）5. Landfill (Final disposal)

Technology	**a. Technology for designing and constructing landfill sites**
Outline	When you construct landfill sites, these are a technology for designing a most suitable landfill site depending on waste properties and required management levels, as well as a technology required for constructing landfill sites based on the design. In other words, these are a design technology to comply with conditions of a site location and landfilled waste, and the related regulations as well as a construction technology required at the time of construction of actual landfill sites. One of landfill systems is semi-aerobic landfill system (Fukuoka method) developed in Japan. This system is characterized by removing water inside the landfill site via drainage extending vertically and horizontally throughout the site and it takes air naturally into the landfill site through the connection from gas collection pipes for releasing gases generated in the site to the end of the drainage.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ You should consider types of waste to be landfilled. In particular, you should consider whether waste contains hazardous substances or not. ➢ Surrounding environment around a landfill site (ground and others) ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Mitigating negative impact of hazardous waste on human health and environment
Points to consider in introduction	● A technology appropriate for waste properties in individual disposal sites should be introduced. ● When a landfill site is not constructed by using an appropriate technology, it could lead to water or soil contamination.

	● When you consider location requirements, you also need to consider routes to carry in waste, traffic conditions around neighboring areas, and road maintenance. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Constructing a managed landfill site (resource circulation and waste management sector 5-a) ● Promoting technology for reducing amount of waste landfilled (resource circulation and waste management sector 5-b)

Technology	**b. Landfill site management technology**
Outline	This is a technology for appropriately managing a landfill site. Required technologies vary depending on waste to be landfilled. For example, when you landfill waste containing a certain level or more of heavy metals or harmful chemical substances, you should manage and dispose of waste not to leak hazardous substances, and thus lay down an impermeable liner and treat leachate. On the other hand, if you landfill waste which does not affect environment, you need not shield the site. However, it is better to monitor impact to surrounding environment.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ You should consider types of waste to be landfilled. In particular, you should consider whether waste contains hazardous substances or not. ➢ Surrounding environment around a landfill site (ground and others) ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Mitigating negative impact of hazardous waste on human health and environment
Points to consider in introduction	● A technology appropriate for waste properties in individual disposal sites should be introduced. ● If an appropriate management technology is not introduced, it could cause water or soil contamination. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.

Related policy packages	● Constructing a managed landfill site (resource circulation and waste management sector 5-a) ● Promoting technology for reducing amount of waste landfilled (resource circulation and waste management sector 5-b)

力）6. Hazardous waste

Technology	**a. Hazardous waste treatment technology**
Outline	This is a technology for appropriately treating hazardous waste. There are various types of hazardous waste including explosive or high flammable waste and heavy metals, so that hazardous waste should be appropriately treated depending on material properties. For example, waste oil and other high flammable waste should be disposed of in a low risk method, whereas waste which heavy metals could leach out of should be converted into being insoluble and stabilized by using cement and pharmacological agents in order not to emit them into surrounding environment.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ A technology appropriate for properties of hazardous waste (explosive properties, types of risks to human health and environment) ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Mitigating negative impact of hazardous waste on human health and environment ● Mitigating environmental pollution such as water, air, or soil contamination through an appropriate treatment
Points to consider in introduction	● When you consider a technology to be introduced, you should first identify hazardous substances which you should take measures. Secondly, you will screen such hazardous substances. Finally, you will check the properties of such substances and then introduce a technology applicable to the properties of the hazardous waste. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.

Related policy packages	● Developing a scheme for collecting hazardous substances (resource circulation and waste management sector 6-a) ● Mandatory appropriate treatment of hazardous substances (resource circulation and waste management sector 6-b)

Technology	**b. Technology for managing a hazardous waste landfill site**
Outline	This is a technology for appropriately managing a hazardous waste landfill site. A hazardous waste landfill site should be isolated from surrounding environment because waste containing hazardous substances will be brought in. For example, a seepage technology for preventing rainwater from leaking into the landfill site and shielding leachate containing contaminated matter, a leachate treatment system and facilities for treating gas generated from waste are required.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Preventing surrounding environmental degradation caused by leaching of hazardous substances ● Appropriate introduction of a technology prevents environmental pollution (water contamination, air pollution, and soil contamination) caused by hazardous substances included in a shielded landfill site.
Points to consider in introduction	● If a site is appropriately managed or maintained, the original effect of the technology cannot be obtained, or instead pollution caused by hazardous substances could expand. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Constructing a managed landfill site (resource circulation and waste management sector 5-a)

キ）7. E-waste

Technology	**a. E-Waste recycling technology**

Outline	This is a technology for improving efficiency of demolition of e-waste, and increasing a recycling rate. Electrical and electronic equipment is composed of various types of components and materials, and includes a lot of element technologies. Recycling technologies are mainly classified as follows. ● A technology for increasing the value of raw materials ● A technology for improving productivity ● Technologies for sorting and recycling plastic
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● A recycling technology should be selected based on properties of e-waste equipment to be brought in recycling facilities. ● A recycling technology should be selected corresponding to the existing line of recycling facilities. ● After the introduction of recycling technology, a market for products needs to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 7-a)

Technology	**b. CFC recovery and treatment technology**
Outline	This is a technology for recovering and destroying specified chlorofluorocarbon used in electrical and electronic equipment, which causes ozone depletion and global warming. There are examples of CFC-

	containing e-waste, such as air-conditioners, refrigerators and freezers, and dehumidifiers that use CFC as refrigerant as well as refrigerators and freezers that use CFC as heat insulator. Technologies are mainly classified into a CFC recovery technology and a CFC destruction technology. A CFC recovery technology is a gas compression method to absorb CFC gases, compress it in a compressor, cool it into liquid, and recover it in a container. There are various CFC destruction technologies. The United Nations Environment programme (UNEP) recommend seven types of destruction technologies, including the rotary kiln method, the cement kiln method and the plasma decomposition method which is mainly developed to destroy CFCs. These methods were approved by the Meeting of the Parties to the Montreal Protocol.
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Higher efficiency of CFC recovery and destruction ➢ High durability of a facility against chloride and fluoride as degradation products ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Promoting protection of the ozone layer ● Preventing global warming
Points to consider in introduction	● When you destroy CFC, you should confirm that a technology can definitely deal with and dispose of waste gas, waste water, and ash containing chloride and fluoride as degradation products, as well as a small amount of hazardous substances as by-products. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Mandatory recycling (resource circulation and waste management sector 7-a)

Technology	**c. Compression and shredding treatment**
Outline	This is a technology for compressing and shredding waste in order to reduce waste volume of e-waste and improve treatment efficiency. Compressing collected e-waste achieves high efficiency of transport. Mechanization of waste compression and transshipment operations reduces

	waste dispersion and enables you to conduct hygienic transport and treatment. In addition, e-waste composed of metals, plastics, and other raw materials are shredded into each component, and thereby being easily recovered. There are various types of shredding machines, which are basically classified into shear shredder (horizontal and vertical) and rotary shredder (low-speed and high-speed rotation).
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing the efficiency of collection, transport, and treatment by reducing waste volume ● Achieving hygienic waste collection, transport, and treatment ● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● Compression treatment achieves volume reduction. However, in many cases, compressed waste will be landfilled. You should consider introducing other treatment methods with lower environmental burden. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 7-a)

Technology	**d. Advanced sorting**
Outline	This is a technology for sorting waste that is previously sold as mixed products or disposed of as mixed waste. Technologies for sorting e-waste derived mixed metals or mixed plastics are used for a specific gravity sorter,

	a color sorter, an X-ray Fluorescence (XRF) sorter, and a Laser-Induced Breakdown Spectroscopy (LIBS) sorter.
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● There are various advanced sorting technologies. You should select a cost-effective technology appropriate for target waste properties. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 7-a)

Technology	**e. Burn-in test and repair technology for used electrical and electronic equipment**
Outline	This is a testing and technology for utilizing e-waste as second hand electrical and electronic equipment. Preferably, distribution of secondhand electrical and electronic equipment needs to conduct burn-in test to make sure that the equipment is available, and to develop repairing technology when it is out of order. Burn-in test with using a specific apparatus will improve its accuracy, thereby leading to reusing parts.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Parts applicable to burn-in test (amount of distribution, and prices) ➢ Technical ability of an inspector ➢ Costs (initial cost and running cost)

	➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Promoting reuse of parts and improving the efficiency ● Stimulating reuse of used electrical and electronic equipment
Points to consider in introduction	● An appropriate technology should be selected corresponding to a required inspection. ● Burn-in test needs energy. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● A system for promoting reuse of electrical and electronic equipment (resource circulation and waste management sector 7-b)

ク）8. Motor vehicles

Technology	**a. Material recycling of ASR**
Outline	This is a sorting recovery technology for ASR (an abbreviation for Automobile Shredder Residue and is also called shredder residue). ASR is a mixture of various materials. The composition of ASR varies based on technology used for shredding process and separation of vehicles beforehand. Principal components are resin, urethane foam, fiber, rubber, and other combustible waste. The rest of components are unseparated metals, glass, sand, and moisture. Major technology is a combination of material separation and alternative fuel production. ● Recovering a single material needs sorting and recycling ASR. Sorting is conducted by using individual screens, wind power sorting, gravity separators, magnetic separators, and eddy current separators. During the separation process, gained materials are a mixture of copper, other remained nonferrous metals, glass, and light weight resin. Resin remained in the final process is used as alternative fuel.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Recycling rate

	➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Using recycled resources efficiently ● Reducing the amount of landfill waste ● Promoting appropriate treatment
Points to consider in introduction	● A recycling technology should be selected based on properties of ASR brought in recycling facilities. ● A recycling technology should be selected corresponding to the existing line of recycling facilities. ● After the introduction of recycling technology, a market for products needs to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**b. Thermal recovery of ASR**
Outline	These are technologies for heat recovery and power generation after the incineration process of ASR (an abbreviation for Automobile Shredder Residue and is also called shredder residue). Thermal recycling technologies of ASR are classified as follows: ● Alternative fuel production + raw material production ASR has a higher calorific value and is thus used as alternative fuel for coal and heavy oil. Therefore, for example, it is directly used for a smelting furnace. For another example, it is treated beforehand to improve efficiency in the existing facilities, and then brought. ● Incineration treatment + heat recovery + raw material production ASR is incinerated in a waste incinerator, and heat is then recovered as steam or power generated by a waste heat boiler. Incineration ash and residue undergo melting treatment, and are then recovered as mixed metals and slag. In addition, the obtained metals are used counterweight, while slag is efficiently used as pavement materials.

	● Dry distillation gasification + gas utilization (heat recovery) + raw material production ASR is brought into a gasification furnace and dry distillation gas is used as industrial material and fuel gas. Forms of furnaces are classified into kiln-type, fluidized-bed type, and shaft-furnace type.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Recycling rate ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Using energy efficiently ● Reducing the amount of landfill waste ● Promoting appropriate treatment
Points to consider in introduction	● A recycling technology should be selected based on properties of ASR to be brought in recycling facilities. ● A recycling technology should be selected corresponding to the existing line of recycling facilities. ● After the introduction of recycling technology, places for which energy is used and a market for products need to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**c. Material recycling of plastics**
Outline	This is generally referred to as a material recycling technology for plastic used for some of vehicle's interior and exterior parts. Plastic recycling technology is classified into two technologies: one is a technology for removing an exterior plastic part such as a bumper before shredding

	vehicles, and then shredding, melting, molding, and producing a recycled part as a bumper itself; and another is a technology for recovering plastic from ASR and recycling plastic material. ● A material recycling technology of removed plastic parts beforehand ● An advanced technology for sorting plastics from ASR
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Recycling rate ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece)
Points to consider in introduction	● When you use an advanced technology for sorting plastics from ASR, a recycling technology should be selected based on properties of ASR to be brought in recycling facilities. ● A recycling technology should be selected corresponding to the existing line of recycling facilities. ● After the introduction of recycling technology, a market for products needs to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**d. CFC recovery and treatment technology**
Outline	These are technologies for recovering and destroying specified chlorofluorocarbon used in vehicles, which causes ozone depletion and global warming. For example, a car air-conditioner contains CFC as refrigerant in vehicle.

	Technologies are mainly classified into a CFC recovery technology and a CFC destruction technology. A CFC recovery technology is a gas compression method to absorb CFC gases, compress it in a compressor, cool it into liquid, and recover it in a container. There are various CFC destruction technologies. The United Nations Environment Programme (UNEP) recommend seven types of destruction technologies, including the rotary kiln method, the cement kiln method and the plasma decomposition method which is mainly developed to destroy CFCs. These methods were approved by the Meeting of the Parties to the Montreal Protocol.
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Higher efficiency of CFC recovery and destruction ➢ High durability of a facility against chloride and fluoride as degradation products ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Promoting protection of the ozone layer ● Preventing global warming
Points to consider in introduction	● When you destroy CFC, you should confirm that a technology can definitely deal with and dispose of waste gas, waste water, and ash containing chloride and fluoride as degradation products, as well as a small amount of hazardous substances as by-products. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**e. Compression and shredding treatment**
Outline	This is a technology for compressing and shredding waste in order to reduce the volume of end-of-life vehicles and improve treatment efficiency. Compressing collected end-of-life vehicles achieves high efficiency of transport. Mechanization of waste compression and transshipment operations reduces waste dispersion and enables you to conduct hygienic transport and treatment. In addition, the end-of-life vehicles composed of metals, plastics, and other raw materials are manually disassembled by single element, and then

	shredded into each component, thereby being easily recovered. There are various types of shredding machines, which are basically classified into shear shredder (horizontal and vertical) and rotary shredder (low-speed and high-speed rotation).
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing the efficiency of collection, transport, and treatment by reducing waste volume ● Achieving hygienic waste collection, transport, and treatment ● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● Compression treatment achieves volume reduction. However, in many cases, compressed waste will be landfilled. You should consider introducing other treatment methods with lower environmental burden. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**f. Advanced sorting**
Outline	This is a technology for sorting waste that is previously sold as mixed products or disposed of as mixed waste. Technologies for sorting ASR derived mixed metals or mixed plastics are used for a gravity sorter, a color sorter, an X-ray Fluorescence (XRF) sorter, and a Laser-Induced Breakdown Spectroscopy (LIBS) sorter.
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation.

	➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● There are various advanced sorting technologies. You should select a cost-effective technology appropriate for target waste properties. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 8-a)

Technology	**g. Inspection and assembly technology of reused parts of vehicles**
Outline	This is technology for inspecting and assembling reused parts of vehicles. A vehicle is composed of a lot of parts. It is a representative example of products suitable for long-term use by reusing individual parts. Reusable parts of vehicles are often globally reused as they are. Reusing parts is classified into two types: reused and rebuilt parts. Reused parts are prepared by removing reusable parts from used vehicles, cleaning, washing, visually checking, assembling a car, inspecting by testers, and commercializing them. Rebuilt parts are prepared by removing reusable parts from used vehicles or replacing parts when it is repaired, replacing worn or deteriorated built-in component parts with new parts, reassembling them, checking the quality, and commercializing them.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Assuring security ➢ Costs (initial cost and running cost)

	➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing environmental burdens compared to newly manufactured vehicles ● Facilitating purchase of vehicles by low-income earners
Points to consider in introduction	● Assuring security should be considered. ● Distribution of old-type fuel-inefficient vehicles for a long time could increase energy consumption compared to new-type vehicles. On the other hand, it reduces energy required for manufacturing. ● Distribution of old-type fuel-inefficient vehicles for a long time could lead to cause air pollution by exhaust gases. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● A system for promoting reuse of vehicles and the parts (resource circulation and waste management sector 8-b)

ケ）9. Construction waste

Technology	**a. Concrete and asphalt recycling technology**
Outline	This is generally referred to as a technology for recycling waste concrete blocks and waste asphalt/concrete blocks generated by construction and demolition works into recycled aggregate. Concrete blocks can be recycled into recycled aggregate and base course material, while asphalt/concrete blocks can be recycled into base course material and recycled hot mix asphalt. ➢ Recycled aggregate ✧ Heating and grinding method ✧ Screw grinding method ✧ Eccentric rotor method ➢ Roadbed material ➢ Recycled hot mix asphalt
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost)

	➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing construction waste volume ● Using resources efficiently
Points to consider in introduction	● After the introduction of a recycling technology, a market for products needs to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 9-a)

Technology	**b. Wood recycling technology**
Outline	This is a technology for recycling wood generated by construction and demolition works. Construction waste wood is brought in a shredding facility and thermally recycled (used as fuel) or material recycled into particle board and recycled paper. Recycling technology is classified as follows: ➢ Particle board and Medium-density fiberboard (MDF) They are made from woody shredded chips by selecting and shredding construction demolition material and waste lumber in a shredding treatment facility, and then removing foreign matter. ➢ Paper (pulp) Pulp is manufactured through processes of decomposing resin of the above mentioned shredded chips, washing, dehydrating, and bleaching. ➢ Ethanol By undergoing hydrolysis of crushed chips which adhesive and metals are removed from, sugar fermentation, distillation, and dehydration, ethanol and lignin are refined as fuel for the use in vehicles and boiler, respectively. ➢ Thermal recycling (used as fuel) By burning shredded chips, it is used as fuel for furnace.

Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing construction waste volume ● Using resources efficiently ● Reducing greenhouse gas emission through the utilization of biomass
Points to consider in introduction	● After the introduction of a recycling technology, a market for products needs to be secured. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d) ● Mandatory recycling (resource circulation and waste management sector 9-a)

Technology	**c. Construction sludge recycling technology**
Outline	This is a technology for recycling construction waste sludge generated by construction and demolition works. Construction waste sludge is recycled into aggregate, blocks, and banking materials by utilizing technologies of calcining and drying treatment. Recycling technologies are classified as follows: ➢ Calcining treatment Construction sludge is burnt at around 1000 degrees. The shape is changed into graininess. It is used as drain materials, aggregate, blocks, and gardening sand for a vegetation base. ➢ Melting treatment This treatment is a treatment at higher temperature than calcining treatment, thereby melting solid content. The shape is changed into graininess or massive form. It is used as alternatives to crushed stones, sand materials, and stone materials.

	➢ Dehydration treatment Dehydrated cake is made by extracting moisture from soil having high moisture ratio. The treatment is basically classified into a mechanical dehydration treatment and a natural dehydration treatment. The dehydrated cake is mainly used as banking materials and backfilling materials. ➢ Drying treatment This treatment is drying soil and enhancing the strength. The treatment is classified into natural drying and mechanical drying treatments. The shape is changed into soil or powder. It is mainly used as banking materials. ➢ Stabilization treatment This is a chemical treatment technology for attaching and mixing cement, lime, and other solidification materials into soil, and then manufacturing improved soil. It is mainly used as banking materials and backfilling materials.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Reducing construction waste volume ● Using resources efficiently
Points to consider in introduction	● After the introduction of a recycling technology, a market for products needs to be secured. ● Since sludge has the diversity of quality, production of materials based on purposes is difficult and costs a lot. ● There are no uniform evaluation standards for recycling methods. It is difficult to compare costs and the quality of products. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

	● Mandatory recycling (resource circulation and waste management sector 9-a)

Technology	**d. Compression and shredding treatment**
Outline	This is a technology for compressing and shredding waste in order to reduce construction waste volume and improve treatment efficiency. Compressing collected construction waste achieves high efficiency of transport. Mechanization of waste compression and transshipment operations reduces waste dispersion and enables you to conduct hygienic transport and treatment. In addition, construction waste composed of metals, plastics, and other raw materials are crushed into each component, and thereby being easily recovered. There are various types of shredding machines, which are basically classified into shear shredder (horizontal and vertical) and rotary shredder (low-speed and high-speed rotation).
Selection of technology	When you select a technology based on the following points, you will select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Securing operation and maintenance equipment, as well as human resources
Expected effects	● Increasing the efficiency of collection, transport, and treatment by reducing waste volume ● Achieving hygienic waste collection, transport, and treatment ● Increasing a recycling rate ● Increasing the value of raw materials (increasing price per piece) ● Improving productivity (reducing treatment cost)
Points to consider in introduction	● Compression treatment achieves volume reduction. However, in many cases, compressed waste will be landfilled. You should consider introducing other treatment methods with lower environmental burden. ● Continuous use of technology requires securing operation and maintenance equipment, as well as human resources.
Related policy packages	● Developing a system for promoting collection and recycling (resource circulation and waste management sector 0-c) ● Supporting for technology development (resource circulation and waste management sector 0-d)

	● Mandatory recycling (resource circulation and waste management sector 9-a)

1.3 Verification of solution after introduction（Reference of "3.3 Introduction of solutions" in the Guidebook）

A certain period after introducing a solution, you should measure the effect, and verify whether the solution is properly selected and implemented.

You should monitor indicators and verify the effect based on preset goals, targets, and indicators to verify the effect after the introduction of a solution. Here are lists of points to be checked for expected effects in the resource circulation and waste management sector and the relevant items in other sectors. Please refer to the lists when you review goals, targets, and indicators as well as verify the effect.

Table 1-1 Points to be checked for expected effects
in the resource circulation and waste management sector

Evaluation axis		Points to be checked for expected effects
Governance		➢ Did the introduction and appropriate enforcement of a new legal system promote proper waste management? (e.g. less illegal dumping, increased rates of waste collection and separate collection) ➢ Did the introduction and appropriate enforcement of a new legal system promote efficient utilization of resources? (e.g. increased rate of recycling) ➢ Did the introduction and appropriate enforcement of a new legal system promote understanding of waste management? ➢ Did public awareness of civil activities rise? Was a community engaging in civil activities well formed? Did civil activities contribute to reducing administrative costs?
Municipal waste	Generation	➢ Was waste generation tracked? ➢ Was waste generation reduced?
	Collection and transport	➢ Did rates of waste collection and transport rise? ➢ Were costs of waste collection and transport reduced?
	Sorting	➢ Did a rate of sorting at source rise? ➢ Was the quality of sorting at source improved? (Could sorting at source be implemented by different types of waste?) ➢ Did a rate of sorting after collection rise? ➢ Was the quality of sorting after collection improved? (Could sorting after collection be implemented by different types of materials? Did a recycling rate of materials sorted after collection rise?) ➢ Was sorting at source as well as sorting after collection advanced or more efficient?
	Appropriate treatment and recycling	➢ Did rates of appropriate treatment and recycling rise? ➢ Did a material recycling rate rise? ➢ Did energy recovery increase? ➢ Did a market for recycled products expand? Did the quality of recycled products improve?
	Landfill (Final disposal)	➢ Was waste which had been informally disposed of, properly treated? ➢ Did recycling reduce landfilled amount? ➢ Was a landfill site properly managed? ➢ Did residual life years of a landfill site increase?
Hazardous waste		➢ Did a rate of hazardous waste sorting at source rise?

Evaluation axis	Points to be checked for expected effects
	➢ Did a rate of hazardous waste sorting after collection rise? ➢ Did rates of appropriate treatment of hazardous waste and detoxification treatment rise?
E-waste	➢ Did a rate of e-waste sorting at source rise? ➢ Did a recycling rate of e-waste rise? ➢ Did a market for recycled products expand? Did the quality of recycled products improve? ➢ Did the amount of distributed reuse products in distribution increase? ➢ Was non-reusable waste appropriately treated? ➢ Were e-waste derived hazardous substances appropriately treated?
Motor vehicles	➢ Did a rate of end-of-life-vehicle sorting at source rise? ➢ Did a recycling rate of used vehicles rise? ➢ Did a market for recycled products expand? Did the quality of recycled products improve? ➢ Did the amount of distributed reuse products in distribution increase? ➢ Was non-reusable waste appropriately treated? ➢ Were end-of-life-vehicle derived hazardous substances appropriately treated?
Construction waste	➢ Did a rate of construction and demolition waste collection rise? ➢ Were hazardous substances of construction-waste origin properly treated? ➢ Did a recycling rate and a recycling amount of construction waste rise? ➢ Did a market for recycled products expand? Did the quality of recycled products improve?

2. Relevant items in other sectors (Reference of "1.3 Target sector and range of development of sustainable cities in this Guidebook)

Once you start the development of sustainable cities in the resource circulation and waste management sector, it may affect other sectors. It may be positive effect due to synergetic effect, or may be negative effect due to a trade-off relationship. Therefore, the Guidebook will extract and consider specifically related sectors, as relevant items in other sectors, from water, air, soil, and energy sectors related closely to the resource circulation and waste management.

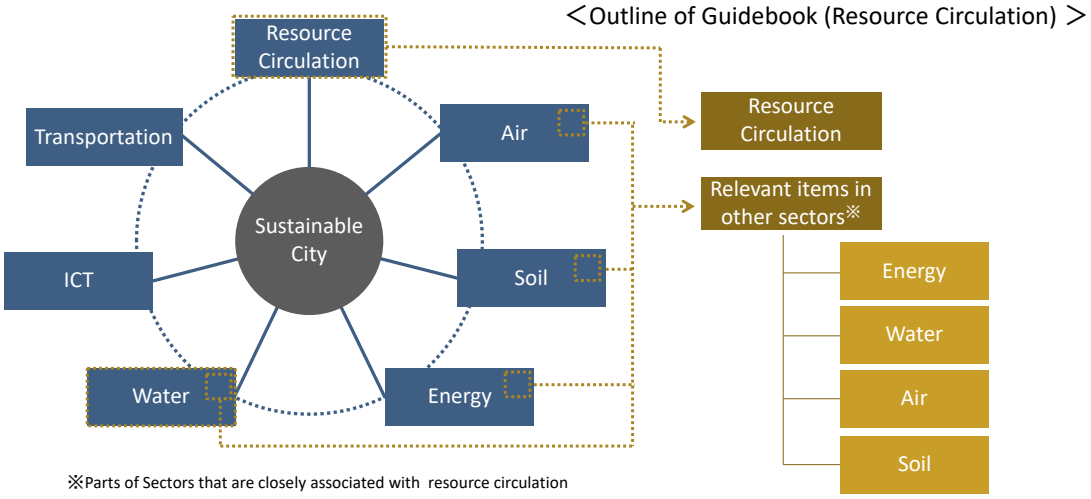


Figure 2-1 Structure of this Guidebook (Resource Circulation and Waste Management)

(1)Current-status Evaluation method

Each of the relevant items in other sectors (energy sector, water sector, air sector, and soil sector) has two evaluation axes. In total, there are eight axes. The evaluation axes and evaluation items are shown in the below table.

Table 2-1 Evaluation axes and evaluation items for relevant items in other sectors

Evaluation axis		Evaluation item
Major category	Minor category	
Energy	Energy recovery	Heat utilization and power generation
		Fuel utilization (e.g. fuel utilization of residue from biological treatment, biomass power generation, Refuse Derived Fuel (RDF))
	Energy saving	Energy saving in operations of waste treatment and recycling
		Energy saving in infrastructure of waste treatment and recycling
Water	Regulation and monitoring	Establishment of control criteria
		Implementation of monitoring
	Countermeasures against pollution sources	Implementation of drainage system at waste treatment and recycling facilities (e.g. incineration facilities, landfill sites)
Air	Regulation and monitoring	Establishment of control criteria
		Implementation of monitoring
	Countermeasures against pollution sources	Implementation of emission control (monitoring and guidance) at waste treatment and recycling sites (e.g. incineration facilities)
		Implementation of emission control (monitoring and guidance) in vehicles used in waste treatment
Soil	Regulation and monitoring	Establishment of control criteria
		Implementation of monitoring
	Countermeasures	Implementation of countermeasures against soil contamination at waste

	against soil contamination	treatment and recycling facilities

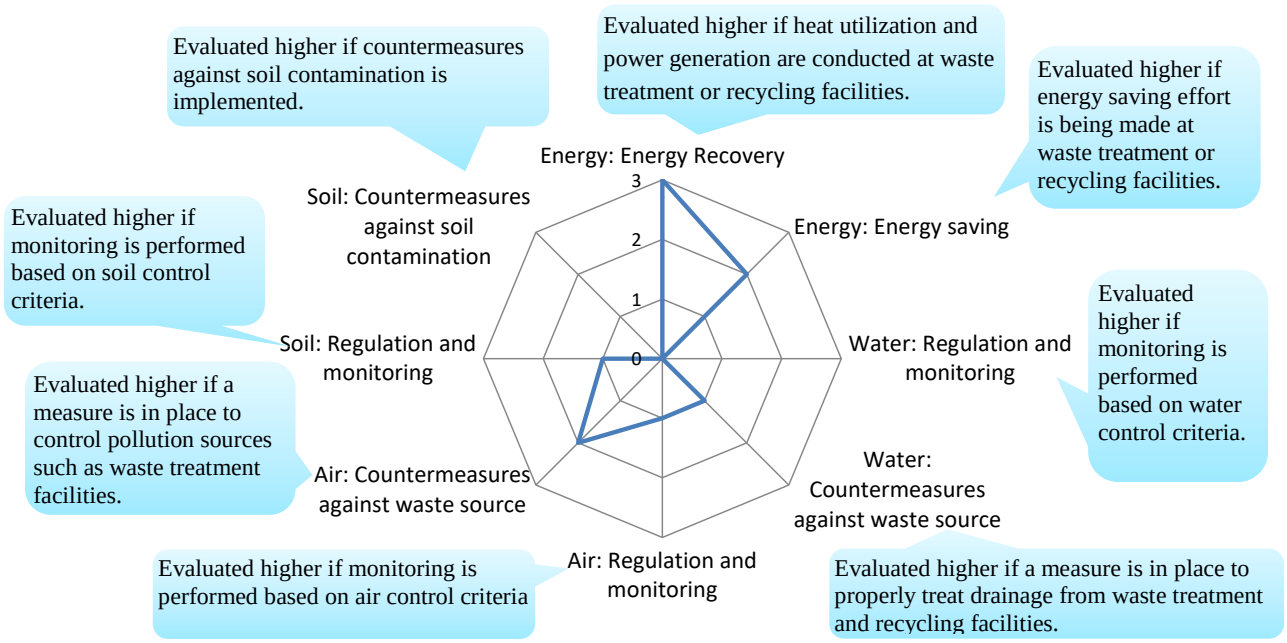


Figure 0-2 Image of the Current-status Evaluation results for relevant items in other sectors

* Please note that the Current-status Evaluation of the Guidebook should not be used to compare with other cities. This is because cities have different definitions of waste that they evaluate, as well as some evaluation items need subjective judgement of individual cities and a strict quantitative evaluation is impossible for those. However, the Current-status Evaluation is useful for identifying an overall trend of the development status of a city and can be used for comparing trends of individual cities.

(2)Relevant items in other sectors

Evaluation axis		Evaluation item	Criteria	Check ※Subjective answers are acceptable.		Evaluation criteria and points (Not to be provided in the Guidebook)	
Major category	Minor category						
Energy	1.Energy recovery	11.Heat utilization and heat recovery (The applicable facilities should be directly managed by the city. Private facilities may be included in this case only if the facilities are monitored by the city.)	111.Check if 50% or more of incineration facilities in your city, generate power or efficiently use waste heat. (Supplying energy to others is also included.)	☐	50% or more of incineration facilities in your city, generate power or efficiently use waste heat. (Supplying energy to others is also included.)	If checked: 1 point	Evaluated by total score 6/5 points→Grade 3 4/3 points→Grade 2 2/1 point→Grade 1 0 point→Grade 0
			112.Check all appropriate answers regarding power generation at Waste to Energy facilities.	☐	Utilizing generated power on site	If checked: 1 point	
				☐	Supplying generated power to others	If checked: 1 point	
			113.Check if incineration facilities (including power generation equipment) conduct efficiently use of heat except for power generation. (Supplying heat to others is also included.)	☐	Conducting efficient use of waste heat. (Suppling waste heat to others.)	If checked: 1 point	
			114.Check all appropriate answers regarding heat utilization except for power generation at incineration facilities (including power generation equipment).	☐	Utilizing generated heat on site	If checked: 1 point	
				☐	Supplying generated heat to others	If checked: 1 point	
		12.Fuel utilization (fuel utilization after biological treatment *, biomass power generation, and introduction of Refuse Derived Fuel (RDF)) *Biological treatment includes aerobic compost and anaerobic digestion) (The applicable facilities should be directly managed by the city. Private facilities may be included in this case only if the facilities are monitored by the city)	121.Check if 50% or more of waste treatment facilities excluding incineration facilities (including power generation equipment) in your city, efficiently use product as fuel. (Supplying energy to others is also included.)	☐	50% or more of waste treatment facilities excluding incineration facilities (including power generation equipment) in your city, efficiently use product as fuel. (Supplying energy to others is also included.)	If checked: 1 point	Evaluated by total score 6/5 points→Grade 3 4/3 points→Grade 2 2/1 point→Grade 1 0 point→Grade 0
			122.Check all appropriate answers regarding power generation at waste treatment facilities excluding incineration facilities (including power generation equipment) in your city.	☐	Utilizing generated power on site	If checked: 1 point	
				☐	Supplying generated power to others	If checked: 1 point	
			123.Check if product-derived fuel is efficiently used (excluding power generation) at waste treatment facilities excluding incineration facilities (including power generation equipment). (Supplying energy to others is also included.)	☐	Conducting efficient use of product-derived fuel (excluding power generation) (Suppling fuel to others is also included.)	If checked: 1 point	
			124.Check all appropriate answers regarding the utilization of product-derived fuel (excluding power generation) at waste treatment facilities excluding incineration facilities (including power generation equipment).	☐	Utilizing product-derived fuel on site	If checked: 1 point	
				☐	Supplying product-derived fuel to others	If checked: 1 point	
	2.Energy saving	21.Energy saving in operations of waste treatment and recycling	211.Check if any energy saving in operations of waste management and recycling (utilizing IoT etc.) are in force on waste collection vehicles or at waste treatment and recycling facilities.	☐	Energy saving in operations of waste management and recycling (utilizing IoT etc.) is implemented in places where wastes collection and transport and treatment and recycling are implemented.	If checked: 1 point	Evaluated by total score 3 points→Grade 3 2 points→Grade 2 1 point→Grade 1 0 point→Grade 0
		22.Energy saving in infrastructure of waste treatment and recycling	221.Check if any energy saving in infrastructure of waste treatment and recycling are in force on waste collection vehicles or at waste treatment and recycling facilities.	☐	Energy consumption is monitored at waste treatment and recycling facilities	If checked: 1 point	
				☐	Energy-saving effort is being made at waste treatment and recycling facilities	If checked: 1 point	
				☐	Facilities more than 20 years old are used without substantial remodeling	If checked: -1 point	
Water	3.Regulation and monitoring	31.Establishment of control criteria	311.Specify the presence/absence of control criteria of water quality (except for ground water) for heavy metals including mercury, lead, and cadmium ※If control criteria is established, specify applicable items in a separate sheet.	○	Control criteria are established	Established: 1 point	Evaluated by total score 4 points→Score 3 3 points→Score 2 2/1 point→Score 1 0 point→Score 0
				○	Control criteria are not established	Not established: No point	
		32.Implementation of monitoring (applicable to all facilities that treat and recycle waste)	321.Choose the most appropriate answer regarding water quality monitoring (except for ground water). (Please choose on the basis of the applicable monitoring regulation in the economy or the city. For example, such regulations may require reporting the percentage of monitoring points actually monitored of all designated monitoring points and monitoring frequency.)	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	
				○	70% or more		
				○	30% or more		
				○	Little implemented		
	4.Countermeasure against pollution sources	41.Implementation of a drainage system at waste treatment and recycling facilities (e.g. incineration facilities and landfill sites)	411.Is monitoring conducted or guidance provided regarding drainage control measures at waste treatment and recycling facilities?	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	Evaluated by total score 3 points→Score 3 2 points→Score 2 1 point→Score 1 0 point→Score 0
				○	70% or more		
				○	30% or more		
				○	Little implemented		

Evaluation axis		Evaluation item	Criteria	Check ※Subjective answers are acceptable.		Evaluation criteria and points (Not to be provided in the Guidebook)	
Major category	Minor category						
Air	5.Regulation and monitoring	51.Establishment of control criteria	511.Specify the presence/absence of air control criteria for dioxins, SOx, and Nox ※If control criteria is established, specify applicable items in a separate sheet.	○	Control criteria are established	Established: 1 point	Evaluated by total score 4 points→Score 3 3 points→Score 2 2/1 point→Score 1 0 point→Score 0
				○	Control criteria are not established	Not established: No point	
		52.Implementation of monitoring (applicable to all facilities that treat and recycle waste)	521.Choose the most appropriate answer regarding air monitoring. (Please choose on the basis of the applicable monitoring regulation in the economy or the city. For example, such regulations may require reporting the percentage of monitoring points actually monitored of all designated monitoring points and monitoring frequency.)	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	
				○	70% or moe		
				○	30% or more		
				○	Little implemented		
	6.Countermeasure against pollution source	61.Implementation of emission control (monitoring and guidance) at waste treatment and recycling sites (e.g. incineration facilities)	611.Is monitoring conducted or guidance provided emission control measures at waste treatment and recycling facilities?	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	Evaluated by total score 6/5 points→Score 3 4/3 points→Score 2 2/1 point→Score 1 0 point→Score 0
				○	70% or moe		
				○	30% or more		
				○	Little implemented		
		62.Implementation of emission control (monitoring and guidance) in waste-treatment vehicles	621.Is monitoring conducted or guidance provided regarding emission control measures on waste treatment vehicles?	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	
				○	70% or moe		
				○	30% or more		
				○	Little implemented		
Soil	7.Regulation and monitoring	71.Establishment of control criteria	711.Specify the presence/absence of soil control criteria for heavy metals including mercury, lead, and cadmium ※If control criteria is established, specify applicable items in a separate sheet.	○	Control criteria are established	Established: 1 point	Evaluated by total score 4 points→Score 3 3 points→Score 2 2/1 point→Score 1 0 point→Score 0
				○	Control criteria are not established	Not established: No point	
		72.Implementation of monitoring (applicable to all facilities that treat and recycle waste)	721.Choose the most appropriate answer regarding ground-water quality monitoring. (Please choose on the basis of the applicable monitoring regulation in the economy or the city. For example, such regulations may require reporting the percentage of monitoring points actually monitored of all designated monitoring points and monitoring frequency.)	○	95% or more	95% or more: 3 points 70% or more: 2 points 30% or more: 1 point Little implemented: no point	
				○	70% or moe		
				○	30% or more		
				○	Little implemented		
	8.Countermeasures against soil contamination	81.Implementation of countermeasures against soil pollution at waste treatment and recycling facilities	811.What measures are taken against soil contamination at waste treatment and recycling facilities?	○	The survey is implemented and there is no soil contamination	There is no soil contamination : 3 points There is soil contamination. Measures are in place to control the sources of soil contamination : 1 point There is soil contamination. Measures are in place to control contaminated soil (e.g. purification, removal, containment): 1 point There is soil contamination, but no measures are in place Any soil contamination is not monitored: NO point	Evaluated by total score 3 points→Score 3 2 points→Score 2 1 point→Score 1 0 point→Score 0
				☐	There is soil contamination. Measures are in place to control the sources of soil contamination		
				☐	There is soil contamination. Measures are in place to control contaminated soil (e.g. purification, removal, containment)		
				○	There is soil contamination, but no measures are in place Any soil contamination is not monitored		

Regulated Value Items Sheet

Category	Definition
Regulated value items for controll of water quality	
Regulated value items for controll of air	
Regulated value items for controll of soil	

(3)How to consider solution selection

Here is an example of Current-status Evaluation results for relevant items in other sector, showing how to interpret the evaluation results and how to consider solution selection on each axis. Please refer to the below example at the time of solution selection.

Table 0-1 Example of Relevant items in other sectors

Evaluation axis		How to interpret an evaluation result	How to consider solution selection
Energy	Energy recovery	Evaluated higher if recovered energy is supplied to others through heat utilization and power generation, or fuel utilization (e.g. fuel utilization after biological treatment, biomass power generation, Refuse Derived Fuel (RDF))	➢ An energy recovery method should be considered in terms of an introduced waste treatment facilities, treatment volume, and waste composition. ➢ Recovered energy should be used for not only your own facilities but also others in order to use more recovered energy.
	Energy saving	Evaluated higher if energy saving activities in both operations and infrastructures are carried out at a waste treatment or recycling infrastructure, such as waste collection vehicles and waste recycling facilities.	➢ Energy consumption at waste collection, treatment, and recycling sites should be tracked first. ➢ Based on the tracked energy consumption, possibilities of reducing energy consumption should be considered from a cost-benefit perspective, and then a solution applicable to the city should be determined.
Water	Regulation and monitoring	Evaluated higher if control criteria is set, and monitoring is conducted.	➢ When control criteria of water quality are not set, the quality of water should be monitored and tracked first. (It includes related monitoring items of waste treatment and recycling as well as monitoring in a related site or a facility.) ➢ Control criteria of water quality should be considered and set based on member economy government and municipal circumstances. ➢ Monitoring should be implemented in order to ensure whether control criteria are is complied with or not. Regular and continual monitoring using simple measuring equipment as well as occasional monitoring should be considered.
	Countermeasures against pollution sources	Evaluated higher if countermeasures against drainage are monitored and guided at waste treatment and recycling sites.	➢ Countermeasures against drainage should be introduced at waste treatment and recycling sites. ➢ Implementation status of countermeasures should be monitored and properly advised if

Evaluation axis		How to interpret an evaluation result	How to consider solution selection
			they are not enough.
Air	Regulation and monitoring	Evaluated higher if control criteria of air quality are set and monitored.	➢ When control criteria of air quality are not set, the quality of air should be monitored and tracked first. (It includes related monitoring items of waste treatment and recycling as well as monitoring in a related site or a facility.) ➢ Control criteria of air quality should be considered and set based on member economy government and municipal circumstances. ➢ Monitoring should be implemented in order to ensure whether control criteria are complied with or not. Regular and continual monitoring using simple measuring equipment as well as occasional monitoring should be considered.
	Countermeasures against pollution sources	Evaluated higher if countermeasures against exhaust gases are monitored and guided in waste collection vehicles, and at waste treatment and recycling sites.	➢ Countermeasures against exhaust gases should be introduced in waste collection vehicles, and at waste treatment and recycling sites. ➢ Implementation status of countermeasures should be monitored and properly advised if they are not enough.
Soil	Regulation and monitoring	Evaluated higher if control criteria of soil quality are set and monitored.	➢ When control criteria of soil (groundwater) quality are not set, the quality of soil (groundwater) should first be monitored and tracked. (It includes related monitoring items of waste treatment and recycling as well as monitoring in a related site or a facility.) ➢ Control criteria of soil (groundwater) quality should be considered and set based on member economy government and municipal circumstances. ➢ Monitoring should be implemented in order to ensure whether control criteria are complied with or not. Regular and continual monitoring using simple measuring equipment as well as occasional monitoring should be considered.
	Countermeasures against soil contamination	Evaluated higher if soil contamination is not caused. In addition, evaluated higher if countermeasures against soil contamination are	➢ Soil contamination should regularly be monitored at waste treatment and recycling sites. ➢ If soil contamination is caused, a contaminant source should be identified and treatment of

Evaluation axis		How to interpret an evaluation result	How to consider solution selection
		taken when it is caused.	contaminated soil should be considered. A solution applicable to the city should be determined from a cost-benefit perspective.

(4)An outline of solutions

Here are compiled data of an outline of solutions in relevant items in other sectors. Please refer to the below data when you determine a solution.

・Policy packages

Individual policy packages in relevant items in other sectors are shown below with its outline, responsible entities, expected effects, points to consider in implementation, related technologies and systems, and introduction examples.

Cross-sectional items		a. Supporting for technology development (p.112) b. Education and awareness raising (p.112)
Energy	**1. Energy recovery**	a. A Feed-in Tariffs (FIT) scheme (p.114) b. Subsidies for upgrading into energy recovery facilities (p.115)
	2. Energy saving	a. Increasing the efficiency of waste collection and transport (e.g. a relay transportation and modal shift) (p.116) b. Subsidies for upgrading into energy saving facilities (p.117) c. ESCO* (p.118)
Water	**3. Regulation and monitoring**	a. Setting control criteria of water quality (p.119) b. Monitoring and regular inspections (p.120)
	4. Countermeasures against pollution sources	a. Monitoring and guidance of countermeasures against drainage (p.121)
Air	**5. Regulation and monitoring**	a. Setting control criteria of air quality (p.122) b. Monitoring and regular inspections (p.123)
	6. Countermeasures against pollution sources	a. Monitoring and guidance of countermeasures against exhaust gases (p.124)
Soil	**7. Regulation and monitoring**	a. Setting control criteria of soil quality (p.124) b. Monitoring and inspection of the quality of groundwater (p.125) c. Inspection of soil quality at the time of site closure (p.127)
	8. Countermeasures	a. Monitoring and guidance of measures against soil contamination (p.127) b. Laying out a plan of utilizing land after the closure (p.128)

*ESCO means an abbreviation of energy service company.

0. Cross-sectional items

Policy	**a. Supporting for technology development**
Outline	This is the support provided by a member economy government, local governments, to assist the practical use of technologies for controlling energy, water, air, and soil that are developed by public entities and private businesses. The supporters are a member economy government, local governments or other institutions that serve as proxy for a member economy government or local governments. Entities receiving support are public entities or private companies that have technologies for controlling energy, water, air, and soil and capabilities to conduct pilot projects. The selected entities will receive necessary financial support, carry out pilot projects, develop technologies and report the results in order to promote the technologies.
Responsible entities	● Public entities and business operators that have technologies related to controlling energy, water, air, and soil
Expected effects	● Improving technologies for controlling energy, water, air, and soil ● Promoting technologies for controlling energy, water, air, and soil
Points to consider in implementation	● It is preferable to hold a committee consisting of experts in order to fairly select entities that have a technology applicable for technology development support. ● It is preferable to consider the promotion possibility and promotion measures of the developed technologies at the same time.
Related technologies and systems	● All the technologies and systems of relevant items in other sectors
Introduction examples	-

Policy	**b. Education and awareness raising**
Outline	This aims to develop human resources (capacity building) including administrative officers who consider and draft policies related to controlling energy, water, air, and soil and private business operators who introduce and maintain technologies and systems. It can be mainly divided into two types of efforts: promotional efforts made by providing knowledge for human resource development and compulsory efforts made by making it compulsory knowledgeable people in place. Examples of promotional efforts are guidance and advice from knowledgeable people, the preparation and distribution of reference materials,

	training systems including overseas experiences, and the like. Examples of compulsory efforts are the improvement of the qualification system, and the mandated acquisition of qualifications. Because some cities do not have a clear division of roles among city officers or budgetary procedures, it is assumed that they may not take measures for energy, water, air, and soil. In that case, it is considered necessary to have in mind the necessity and importance of efforts concerning energy, water, air and soil and take measures to enhance performance. Examples of education and awareness-raising of city officers are the distribution of reference materials, and training provided by international institutions or other economies. However, there are some economies that do not provide sufficient education infrastructure. In that case, it is necessary to start with improving infrastructure for basic and higher education.
Responsible entities	● Public entities and business operators that need technologies related to controlling energy, water, air, and soil
Expected effects	● Improving technologies for controlling energy, water, air, and soil ● Promoting and awareness-raising of technologies for controlling energy, water, air, and soil
Points to consider in implementation	● For human resource development (capacity building), it is necessary to secure knowledgeable people with appropriate knowledge and expertise and prepare materials. ● It is necessary to have a qualification system in which appropriate knowledge and expertise are organized in advance.
Related technologies and systems	● All the technologies and systems of relevant items in other sectors
Introduction examples	An example of compulsory efforts is as follows. While Japan achieved a dramatic economic growth after the war, industrial development for economic growth caused various kinds of pollution problems. Triggered by pollution problems, many laws, such as the Basic Act for Environmental Pollution Control, the Air Pollution Control Act, and the Water Pollution Prevention Act, were amended or enacted. However, many of the factories that were required to meet the restricted regulation standards did not have sufficient technical staff. Accordingly, a law requiring the establishment of a human resource organization with technical knowledge concerning pollution prevention within a factory was enacted. With the enactment of this law, the pollution control manager system started and it required organizations

	specified by law to acquire a license. The establishment of the pollution control manager system and the mandated acquisition of the license led to an increase in the number of knowledgeable people, and this contributed to a higher pollution prevention control standard.

1. Energy: Energy recovery

Policy	**a. A Feed-in Tariffs (FIT) scheme**
Outline	This is a system that guarantees by law that electric power companies buy power generated by Waste to Energy at a certain price. Because the electricity sales price is guaranteed for a long period, there will be a lower risk of investment and this makes it possible to promote the expansion of power generation using waste or methane gas deriving from waste as fuel. The system is often designed mainly targeting renewable energy. Other sources of energy besides the one deriving from waste are solar power, wind power, hydraulic power, and geothermal power.
Responsible entities	● A member economy government (More effects will be expected if a member economy government carries out this scheme in a wider range than that of a power grid system in certain area.) ● Owners of waste incineration facilities ● Power users
Expected effects	● Promoting renewable energies ● Reducing prices of renewable energy ● Decreasing dependence on fossil fuel ● Preventing global warming ● The introduction of this scheme stabilizes incomes of power generation using waste as raw materials, including Waste to Energy and methane gas recovery, thereby leading to promoting its introduction.
Points to consider in implementation	● The purchasing prices and the purchasing periods should be given full consideration in terms of reduced introduction costs and widespread use in society as a whole. ● You should pay attention to the consistency with the legal systems for waste management and 3R, and the terms and definition in the legal system. ● You should pay attention to the consistency with the master plan of power supply. ● FIT scheme may restrict cross-border electricity trade.

Related technologies and systems	● Waste to Energy (relevant items in other sectors 1-a) ● Heat recovery system (e.g. a heat supply system for internal facilities, and a regional heat supply system) (e.g. methane fermentation, and a landfill site) (relevant items in other sectors 1-b) ● Methane gas recovery (relevant items in other sectors 1-c)
Introduction examples	In May 2014, the Vietnamese government issued the Decision No: 31/2014/QD-TTg Decision on Supporting Mechanism for Development of Power Generation Projects Using Solid Waste in Viet Nam. It stipulates that electricity generated by burning gas collected from landfills as well as electricity generated from directly burning solid waste should be purchased for 20 years. Based on the decision, in October 2015, Viet Nam's Ministry of Industry and Trade issued the Circular No: 32/2015/TT-BCT Circular on Project Development and Model Electricity Sale Contract Applied to Generation Projects Using Solid Waste, providing a model electricity sale contract. The Article 10 of this Circular explicitly states that the basic content of the contract must not be changed. (However, more content can be added to the contract.) If you would like to apply a Feed-in Tariffs (FIT) scheme to the contract, you should make a contract with the Viet Nam Electricity (EVN) based on the model contract.

Policy	**b. Subsidies for upgrading into energy recovery facilities**
Outline	This is a subsidy system for upgrading into energy recovery facilities. In a waste incineration facility, waste gas generated from burning waste contains a large amount of thermal energy. Carrying out various renovation for power generation and heat supply will lead to the efficient use of energy .As a way of promoting such a renovation, a supporting system for offering subsidies and public funding should be developed.
Responsible entities	● Owners of waste incineration facilities
Expected effects	● Efficient use of energy in a waste incineration facility ● Preventing global warming ● Reducing initial cost of energy recovery leads to promote introduction of renovation.
Points to consider in implementation	● If you check renovation plans beforehand, renovation will be more effective and efficient.

Related technologies and systems	● Waste to Energy (relevant items in other sectors 1-a) ● Heat recovery system (e.g. a heat supply system for internal facilities, and a regional heat supply system) (relevant items in other sectors 1-b) ● Methane gas recovery (e.g. methane fermentation, and a landfill site) (relevant items in other sectors 1-c) ● Fuel production from residuals (relevant items in other sectors 1-d) ● Utilizing woody biomass as fuel (relevant items in other sectors 1-e)
Introduction examples	As a project for promoting the introduction of waste energy and low carbon, Japan has practiced a system in which the member economy government provides business operators including private companies that improve facilities for waste thermal recovery and waste fuel production with a subsidy covering a part (up to one-third) of the expenses required for improvement.

2. Energy: Energy saving

Policy	**a. Increasing the efficiency of waste collection and transport (e.g. a relay transportation and modal shift)**
Outline	This makes waste collection and transport efficient by transfer stations and modal shift. In the waste treatment process, more energy is spent on waste collection and transport. In addition, when you introduce a high efficiency waste treatment facility, the facility will be larger and consolidated as well as long-distance waste transportation will be carried out, thereby requiring more and more energy. In order to make waste collection and transport efficient, and reduce energy consumption, you should introduce a transfer station to reduce the total distance of collection and transport, and select a means of transport with less fuel consumption such as trains or ships (e.g. modal shift).
Responsible entities	● Local governments (Responsible for waste collection and transport) ● Businesses operators (waste collection and transport)
Expected effects	● Reducing energy consumption by increasing the efficiency of waste collection and transport ● Cutting down on expenses of waste collection and transportation, as well as burdens ● Preventing global warming ● Improving the efficiency of waste collection and transport.

Points to consider in implementation	● This policy requires a certain amount of initial costs, including for introduction of equipment and installation of a transfer station. ● If the policy is not considered based on actual situation, it may increase energy consumption.
Related technologies and systems	● A vehicle dispatching system (resource circulation and waste management sector 2-b) ● Optimized facility operation and improved transportation through the Internet of Things (IoT) (e.g. smart trash cans, and a vehicle dispatching system) (relevant items in other sectors 2-c)
Introduction examples	Japan has introduced a transfer station to efficiently collect and transport waste. In cities with wide collection areas, where garbage collection areas expand according to expanded urban areas, there are transfer stations where garbage is transshipped from small or medium-sized vehicles onto large transport vehicles. Transport efficiency increases through transshipment onto large transport vehicles at transfer stations. This contributes to cost reduction and the protection of the environment by reducing the amount of fuel used by transport vehicles. In Japan, many compactor-container transfer stations systems have been introduced. In Ho Chi Minh City, waste that is firstly collected using handcarts by an environment public corporation or unofficial private organizations are brought into two transfer stations. At transfer stations, the waste is stored in a 660-liter container with a cover, and transported in handcarts, on tricycles, on tricycle scooters, and in 2 to 4-ton compactor collection vehicles to treatment facilities or landfills.

Policy	**b. Subsidies for upgrading into energy saving facilities**
Outline	This is a subsidy system for upgrading into energy saving facilities. Reducing power consumption by optimizing control of equipment or shifting an operation system of an incineration facility into a continuous operation system, can promote energy saving. As a way of promoting such changes, a supporting system for offering subsidies and public funding should be developed.
Responsible entities	● Owners of facilities (business operators, local governments and the like)
Expected effects	● Promoting energy saving in a facility can reduce greenhouse gas emissions. ● Preventing global warming

Points to consider in implementation	● If you check renovation plans beforehand, renovation will be more effective and efficient.
Related technologies and systems	● Low-emission vehicles (relevant items in other sectors 2-a) ● Displaying energy at a waste treatment site (relevant items in other sectors 2-b) ● Optimized facility operation and improved transportation through the Internet of Things (IoT) (e.g. smart trash cans, and a vehicle dispatching system) (relevant items in other sectors 2-c)
Introduction examples	Japan takes measures to support the introduction of energy-saving facilities as follows. ● Ministry of Economy, Trade and Industry (METI)'s Energy Use Rationalization Business Support Subsidy: a subsidy for the cost required for energy saving by replacing existing facilities and systems in factories, offices or by renovation including the improvement of production processes. ● METI's Subsidy for Project Cost to Promote the Introduction of Specified Equipment for Energy Use Rationalization: interest payment assistance on necessary loans from private financial institutions which is given to business operators that have introduced energy-saving facilities or installed energy-saving equipment ● Green Investment Tax Cut: a system in which if individuals or corporations obtain targeted energy-saving equipment and use it for the purpose of business within one year, they are given a tax break by choosing between a 30% special depreciation of the acquisition price or a 7% tax relief (for SMEs only) ● Japan Finance Corporation: financial support for business operators that have installed energy-saving equipment

Policy	**c. ESCO**
Outline	ESCO is an abbreviation for Energy Service Company, which covers renovation expenses of energy saving service projects through energy reduction. ESCO is characterized by making a performance contract which ensures energy saving. Therefore, it can carry out a renovation for energy saving without generating an additional cost.
Responsible entities	● Owners of facilities (business operators, local governments)

Expected effects	● ESCO can promote energy efficiency at a facility without an additional cost. ● Preventing global warming
Points to consider in implementation	● You should choose an entity proposing an appropriate policy with a long-term perspective.
Related technologies and systems	● Displaying energy at a waste treatment site (relevant items in other sectors 2-b) ● Optimized facility operation and improved transportation through the Internet of Things (IoT) (e.g. smart trash cans, and a vehicle dispatching system) (relevant items in other sectors 2-c)
Introduction examples	In Japan, Japan Association of Energy Service Companies was established in 1999 as a private entity to promote ESCO. Since then, it has engaged in activities to promote ESCO projects together with private business operators and entities in close collaboration with the member economy government. It engages in promotion activities inside Japan, and since 2005, has put efforts into promotion activities in Asia.

3. Water: Regulation and monitoring

Policy	**a. Setting control criteria of water quality**
Outline	This policy is establishing a law with the aim of preventing water pollution and setting control criteria for water quality. You should set environmental quality standard as a policy goal, and emission standards as control criteria to meet the environmental quality standard. Emission standards are targeted at facilities which can generally identify emission sources of wastewater. There are two methods: a method for controlling the concentration of wastewater contaminants (concentration regulation); and the other method for controlling the number of contaminants in wastewater (regulation of total emission). Monitoring items of water quality of waste water from a treatment facility or a landfill site, are pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), coliform bacteria, heavy metals, dioxin.
Responsible entities	● A member economy government ● Local governments ● Business operators (business operators which generate waste water)
Expected effects	● Preventing water contamination

	● Preventing negative impact to human health
Points to consider in implementation	● You should define regulated substances and control criteria referring to the actual quality of water as well as numerical values of other economies which have already set control criteria. ● You should not only set control criteria but also monitor or regularly inspect whether entities comply with the control criteria. ● In an enclosed sea area where population and industries are concentrated, concentration regulation is not enough. Regulation of total emission may be needed. ● In addition to the general criteria and standards, you should consider the necessity of setting criteria specific to waste related facilities (e.g. incineration facilities), so that you should ensure the compliance of such facilities. ● Capacity building for measuring is required.
Related technologies and systems	● Simplified water quality analyzer (relevant items in other sectors 3-a) ● A water quality monitoring system (relevant items in other sectors 3-b)
Introduction examples	In Japan, designated business operators should comply with nationwide criteria of waste water into a public water area. There are criteria of 43 items including BOD (160 mg/L), COD (160 mg/L), SS (200 mg/L), coliform bacteria (daily average 3,000 counts/cm^3), and dioxins (10 pg-TEQ/L). In addition, the Tokyo Metropolitan government and many other local governments define further criteria severer than member economy government uniform ones on multiple items. In Viet Nam, the Industrial Waste Water Discharge Standards (TCVN 5945-1995) stipulates the maximum limit values of 33 substances contained in wastewater, including heavy metals and organochlorine compound, by three types of water area where wastewater is discharged.

Policy	**b. Monitoring and regular inspections**
Outline	This is a system for business operators to be obligated to carry out regular and extraordinary inspections of water quality to determine whether the water quality satisfies the control criteria or not. Regular inspections of the water quality should be conducted to monitor the water quality and find abnormality.
Responsible entities	● Business operators (business operators which generate waste water)

Expected effects	● Preventing water contamination ● Preventing negative impact to human health ● Preventing water contamination in the future ● Finding water contamination in a timely manner
Points to consider in implementation	● You should consider an appropriate method and the frequency of inspections referring to the actual quality of water as well as regulations of other economies which have already required a mandatory regular or extraordinary inspection. ● Appropriate monitoring and inspection should be conducted at waste treatment and recycling facilities in a timely manner. ● Capacity building for measuring is required.
Related technologies and systems	● Simplified water quality analyzer (relevant items in other sectors 3-a) ● A water quality monitoring system (relevant items in other sectors 3-b)
Introduction examples	In Japan, waste incineration facilities and landfill sites are obligated to measure pH, BOD, COD, SS, and coliform bacteria at least once a month, as well as heavy metals and cyanide at least once a year with using special methods.

4. Water: Countermeasures against pollution sources

Policy	**a. Monitoring and guidance of countermeasures against drainage**
Outline	Staffs of local governments carry out on-site inspections at factories and workplaces based on a system stipulating control criteria of water quality and a regular inspection, in order to monitor the compliance with drainage criteria. If they find business operators which have already violated or may violate the control criteria of water quality, the staffs of local governments offer them guidance on improving the situation.
Responsible entities	● Business operators (business operators which generate waste water) ● Local governments
Expected effects	● Preventing measures water contamination in the future ● Monitoring water contamination in a timely manner
Points to consider in implementation	● Capacity building for monitoring and providing guidance is required.
Related technologies and systems	● Wastewater treatment facility (e.g. biological, physical, and advanced treatment) (relevant items in other sectors 4-a)

Introduction examples	In Japan, under the Water Pollution Control Law and municipal laws, municipal staffs check the operation of wastewater treatment facilities as well as the compliance of emission standards such as inspection of wastewater quality as required.

5. Air: Regulation and monitoring

Policy	**a. Setting control criteria of air quality**
Outline	This policy is establishing a law with the aim of preventing air pollution and setting control criteria of waste gas. You should set environmental quality standard as a policy goal, and emission standards as control criteria to meet the environmental quality standard. Emission standards are targeted at facilities which can generally identify sources of exhaust gases. There are two methods: a method for controlling the concentration of air pollutants (concentration regulation); and the other method for controlling the number of air pollutants in waste gas (regulation of total emission). Monitoring items of regulated air pollutants are sulfur oxide, smoke and dust, chlorine and hydrogen chloride, fluorine, hydrogen fluoride, and silicon fluoride, lead and lead compounds, cadmium and cadmium compounds, nitrogen oxides, Volatile Organic Compounds (VOC), dust particles, dioxins.
Responsible entities	● A member economy government ● Local governments ● Factories and workplaces which may emit air pollutants (fixed waste sources) ● Automobiles (mobile sources)
Expected effects	● Preventing air pollution ● Preventing negative impact to human health
Points to consider in implementation	● You should define regulated substances and control criteria referring to the actual quality of air as well as numerical values of other economies which have already set control criteria. ● You should not only set control criteria but also monitor or regularly inspect whether entities comply with the control criteria. ● In a large-scale plant, concentration regulation is not enough. Regulation of total emission may be needed.

	● In addition to the general criteria, you should consider the necessity of setting criteria specific to waste related facilities (e.g. incineration facilities), so that you should ensure the compliance of such facilities. ● Capacity building for measuring is required.
Related technologies and systems	● Simplified exhaust gas analyzer (relevant items in other sectors 5-a) ● An exhaust gas monitoring system (relevant items in other sectors 5-b)
Introduction examples	In Japan, under the Air Pollution Control Act, measures are carried out against air pollutants emitted or flied from fixed sources (e.g. factories or workplaces). It stipulates emission standards and regulation of total emission by types of substances (e.g. soot and smoke, Volatile Organic Compounds, and dust particles) and types and size of facilities. In Viet Nam, under the Industrial Emission Standards -Inorganic Substances and Dusts (TCVN 5939-1995) and the Air quality -Industrial emission standards- Organic substances (TCVN 5940-1995), emission regulations is stipulated.

Policy	**b. Monitoring and regular inspections**
Outline	This is a system for business operators to be obligated to carry out regular and extraordinary inspections of air pollutants to determine whether waste gas satisfies the control criteria or not. Regular inspections of the waste gas should be conducted to monitor air pollutant emissions and find abnormality.
Responsible entities	● Business operators (business operators which generate waste gas)
Expected effects	● Preventing air pollution ● Preventing negative impact to human health ● Preventing air pollution in the future ● Finding air pollution in a timely and properly manner
Points to consider in implementation	● You should consider an appropriate method and the frequency of inspections referring to the actual quality of air as well as regulations of other economies which have already required a mandatory regular or extraordinary inspection. ● Appropriate monitoring and inspection should be conducted at facilities which have a process of waste incineration in a timely manner. ● Capacity building for measuring is required.

Related technologies and systems	● Simplified exhaust gas analyzer (relevant items in other sectors 5-a) ● An exhaust gas monitoring system (relevant items in other sectors 5-b)
Introduction examples	In Japan, waste incineration facilities (grate area is 2 m^2 or more, and incineration capacity is 200 kg/hour or more) are facilities generating soot and smoke stated under the Air Pollution Control Act. The facilities are obligated to measure sulfur oxide, nitrogen oxides, and smoke and dust at least once two months based on individual specific methods.

6. Air: Countermeasures against pollution sources

Policy	**a. Monitoring and guidance of countermeasures against exhaust gases**
Outline	Staffs of local governments carry out on-site inspections at factories and workplaces based on a system stipulating control criteria of waste gas and a regular inspection, in order to monitor the compliance with waste gas criteria. If they find business operators which have already violated or may violate the control criteria of waste gas, the staffs of local governments offer them guidance on improving the situation.
Responsible entities	● Business operators (business operators which generate waste gas) ● Local governments
Expected effects	● Preventing air pollution in the future ● Monitoring air pollution in a timely manner
Points to consider in implementation	● Capacity building for monitoring and providing guidance is required.
Related technologies and systems	● Dust collector (relevant items in other sectors 6-a) ● Sulfur oxides and hydrogen chloride treatment technology (relevant items in other sectors 6-b) ● Nitrogen oxide reduction technology (relevant items in other sectors 6-c) ● Dioxin emission control (relevant items of resource circulation and waste management sector 6-d)
Introduction examples	In Japan, under the Air Pollution Control Act, staffs of local governments require that business operators which generate waste gas allow them to enter factories and workplaces whether they comply with the criteria or not, as well as report the required items to them.

7. Soil: Regulation and monitoring

Policy	**a. Setting control criteria of soil quality**
Outline	This is establishing a law to prevent soil contamination and setting control criteria of soil contamination. For example, this policy is setting elution criteria and content amounts for hazardous substances contained in the soil, which could endanger human health. Potential risks are an intake of contaminated groundwater caused by the elution of hazardous substances from contaminated soil, as well as a direct intake of contaminated soil containing hazardous substances. Examples of hazardous substances are shown below. ➢ Volatile organic compounds (e.g. carbon tetrachloride, 1,2-dichloromethane, and 1,2-dichloroethylene) ➢ Heavy metals (e.g. cadmium and cadmium compounds, hexavalent chromium compounds, and cyanogen compounds) ➢ Agricultural chemicals (e.g. simazine, benthiocarb and thiuram)
Related entities	● Business operators (Owners or administrators of factories which manufacture, use or treat hazardous substances)
Expected effects	● Preventing soil contamination
Points to consider in implementation	● You should consider this policy together with a policy of c. “Inspection of soil at a time of site’s closure.” ● In addition to the general criteria, you should consider the necessity of setting criteria specific to waste related facilities (e.g. incineration facilities), so that you should ensure the compliance of such facilities. ● Capacity building for measuring is required.
Related technologies and systems	● Analysis equipment for the quality of groundwater and soil (relevant items in other sectors 7-a)
Introduction examples	In Japan, under the Soil Contamination Countermeasures Act, when a person closes a plant which used hazardous substances, or when a person makes changes to the form or nature of land (at or over 3,000 m^2), and when there is a threat of soil contamination which may endanger human health, a land owner is obligated to investigate soil contamination. Mandatory investigations are investigation on soil gas, investigation on soil elution, and investigation on soil contents. If at least one of designated hazardous substances (in total 25 kinds) exceeds the standards, a prefectural governor designates and publicly announces the site as a designated area, depending on the presence or absence of negative effects on health.

Policy	**b. Monitoring and inspection of the quality of groundwater**
Outline	This is a mandatory regular and extraordinary inspection of water contaminants stipulated by a legal system for business operations in order to determine that the quality of groundwater satisfies the control values or not. Monitoring of the quality of groundwater is classified as follows: 1) Comprehensive survey This is a survey of the quality of groundwater carried out in order to monitor the overall condition of the quality of groundwater in a region. You should set up an annual plan depending on a regional situation, and systematically carry out the survey. 2) Regional survey around contaminated wells When contamination is newly confirmed by a comprehensive survey or a report from a business operator, this is the survey of the quality of groundwater carried out in order to contribute to finding the cause of the contamination as well as confirm its extent. As required, this survey should be conducted when soil contamination is found. 3) Constant monitoring survey This is a survey for constantly monitoring a contaminated region.
Responsible entities	● Business operators (Waste treatment operators) ● Business operators using hazardous substances
Expected effects	● Preventing soil contamination in the future ● Monitoring soil contamination in a timely manner
Points to consider in implementation	● As a key monitoring region, you should select the following regions. ➢ A region which is considered to have a significant impact on water utilization when pollution causes, considering the situation of groundwater usage. ➢ A region which holds a strong probability of contamination or needed to prevent contamination, based on the location of factories and workplaces utilizing hazardous substances as well as current situation in agriculture and livestock industries. (As basic information for making your decision, you should place an importance on situation of soil contamination and information of land after the closure of a landfill.) ● Capacity building for measuring is required.

Related technologies and systems	● Analysis equipment for the quality of groundwater and soil (relevant items in other sectors 7-a)
Introduction examples	In Japan, under the Water Pollution Control Law, local governments carry out an investigation on the quality of groundwater every year, and announce the results of the investigation. Investigation items are 28 items as environmental standards of the groundwater.

Policy	**c. Inspection of soil quality at the time of site closure**
Outline	This is a mandatory soil inspection at a time of site's closure, stipulated by law. For example, when a factory using hazardous substances is closed, a land owner carries out a survey on soil contamination and then reports to the authorities on the result of the survey. As a result of the survey, when soil contamination exceeds predefined criteria, you should take measures to remove contaminants. Here are procedures of the survey on soil contamination: ➢ Confirming a target area and substances ➢ Classifying risks of soil contamination ➢ Setting compartments which material sampling is carried out ➢ Material sampling and measurement ➢ Assessment and report of the result of the survey on soil contamination
Responsible entities	● Business operators (Owners or administrators of factories which manufacture, use or treat hazardous substances)
Expected effects	● Preventing negative impact caused by soil contamination on human health
Points to consider in implementation	● Capacity building for inspecting is required.
Related technologies and systems	● Analysis equipment for the quality of groundwater and soil (relevant items in other sectors 7-a)
Introduction examples	In Japan, under the Soil Contamination Countermeasures Act, when a person closes a plant which used hazardous substances, or when a person makes changes to the form or nature of land (at or over 3,000 m^2), and when a local government finds the threat of soil contamination, a land owner is obligated to investigate soil contamination.

8. Soil: Countermeasures

Policy	**a. Monitoring and guidance of measures against soil contamination**
Outline	The authorities designate contaminated area, and manage the designated area. Management methods are taking measures for removing contaminants and for restricting responsible entities to change the form or nature of the land. When contaminants are removed and the authorities then confirmed the completion of the removal, the authorities will lift the designation.
Responsible entities	● A land owner or administer (including public entities)
Expected effects	● Preventing negative impact caused by soil contamination on human health
Points to consider in implementation	● You should consider the consistency with the development applicable laws and regulations.
Related technologies and systems	● Countermeasures against pollution sources (e.g. countermeasures for controlling heavy metals and dioxins) (relevant items in other sectors 8-a) ● Managing contaminated soil after the site closure (e.g. in-situ soil remediation, soil excavation and removal, and soil containment) (relevant items in other sectors 8-b)
Introduction examples	In Japan, under the Soil Contamination Countermeasures Act, if at least one of designated hazardous substances (in total 25 kinds) exceeds the standards, a prefectural governor shall designate and publicly announce the site as an area which requires action, or an area for which notification is required upon change to form or nature, depending on the presence or absence of negative effects on health.

Policy	**b. Laying out a plan of utilizing land after the closure**
Outline	This is a policy for laying out a plan of utilizing the land after the completion of landfill, at a construction or operation stage. Creating a plan in advance can utilize land effectively. Here are examples of utilizing land after the closure. ➢ Factory sites, power generation facilities (e.g. solar power generation), disaster-prevention facilities, parking spaces, temporary places for disaster waste, parks, green spaces, and athletic fields
Responsible entities	● A land owner or administer (including public entities)

Expected effects	● Utilizing land effectively
Points to consider in implementation	● Communication with local residents
Related technologies and systems	● Managing contaminated soil after the site closure (e.g. in-situ soil remediation, soil excavation and removal, and soil containment) (relevant items in other sectors 8-b)
Introduction examples	Recently in Japan, there is an example of introducing photovoltaic power generation facilities as the utilization of the land which was a landfill site. Specifically, the Ministry of the Environment, Japan carries out a project for promoting the introduction of photovoltaic power generation facilities at landfill sites. The Ministry conducts Feasibility Study on the Introduction of Photovoltaic Power Generation at Waste Landfill Sites and provides subsidies for the Introduction and Demonstration of Advanced Installation and Maintenance Technologies.

・Technologies and systems

Technologies and systems in relevant items in other sectors are shown below with its outline, selection of technology, expected effects, points to consider in introduction, and related policy packages.

In addition, in the Appendix 3, an information collection sheet used for collecting data of technologies and systems from a business operator is attached. Please use the sheet when you ask a business operator about information on technologies and systems.

Energy	1. Energy recovery	a. Waste to Energy (p.131) b. Heat recovery system (e.g. a heat supply system for internal facilities, and a regional heat supply system) (p.132) c. Methane gas recovery (e.g. methane fermentation, and a landfill site) (p.132) d. Fuel production from residuals (p.133) e. Utilizing woody biomass as fuel (p.134)
	2. Energy saving	a. Low-emission vehicles (p.135) b. Displaying energy at a waste treatment site (p.136) c. Optimized facility operation and improved transportation through the Internet of Things (IoT) (e.g. smart trash cans, and a vehicle dispatching system) (p.137)
Water	3. Regulation and monitoring	a. Simplified water quality analyzer (p.138) b. A water quality monitoring system (p.139)
	4. Countermeasures against pollution sources	a. Wastewater treatment facility (e.g. biological, physical, and advanced treatment) (p.140) b. Utilizing internal circulation of processed water in a facility (p.142) c. Leachate collection and removal facility at landfill site (p.142) d. Recovering valuable substances from wastewater (p.143)
Air	5. Regulation and monitoring	a. Simplified exhaust gas analyzer (p.144) b. An exhaust gas monitoring system (p.145)
	6. Countermeasures against pollution sources	a. Dust collector (p.145) b. Sulfur oxides and hydrogen chloride treatment technology (p.147) c. Nitrogen oxide reduction technology (p.148) d. Dioxin emission control (p.149) e. Environmentally friendly vehicle (eco car) (p.150) f. Recovery of valuable substances from exhaust gases (p.150)
Soil	7. Regulation and monitoring	a. Analysis equipment for the quality of groundwater and soil (p.151) b. A monitoring system for the quality of groundwater and soil (p.152)
	8. Countermeasures	a. Countermeasures against pollution sources (e.g. countermeasures for controlling heavy metals and dioxins) (p.153) b. Managing contaminated soil after the site closure (e.g. in-situ soil remediation, soil excavation and removal, and soil containment) (p.153)

1. Energy: Energy recovery

Technology	**a. Waste to Energy**
Outline	This is power generation using waste as an energy source. In general, it is referred to as a power generation system for driving steam turbine with recovered heat generated when waste is incinerated. In addition, another method is to obtain flammable gas after the thermal decomposition of waste. It may be considered as one of methods of the following "b. remaining heat recovery system." This power generation uses generated energy while waste incineration, thereby reducing the use of fossil fuels and preventing greenhouse gas emissions. Compared to solar and wind power generation, this system has an advantage of relatively stable supply of waste as an energy source. There are two types of facilities: a parallel established facility which adds a heat recovery system to a waste incineration facility; and a single Waste to Energy facility utilizing Refuse Derived Fuel (RDF). Please also refer to the incineration and reuse of incineration residue (resource circulation and waste management sector technologies and systems 4-a).
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Probability of generating toxic gas (dioxins) ➢ Power generation efficiency ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Reducing greenhouse gas emissions ● Preventing global warming ● Using energy efficiently (Utilizing waste efficiently) ● Diversifying energy sources ● Capacity building for users of technologies and securing maintenance personnel
Points to consider in introduction	● When you make combustion temperature lower in order to control emissions of hazardous substances (dioxins), power generation efficiency goes down.

	● When you trade surplus power, you should consider electric power transmission.
Related policy packages	● A Feed-in Tariffs (FIT) scheme (relevant items in other sectors 1-a) ● Subsidies for upgrading into energy recovery facilities (relevant items in other sectors 1-b)

Technology	**b. Heat recovery system (e.g. a heat supply system for internal facilities, and a regional heat supply system)**
Outline	The above-mentioned “a. waste power generation” by using heat energy generated in an incinerator of a waste incineration facility is one of a remaining heat recovery system. While heat energy is used by converting it into electricity, steam, warm water, and high-temperature air, energy can be supplied to not only the facilities inside (used for cooling and heating), but also local areas (local heat supply). For concrete examples, there are hot-water supply and air-conditioning in a factory, warm-water supply to greenhouse, and heated pools.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Energy demand (inside facilities and areas) ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Reducing greenhouse gas emissions ● Using energy efficiently ● Diversifying energy sources
Points to consider in introduction	● You should design the system in view of end users of energy. ● You should lay out a heat recovery plan in consideration of seasonal changes of waste quality and the time of suspending an operation. ● Capacity building for users of technologies and securing maintenance personnel
Related policy packages	● A Feed-in Tariffs (FIT) scheme (relevant items in other sectors 1-a) ● Subsidies for upgrading into energy recovery facilities (relevant items in other sectors 1-b) ● ESCO (relevant items in other sectors 2-c)

Technology	**c. Methane gas recovery (e.g. methane fermentation, and a landfill site)**

Outline	This is a system using recovered methane gas generated from organic waste such as food waste as biomass energy. There are two methods: one is methane fermentation which organic waste is collected and fermented in a special facility; and another is a method for recovering landfill-gas (LFG) generated from a landfill site. When you use food waste for methane fermentation, you can efficiently recover more energy than a Waste to Energy. Please also refer to the methane fermentation (resource circulation and waste management sector technologies and systems 4-b).
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability and continuity (in particular, when waste needs to be separated.) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Reducing greenhouse gas emissions ● Preventing global warming ● Using energy more efficiently ● Diversifying energy sources
Points to consider in introduction	● When you carry out methane fermentation, you should in advance separate waste which can be suitable for methane fermentation or not as much as possible. ● You should also consider treatment system of other flammable waste, foreign matter, and methane fermentation residue. ● This is also used as an appropriate treatment technology of the municipal waste.
Related policy packages	● A Feed-in Tariffs (FIT) scheme (relevant items in other sectors 1-a) ● Subsidies for upgrading into energy recovery facilities (relevant items in other sectors 1-b)

Technology	**d. Fuel production from residuals**
Outline	This is a technology for drying sludge, heating it under the low-oxygen condition to remove moisture and absorption gas components, and

	producing carbide mainly composed of carbon used as fuel. This can be used as an alternative fuel for coals at a thermal power plant.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ A sludge recycling rate ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Appropriate treatment of sludge and efficient utilizing of sludge ● If sludge has been landfilled before, a landfill site can be used longer. ● Reducing greenhouse gas emissions ● Preventing global warming
Points to consider in introduction	● An odor may generate depending on methods. ● More energy is needed for drying sludge. It is preferable for you to consider an effective use of natural energy or waste heat at the same time. ● Capacity building for users of technologies and securing maintenance personnel
Related policy packages	● Subsidies for upgrading into energy recovery facilities (relevant items in other sectors 1-b)

Technology	**e. Utilizing woody biomass as fuel**
Outline	Technology using woody biomass as fuel. Waste-derived woody biomass is mainly forest residues generated during logging and bucking such as branches and leaves, chaff, barks and sawdust generated from sawmills, house demolition residues, and pruned branches of roadside trees. Woody biomass is mainly processed into chips and pellets. They can be used as renewable energy for boilers and power-generating equipment in the wood industry, public facilities and power plants.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Place where woody biomass is generated

	➢ Status of woody biomass (water content, if there are foreign substances) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Capacity building for users of technologies and securing maintenance personnel.
Expected effects	● Reducing greenhouse gas emissions ● Preventing global warming ● Using energy more efficiently ● Diversifying energy sources
Points to consider in introduction	● It is necessary to select technologies in accord with the place where the woody biomass is generated and its status. ● It is necessary to secure fuel users. ● Capacity building for users of technologies and securing maintenance personnel. ● It is also possible to promote the technology in synchronization with the Feed-in-Tariffs (FIT) scheme.
Related policy packages	● A Feed-in Tariffs (FIT) scheme (relevant items in other sectors 1-a) ● Subsidies for upgrading into energy recovery facilities (relevant items in other sectors 1-b)

2. Energy: Energy saving

Technology	**a. Low-emission vehicles**
Outline	A low-emission vehicle is a vehicle that emits less greenhouse gas or air pollutants, and reduces environmental load. There are Compressed Natural Gas (CNG) vehicles, and hybrid vehicles.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Target users ➢ Manageability of the supply of energy source ➢ Costs (initial cost and running cost) ➢ Manageability (maintenance) ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Reducing greenhouse gas emissions

	● Preventing global warming ● Mitigating air pollution ● Promoting the introduction of environmentally friendly vehicles by private entities along with the development of energy supply system ● When vehicles are used for waste collection and transport, replacing the vehicles with environmentally friendly vehicles can reduce negative effects on environment.
Points to consider in introduction	● When you introduce low-emission vehicles using fuel except gasoline, you should secure a refueling station at the same time. ● Capacity building for users of technologies and securing maintenance personnel
Related policy packages	● Increasing the efficiency of waste collection and transport (e.g. a relay transportation and modal shift) (relevant items in other sectors 2-a) ● Subsidies for upgrading into energy saving facilities (relevant items in other sectors 2-b)

Technology	**b. Displaying energy at a waste treatment site**
Outline	This is a system for collecting data of energy consumption, displaying them in the form of tables or graphs, understanding current situation, identifying and analyzing issues and improving the situation. This includes not only installing a measuring instrument but also collecting and organizing the current data. For example, when you compare and review energy consumption of individual facilities, you are able to estimate facilities which generate redundant energy. When you adopt an energy saving measure, you should display data first, and then decide the effective measures.
Selection of technology	After considering technologies based on the following points, you will select a technology depending on issues and your situation. ➢ Utilization of facilities ➢ Rated capacity of each equipment ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Understanding energy consumption can achieve efficient use of energy ● Improving the effectiveness of an energy saving measure ● Collecting and understanding quantitative data of the effect of an energy saving measure ● Preventing global warming

	● Reducing energy consumption at waste treatment and recycling facilities
Points to consider in introduction	● By hypothesizing energy consumption beforehand, you will be able to display the data more efficiently. ● Capacity building for users of technologies and securing maintenance personnel
Related policy packages	● Subsidies for upgrading into energy saving facilities (relevant items in other sectors 2-b) ● ESCO (relevant items in other sectors 2-c)

Technology	**c. Optimized facility operation and improved transportation through the Internet of Things (IoT) (e.g. smart trash cans, and a vehicle dispatching system)**
Outline	This technology aims at promoting energy saving by making a waste treatment process more efficient utilizing the Internet of Things (IoT). The examples of this technology include: the introduction of an autonomous control system, which controls an appropriate treatment in a treatment facility and a smart trash bin system, which is a waste collection box equipped with a sensor to transmit information about waste collection requirements.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Manageability (automation, operation management) ➢ Costs (initial cost and running cost) ➢ Processing capacity ➢ Capacity building for users of technologies and securing maintenance personnel
Expected effects	● Optimizing control can establish a higher efficient waste treatment system. ● Saving energy and human resources ● Preventing global warming ● Reducing energy consumption at waste treatment and recycling facilities
Points to consider in introduction	● This requires a number of sensors to be equipped and you should consider how to deal with problems.

	● Since there are few examples of introduction in the world, you should carefully design a plan depending on current situation of individual cities. ● Capacity building for users of technologies and securing maintenance personnel
Related policy packages	● Increasing the efficiency of waste collection and transport (e.g. a relay transportation and modal shift) (relevant items in other sectors 2-a) ● Subsidies for upgrading into energy saving facilities (relevant items in other sectors 2-b) ● ESCO (relevant items in other sectors 2-c)

3. Water: Regulation and monitoring

Technology	**a. Simplified water quality analyzer**
Outline	This is a technology for easily measuring designated items of water quality. When you measure the quality of water based on the ISO and other standards or with a designated method will take time and effort, and may require specialized skills. Compared to such official methods, however, the introduction of a simplified analyzer to easily measure items in a short time is useful for daily monitoring of the wastewater quality. In addition, there are methods for enabling you to measure items continuously, or at lower prices. Some pieces of equipment measure items based on the same principle as stipulated in the standards, while other pieces of equipment measure them based on different principles. Therefore, you should consider the difference of results of measurement due to the difference of principles. Representative items of water quality can be measured through simplified measurements by the following equipment. ● pH meter, a continuous measuring device ● BOD meter, a continuous measuring device ● COD meter, a continuous measuring device ● SS meter, a continuous measuring device
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Accuracy of measurement ➢ Principles of measurement ➢ Methods of measurement (continuous or single measurement) ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing

	maintenance personnel and equipment
Expected effects	● Less time and effort for measurement ● Daily and continuous monitoring the quality of water ● Easy monitoring without specialized skills
Points to consider in introduction	● When some items have required measuring methods as well as control criteria, the measuring result may differ depending on method. Therefore, the measuring results by simplified measurement will be considered as a reference. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Setting control criteria of water quality (relevant items in other sectors 3-a) ● Monitoring and regular inspections (relevant items in other sectors 3-b)

Technology	**b. A water quality monitoring system**
Outline	This is a constant monitoring system for measuring the quality of target water in real time by using a measuring equipment and software, and issuing an alert when it exceeds the control criteria.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Accuracy of measurement ➢ Principles of measurement ➢ Methods of measurement (continuous or single measurement) ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Less time and effort for measurement ● Easy monitoring without specialized skills
Points to consider in introduction	● When some items have required measuring methods as well as control criteria, the measuring result may differ depending on method. Therefore, the measuring results by simplified measurement will be considered as a reference. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Setting control criteria of water quality (relevant items in other sectors 3-a)

	● Monitoring and regular inspections (relevant items in other sectors 3-b)

4. Water: Countermeasures against pollution sources

Technology	**a. Wastewater treatment facility (e.g. biological, physical, and advanced treatment)**
Outline	This is a wastewater treatment facility in order for wastewater from a treatment facility and a landfill site to satisfy the designated control criteria. Depending on setting quality of released water and the quality of raw water, you can design a treatment process such as the following methods. A) Biological treatment (plankton method, and biofilm method) B) Physical treatment (coagulating sedimentation, and filtration treatment) C) Advanced treatment
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Quality of raw water ➢ Quality of released water ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained in wastewater ● Preventing contamination in a public water area ● Preventing negative health effects on local residents around the facility and living downstream
Points to consider in introduction	● You should select and install appropriate wastewater treatment equipment at waste treatment and recycling facilities. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Monitoring and guidance of countermeasures against drainage (relevant items in other sectors 4-a)

Specific technology	**a. Wastewater treatment facility －(A) Biological treatment**
Outline	This is a treatment for biologically removing pollutants through a microbial reaction. This treatment is used for treating organic wastewater in an incineration facility and leachate in the primary treatment at a landfill site. It mainly removes organic matter such as BOD and

	SS, nitrogen, and phosphorus. ➢ Plankton method: activated sludge method ➢ Biofilm method: contact oxidation method
Advantages	● Plankton method can clarify a huge amount of heavily contaminated wastewater ● Biofilm method is easy to maintain and manage
Points to consider	● Plankton method needs skilled maintenance and management such as arranging return sludge, and balancing BOD, nitrogen, and phosphorus. ● When treatment water contains hazardous substances, such as cyanogen and phenol, a clarification function causes disorder. ● During the microbial reaction, water temperature affects the speed of treatment.

Specific technology	**a. Wastewater treatment facility －(B) Physical treatment**
Outline	This is a treatment for removing pollutants by physically separating wastewater into pollutants and clean water. There are two treatments: one is a treatment for adding a flocculant and precipitating solid matter; and another is a filtration treatment using membrane or sand. ➢ Coagulating sedimentation: Refractory organics, SS, and heavy metals can be removed. This treatment method is used for inorganic wastewater treatment in an incineration facility, pretreatment for leachate treatment, and separation of sludge after biological treatment. ➢ Sand filtration: SS, BOD, and COD can be removed. This method is used for treating wastewater from a waste pit in an incineration facility, and separation of sludge after biological treatment. ➢ Membrane filtration: This method can choose target items through hole-sizes. If you use a filter with small hole-sizes such as reverse osmosis membrane and nanofiltration membrane, you can obtain clean water without processing other treatments.
Advantages	● Coagulating sedimentation and sand filtration methods are relatively less expensive treatment methods. ● Membrane filtration treatment can perfectly remove any matter you want.
Points to consider	● In a membrane filtration method, you should deal with a clogged filter. It may be expensive in cost because of costs of washing facility and a membrane exchange.

Specific technology	**a. Wastewater treatment facility －(C) Advanced treatment**
Outline	This is a treatment for removing dioxins and heavy metals which may still remain after the biological treatment or the physical treatment. It can remove chromacity and odor. Major treatment methods are advanced oxidation treatment using ozone, hydrogen peroxide, and UV light as well as adsorption treatment utilizing activated carbon. Filtration using reverse osmosis membrane may be considered as advanced treatment.
Advantages	● In addition to the normal treatment, this treatment achieves a higher rate of removing

	dioxins and heavy metals.
Points to consider	● Since the treatment costs higher, it is preferable for you to design this treatment process in the latter part of treatment flow for removing residue only.

Technology	**b. Utilizing internal circulation of processed water in a facility**
Outline	This is a technology for recycling treatment water inside a facility through advanced wastewater treatment with an ion exchange resin or reverse osmosis membrane.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Quality of raw water ➢ Quality of recycled water ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Using water efficiently
Points to consider in introduction	● You should monitor the quality of recycled water and keep the quality to be applicable to the reutilization. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	-

Technology	**c. Leachate collection and removal facility at landfill site**
Outline	This is a technology for treating organic sludge components, heavy metals, and refractory organics contained in leachate at a landfill site. In a landfill site, various kinds of waste are brought in, so that some components in waste may be contained in leachate. Therefore, you need a technology for appropriately treating leachate. Leachate treatment flow is mainly divided into pretreatment, biological treatment, coagulating sedimentation, advanced treatment, and after-treatment processes. You should select appropriate treatment technologies in each process at individual landfill sites.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target waste landfilled

	➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Preventing negative health effects ● Appropriate management of a landfill site by selecting an appropriate leachate collection facility for the landfill site
Points to consider in introduction	● You should select a proper technology depending on properties of waste in the final disposal. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Constructing a managed landfill site (resource circulation and waste management sector 5-a)

Technology	**d. Recovering valuable substances from wastewater**
Outline	This is a technology for recovering valuable substances from wastewater. For example, there is a technology for adsorbing a very small quantity of valuable metals such as precious metals and rare metals remaining in wastewater by using an ion exchange resin.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Types of materials contained in wastewater ➢ Manageability ➢ Recycling rate of valuable substances ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances in wastewater and improving the quality of water ● Using resources efficiently
Points to consider in introduction	● If you do not select a recovery technology applicable to the quality of wastewater, it is difficult to recover valuable metals efficiently from wastewater. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Facilitating development of appropriate treatment and recycling technologies (resource circulation and waste management sector 4-a)

5. Air: Regulation and monitoring

Technology	**a. Simplified exhaust gas analyzer**
Outline	This is a technology for easily measuring designated items of air pollutants. When you measure based on the ISO and other standards or with a designated method, it will take time and effort, and may require specialized skills. Compared to such official methods, the introduction of a simplified analyzer to easily measure items in a short time is useful for daily monitoring of the air pollutants contained in exhaust gases. In addition, some other methods enable you to measure items continuously, or at lower prices. Some pieces of equipment measure items based on the same principle as stipulated in the standards, while other pieces of equipment measure them based on different principles. Therefore, you should consider the difference of results of measurement due to the difference of principles. Representative items of air pollution can be measured through simplified measurements by the following equipment. ➢ Nitrogen oxides meter, a continuous measuring device ➢ Sulfur oxide meter, a continuous measuring device ➢ Volatile Organic Compounds (VOC) meter, a continuous measuring device ➢ Multiple-component gases (NOx, SO_2, O_2, CO, and CO_2) meter, a continuous measuring device
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Accuracy of measurement ➢ Principles of measurement ➢ Methods of measurement (continuous or single measurement) ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Less time and effort for measurement ● Daily and continuous monitoring the concentration of air pollutants in exhaust gases ● Easy monitoring without specialized skills
Points to consider in introduction	● When some items have required measuring methods as well as control criteria, the measuring result may differ depending on method.

	Therefore, the measuring results by simplified measurement will be considered as a reference. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Setting control criteria of air quality (relevant items in other sectors 5-a) ● Monitoring and regular inspections (relevant items in other sectors 5-b)

Technology	**b. An exhaust gas monitoring system**
Outline	This is a constant monitoring system for measuring air pollutants in exhaust gases in real time by using a measuring equipment and software, and issuing an alert when it exceeds the control criteria.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Accuracy of measurement ➢ Principles of measurement ➢ Methods of measurement (continuous or single measurement) ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Less time and effort for measurement ● Daily and continuous monitoring the concentration of air pollutants in exhaust gases
Points to consider in introduction	● When some items have required measuring methods as well as control criteria, the measuring result may differ depending on method. Therefore, the measuring results by simplified measurement will be considered as a reference. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Setting control criteria of air quality (relevant items in other sectors 5-a) ● Monitoring and regular inspections (relevant items in other sectors 5-b)

6. Air: Countermeasures against pollution sources

Technology	**a. Dust collector**
Outline	This is equipment for separating soot and dust particles from exhaust gases emitted from factories and workplaces generating soot and smoke, and dust

	particles in order for them to meet the designated control criteria. Major dust collectors are shown below. A) Electrostatic precipitator B) Bag filter dust collector C) Cyclone dust collector D) Scrubber dust collector
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target gases (contained materials, temperature zone) ➢ Emission standards to be complied with ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained in exhaust gases ● Preventing ambient air pollution ● Preventing negative health effects on local residents around the facility
Points to consider in introduction	● Selecting and installing appropriate dust collectors are required at facilities which have a waste incineration process. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Monitoring and guidance of countermeasures against exhaust gases (relevant items in other sectors 6-a)

Specific technology	**a. Dust collector －(A) Electrostatic precipitator**
Outline	This is a dust collector for applying electric charge to particles contained in exhaust gases, attracting and collecting particles to collecting plates. In many cases, this precipitator is used for a coal-fired thermal power boiler, a sintering furnace of a steelmaking plant, a cement kiln, and a waste incinerator.
Advantages	● It has a high efficiency of duct collection because it can collect even tiny particles. ● It is easy to maintain. The running cost is relatively low.
Points to consider	● Equipment cost is higher than those of other methods. ● The size of equipment is large.

Specific technology	**a. Dust collector －(B) Bag filter dust collector**
Outline	This is a dust collector which uses a filter (fabric or nonwoven fabric) to filter and collect particles contained in exhaust gases. The filter requires self-cleaning because collected dust on the surface is accumulated into a layer. Many electric furnaces for steel and waste

	incinerators use this collector.
Advantages	● It can collect particles with a small diameter. ● Dust collection efficiency is high. ● The size of equipment is relatively small.
Points to consider	● The filter requires self-cleaning because collected dust on the surface is accumulated into a layer. Cleaning and exchanges of filters take cost and effort.

Specific technology	**a. Dust collector －(C) Cyclone dust collector**
Outline	This is a dust collector for forcing exhaust gases into a swirling movement, and separating particles with a centrifugal force. Since it cannot collect particles with a diameter of a few micrometers or less, it can be used, in many cases, as primary treatment equipment for removing smoke and dust.
Advantages	● It has a simple structure and no movable part. It is also durable at high temperature. ● It is easy to maintain and effective to collect larger particles.
Points to consider	● It cannot collect particles a few micrometers or less in diameter.

Specific technology	**a. Dust collector －(D) Scrubber dust collector**
Outline	This is a dust collector for collecting particles by bringing water drops or water screen into contact with exhaust gases.
Advantages	● It can remove liquid particle mist. ● It can remove gas at high temperature.
Points to consider	● Wastewater treatment is required.

Technology	**b. Sulfur oxides and hydrogen chloride treatment technology**
Outline	This is a technology for removing sulfur oxide and hydrogen chloride from exhaust gases. Methods are mainly classified into a dry type and a wet type. ➢ Dry type: This is a collection and recovery method for blowing hydrated lime ($Ca(OH)_2$) or other alkaline powder into flues and collecting reaction products with bag filters. ➢ Wet type: This is a recovery method for spraying water or caustic soda (NaOH) into an absorption tower, and collecting reaction products with aqueous solution. The aqueous solution should be treated in a wastewater treatment facility.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target gases (contained materials, temperature zone) ➢ Emission standards to be complied with ➢ Manageability

	➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained in exhaust gases ● Preventing ambient air pollution ● Preventing negative health effects on local residents around the facility and living downstream
Points to consider in introduction	● Selection and introduction of an appropriate treatment technology are required at facilities expected to generate sulfur oxide or hydrogen chloride through a process of waste incineration. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Monitoring and guidance of countermeasures against exhaust gases (relevant items in other sectors 6-a)

Technology	**c. Nitrogen oxide reduction technology**
Outline	A technology for reducing nitrogen oxide in exhaust gases of waste combustion. It is mainly classified into combustion control type and dry type. ➢ Combustion control type: This is a method for preventing nitrogen oxide by controlling combustion. There are two methods: a low-oxygen method and a water injection method. ➢ Dry type: One is a non-catalytic de-NO_x method for spraying ammonia into an incinerator and decomposing nitrogen oxides. Another is a catalytic de-NO_x method for decomposing nitrogen oxides contained in exhaust gases into nitrogen gas on the surface of catalyst.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target gases (contained materials, temperature zone) ➢ Emission standards to be complied with ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained

	in exhaust gases ● Preventing ambient air pollution ● Preventing negative health effects on local residents around the facility and living downstream
Points to consider in introduction	● Selection and introduction of an appropriate treatment technology are required at facilities expected to generate nitrogen oxides through a process of waste incineration. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Monitoring and guidance of countermeasures against exhaust gases (relevant items in other sectors 6-a)

Technology	**d. Dioxin emission control**
Outline	This is a technology for controlling dioxin contained in waste gases. You should take enough measures against dioxins through both combustion control in an incinerator and exhaust gas treatment. ➢ Combustion control in an incinerator: It can prevent dioxin by burning gas at 850 degree or more, keeping residence time of gas in a combustion chamber for two or more seconds, and stirring combustion gases well. ➢ Exhaust gas treatment: One is a method for blowing activated carbon into exhaust gases and collect dust with bag filter dust collector. Another is a method for decomposing dioxins by catalysis.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target gases (contained materials, temperature zone) ➢ Emission standards to be complied with ➢ Manageability ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained in exhaust gases ● Preventing ambient air pollution ● Preventing negative health effects on local residents around the facility and living downstream

Points to consider in introduction	● Selection and introduction of an appropriate treatment technology are required at facilities expected to generate dioxins through a process of waste incineration. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Monitoring and guidance of countermeasures against exhaust gases (relevant items in other sectors 6-a)

Technology	**e. Environmentally friendly vehicle (eco car)**
Outline	Low-emission vehicles are vehicles which cause less emissions of nitrogen oxides and other air pollutants. They include Hybrid Vehicle, Electrical Vehicle, Plug-in Hybrid Vehicle, Fuel Cell Vehicle, Clean Diesel Vehicle, and Compressed Natural Gas Vehicle.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Specific use (cruising distance) ➢ Infrastructure which supplies fuel ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Preventing ambient air pollution
Points to consider in introduction	● When you introduce environmentally friendly vehicles, you should secure a fuel station at the same time. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	-

Technology	**f. Recovery of valuable substances from exhaust gases**
Outline	This is a technology for recovering valuable substances from exhaust gases. For example, there is a technology for adsorbing a very small quantity of valuable metals remaining in exhaust gases through a filter.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Properties of target gases ➢ Manageability

	➢ Recycling rate of valuable substances ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Treating hazardous substances and environmental pollutants contained in exhaust gases ● Using resources efficiently ● Recovery of hazardous substances from exhaust gas and effective use of valuable resources are expected.
Points to consider in introduction	● If you do not select a recovery technology applicable to substances contained in exhaust gases, it is difficult to recover valuable metals efficiently from exhaust gases. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Facilitating development of appropriate treatment and recycling technologies (resource circulation and waste management sector 4-a)

7. Soil: Regulation and monitoring

Technology	**a. Analysis equipment for the quality of groundwater and soil**
Outline	This is a technology for easily measuring designated monitoring items of water and soil contamination. Pieces of analysis equipment for the quality of groundwater and soil are classified into Inductively Coupled Plasma (ICP) emission spectrometer, ICP mass spectrometer, and atomic absorption spectrometer. ➢ ICP emission spectrometer: When an analysis sample is sprayed into the plasma energy at high temperature, atoms of the sample are excited. Emission rays peculiar to elements, generated from the excited atoms are dispersed. ➢ ICP mass spectrometer: When an analysis sample is sprayed into the plasma energy at high temperature, atoms of the sample are excited. Ionized atoms are taken into a vacuum and analyzed by mass spectrometry. ➢ Atomic absorption spectrometer: When an analysis sample is sprayed into a burner, elements are then atomized. Quantitative analysis of elements is performed by transmitting lights and measuring absorption spectra.

	In addition, regarding the quality of water, please refer to Water: Regulation and Monitoring.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Sensitivity of analyzing, easiness of handling, ➢ Costs (initial cost and running cost) ➢ Space ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Obtaining accurate and actual conditions of monitoring items on groundwater quality and soil contamination
Points to consider in introduction	● Pretreatment is required. ● When you analyze the quality of groundwater and soil, you should learn a sampling technology. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Setting control criteria of soil quality (relevant items in other sectors 7-a) ● Monitoring and inspection of the quality of groundwater (relevant items in other sectors 7-b) ● Inspection of soil quality at the time of site closure (relevant items in other sectors 7-c)

Technology	**b. A monitoring system for the quality of groundwater and soil**
Outline	➢ Please refer to countermeasures against water sources.
Selection of technology	➢ The same as above
Expected effects	● The same as above
Points to consider in introduction	● The same as above
Related policy packages	● The same as above

8. Soil: Countermeasures

Technology	**a. Countermeasures against pollution sources (e.g. countermeasures for controlling heavy metals and dioxins)**
Outline	This is a technology for controlling sources of soil contamination. ・ Heavy metals Soil contamination of heavy metals could occur by the elution from waste and underground seepage of inappropriate drain. For more specific countermeasures, please refer to sheets of countermeasures against water pollution sources ・ Dioxins Heavy soil contamination could occur by dioxins at the time of waste incineration. For more specific countermeasures, please refer to sheets of countermeasures against air pollution sources
Selection of technology	● Please refer to the sheets of countermeasures against water pollution sources and air pollution sources.
Expected effects	● The same as above
Points to consider in introduction	● The same as above
Related policy packages	● Monitoring and guidance of measures against soil contamination (relevant items in other sectors 8-a)

Technology	**b. Managing contaminated soil after the site closure (e.g. in-situ soil remediation, soil excavation and removal, and soil containment)**
Outline	These are technologies for managing soil contamination after the site's closure, such as in-situ soil remediation measures, as well as soil excavation and removal measures. ➢ In-situ soil remediation measures: Removing in-situ hazardous substances to remedy land to meet criteria. For example, there is a method for volatilizing hazardous substances contained soil, and suctioning them. Another example is a method for pumping hazardous substances leaching out into groundwater, and removing them. ➢ Soil excavation and removal measures: Excavating and removing contaminated soil, and backfilling the hole with soil removed hazardous substances from the excavated contaminated soil or uncontaminated soil.

	Other than the above removal measures, there is another measure, which is soil containment. Soil containment measures are in-situ containment, seepage containment, and blocking containment.
Selection of technology	When you select a technology, you should compare and consider based on the following points, and select a technology depending on issues and your situation. ➢ Methods for utilizing land ➢ Costs (initial cost and running cost) ➢ Capacity building for users of technologies and securing maintenance personnel and equipment
Expected effects	● Preventing soil contamination from negatively affecting human health
Points to consider in introduction	● When you adopt soil removal measures, any land utilization could not negatively affect human health unless soil contamination occurs in the future. However, the soil removal measures often cost higher than the other measures and need appropriate treatment after the removal. When you adopt containment measures, you should utilize land without damaging a containment facility. ● Capacity building for users of technologies and securing maintenance personnel and equipment
Related policy packages	● Inspection of soil at a time of site's closure (relevant items in other sectors 7-c) ● Monitoring and guidance of measures against soil contamination (relevant items in other sectors 8-a) ● Laying out a plan of utilizing land after the closure (relevant items in other sectors 8-b)

3. Model cases

Here are the results of the Current-status Evaluation on model cities[1]. Please refer to the below results when you review solution on the basis of the results of Current-status Evaluation.

(1) A case study of Kitakyushu City, Fukuoka Prefecture, Japan

In the city of Kitakyushu in Fukuoka prefecture of Japan, we made a trial input into the Current-status Evaluation sheet, and produced a radar chart. In addition, we also input data of when the city started the sorting collection (about 20 years ago), and prepared a radar chart for the purpose of comparison with the current results.

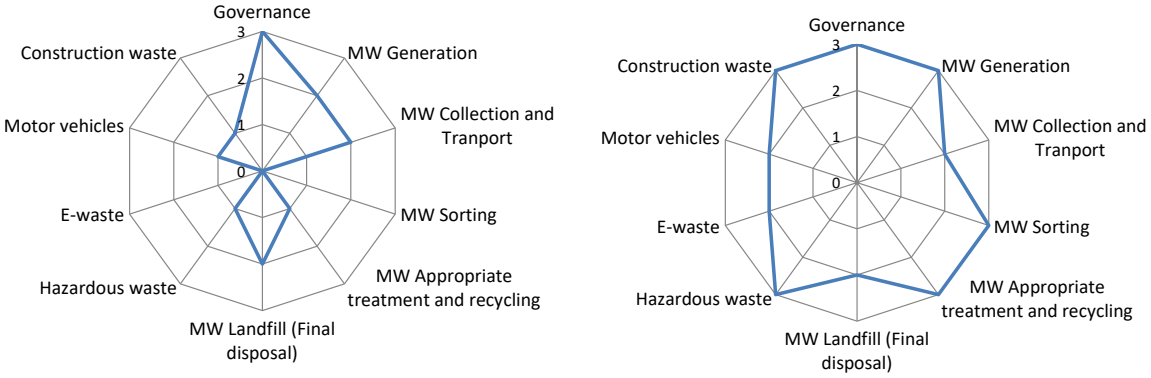


Figure 3-1 Radar charts of the evaluation results
for the resource circulation and waste management sector
[Left: results before the start of sorting (about 20 years ago), right: current results]

By comparing two radar charts of results for the resource circulation and waste management, all axes of the current evaluation earned same points or higher than the evaluation before the start of sorting (about 20 years ago).

The evaluation axis of “MW Sorting” earned zero point by the before the start of sorting, but the current result earned three points. Before the start of sorting (about 20 years ago) in Kitakyushu city, there were only two types of waste, household waste and bulk trash. However, since 1993, Kitakyushu City has expanded sorting categories, and it currently implements waste collection by types of waste as shown in the below figure. In order to reduce the amount of waste and promote recycling, the city introduced pre-paid designated bags for household waste and recyclable waste collection as well as supports community-based environmental activities, and the enhancement of a financial incentive system for citizen groups which collect waste paper. In addition, the city plays a central role in establishing a Regional Resource Recycling Zone while enhancing Eco-Town projects and base functions of environmental industries.

The evaluation axis of “E-waste” earned zero point by the before the start of sorting, but the current result earned two points. According to the Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment enforced in April 2013, Kitakyushu City is currently collecting and recycling small waste electrical and electronic equipment, such as mobile phone, digital camera, video

[1] The Current-status Evaluation on model cities was prepared by using provisional input sheets during the process of the Guidebook development. Please note that the results of the Current-status Evaluation may be different from ones based on the finalized input sheets shown in this Guidebook.

camera, and portable music player. The city placed collection boxes for small waste electrical and electronic equipment at 65 places inside the city. In addition, according to the Home Appliance Recycling Law, not a local government but retailers and manufacturers collect and recycle air-conditioners, televisions, refrigerators and freezers, and washers and dryers same as other cities.

Figure 3-2　How to separate waste and recyclables in Kitakyushu City

Source: Website of the City of Kitakyushu[2]

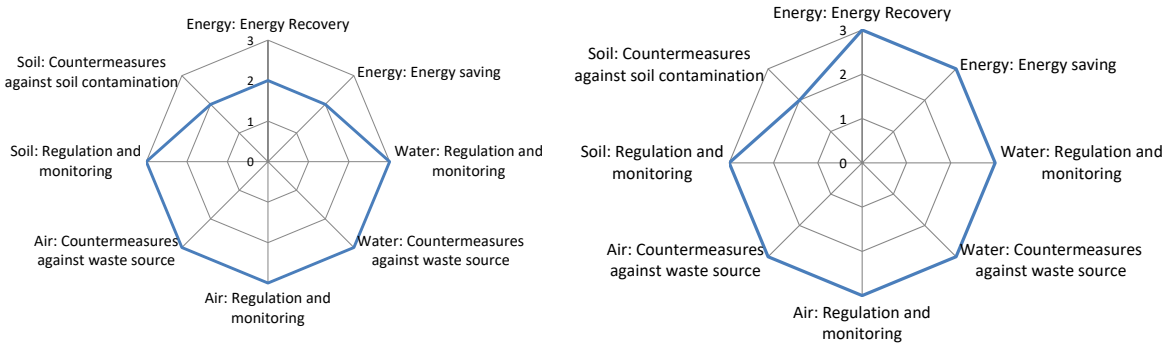


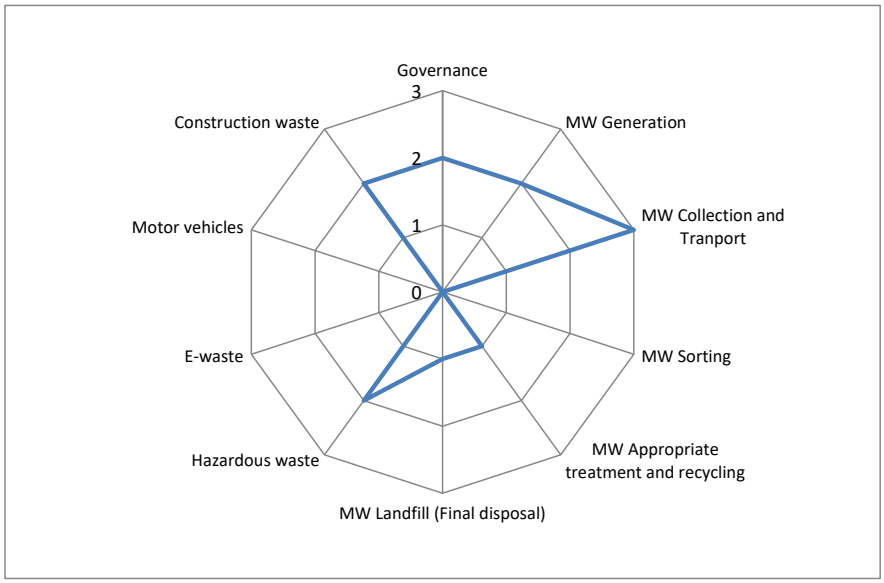
Figure 3-3　Radar charts of the evaluation results for the relevant items in other sectors [Left: results before the start of sorting (about 20 years ago), right: current results]

Compared to the radar charts for the resource circulation and waste management sector, a radar chart for the relevant items in other sectors before the start of sorting (about 20 years ago) had earned higher in many axes. In particular, water and air had earned three points before the start of sorting (20 years ago). It clearly indicates that “Regulation and monitoring” and “Countermeasures” had been carried out earlier. Concerning “Energy” which was evaluated higher than the results before the start of sorting (about 20 years ago), Kitakyushu City established regional cooperative system with neighboring cities and towns for concentrating incineration treatment, and supplies electricity and heat to others, which are generated by high-efficient Waste to Energy. The city also carries out waste collection by hybrid vehicles and other environmentally friendly vehicles.

[2] http://www.city.kitakyushu.lg.jp/kankyou/file_0004.html

(2) A case study of Da Nang City, Viet Nam

In Da Nang city of Viet Nam, we made a trial input into the Current-status Evaluation sheet, and produced a radar chart.



*MW: Municipal Waste

Figure 3-4 A radar chart of the evaluation results for the resource circulation and waste management sector

According to a radar chart for the resource circulation and waste management sector, the evaluation axis of “Municipal Waste (MW) Collection and transport” earned three points, while the evaluation axes of “Governance,” “MW Generation,” “Hazardous waste,” and “Construction waste” gained two points. The evaluation axes of “MW Appropriate treatment and recycling),” and “MW Landfill (Final disposal)” got one point, while “MW Sorting,” “E-waste” and “Motor vehicles” earned zero point.

The evaluation axis of “Governance” earned two points. This is because the development of legal systems and the grasping of waste sources are properly managed. In addition, citizens participate in cleanup activities on a beach which is tourism resources, whereas there are issues on law enforcement.

In the city of Da Nang, it is found that daily amount of municipal waste is 700 tons. Annual amount of municipal waste per citizen is calculated as 244 (kg/person/year) using the number of population in the city, which is 1.045 million people (as of 2015). In addition, the annual GDP per capita is approximately 2,000 USD. Therefore, “MW Generation” was evaluated as two points.

The evaluation axis of “MW Collection and transport” gained three points, because Da Nang city implements waste collection in almost all parts of the area as well as conducts efficient collection and transport utilizing packer vehicles and relay facilities.

On the other hand, waste is not separated and sorted, so that collected waste is landfilled in a managed landfill site as it is. As a result, “MW Sorting” earned zero point.

“MW Appropriate treatment and recycling” got one point, because private entities properly recycle a part of waste, such as plastic and paper. Although the landfill site is managed, the remaining years are only four years. For this reason, “MW Landfill (Final disposal)” gained one point.

The evaluation axis of “Hazardous waste” earned two points, because the city conducts separation and collection of hazardous waste stipulated by a member economy government law, and treats waste

in a designated process through a dedicated route. However, hazardous waste mixed in MW is not recovered. Therefore, this axis was not evaluated as three points.

"E-waste" and "Motor vehicles" are basically entrusted to private entities. They are not properly managed. Therefore, the axes got zero point. Concerning the actual conditions of individual materials, plastic is properly recycled, but the recycling of metal does not satisfy noise standard.

Regarding construction waste generated when houses are torn down, asbestos, fluorescent lamps, and other hazardous waste are properly treated. In addition, almost all materials generated as demolished parts are recycled. However, in some cases, waste is left in a vacant lot when ordinary houses are wrecked. Therefore, "Construction waste" was evaluated as two points.

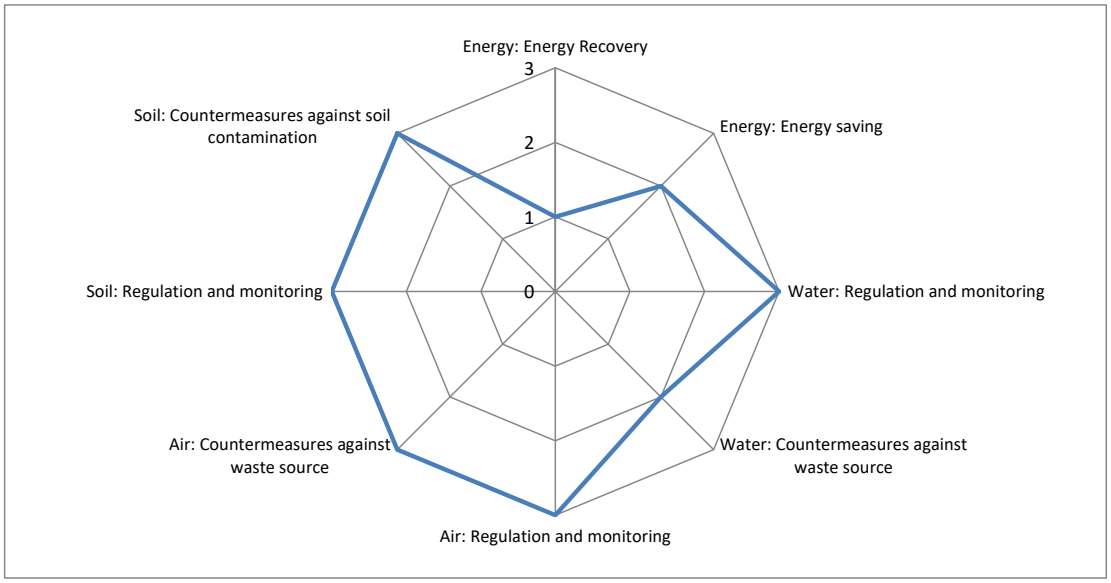


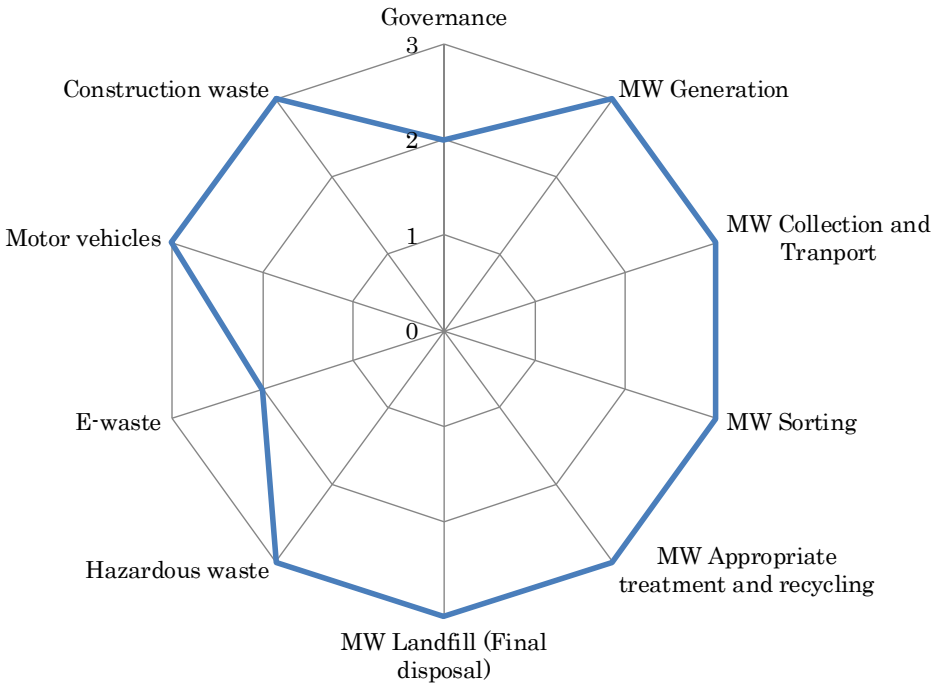
Figure 3-5 A radar chart of the evaluation results for the relevant items in other sectors

Compared to the radar chart for the resource circulation and waste management sector, a radar chart for the relevant items of the sector has higher evaluated items. "Energy: Energy recovery" earned one point because the city is considering incineration and biological treatment, but promotes using biogas generated from livestock compost as fuel. On the other hand, "Energy: Energy saving" got two points because there is no energy saving activity in waste collection, but energy consumption monitoring and energy reduction activities designed to incinerate types of material at a time are conducted in incineration facilities.

Concerning sectors of water, air, and soil, control values are stipulated by the economy and completely monitored, so that the evaluation axes of "Regulation and monitoring" of all sectors earned three points. "Countermeasures against waste sources" are properly taken based on the regulation and monitoring. However, medical waste water is partially treated in an inappropriate manner. For this reason, countermeasures against water sources were evaluated as two points, while countermeasures against air and soil sources were evaluated as three points.

(3) A case study of Singapore

Singapore provided inputs for the current-status evaluation sheet, and produced radar charts below.



*MW: Municipal Waste

Figure Appendix 3-6 A radar chart of the evaluation results for the resource circulation and waste management sector

From the radar chart for the resource circulation and waste management sector, areas for Municipal Waste (MW) Generation, MW Collection and Transport, MW Sorting, MW Appropriate Treatment and Recycling, MW Landfill (Final disposal), Hazardous waste, Motor vehicles, and Construction Waste scored three points, while Governance and E-waste scored two points.

For Governance, there was a proper development of legal systems and management of waste generation sources. With respect to recycling, Singapore has imposed legislation for the provision of recycling receptacles in condominiums and mandatory reporting of waste data and management plans by commercial premises. Although there is no legislation currently that mandates recycling of waste in specific industry or sector, Singapore is looking into that for implementation in future. The criteria on the assessment of civil activities is not applicable to urban Singapore as Singapore has an efficient and comprehensive waste collection system and there are no self-managed municipal communities handling waste management and recycling. Nonetheless, 3R outreach activities have been incorporated at community events to raise the awareness of waste minimisation and recycling among residents.

For MW Generation, the annual amount of domestic waste generated was 385 kg per person per year. This was based on 2,132,341 tonnes of domestic and trade waste generated and population of 5.5 million in Singapore in 2015. Additionally, the annual GDP per capita is approximately 50,897.7 USD in 2015. Based on these figures, MW Generation was evaluated to score three points.

With respect to MW Collection and Transport, Singapore has implemented efficient waste collection for all areas in the city, e.g. Public Waste Collectors (PWCs) are licensed by the National Environment Agency (NEA) for waste collection from domestic and trade premises using compactors and rear-end loaders (RELs). Singapore also has a Tuas Marine Transfer Station for efficient transportation of incineration ash to its offshore landfill.

Singapore scored three points for MW Sorting because it has adopted a system of separating waste at source into commingled recyclables and general waste. Recycling infrastructure, i.e. blue commingled recycling bins, are provided at all HDB estates, private apartments and landed properties.

Singapore scored three points for MW Appropriate Treatment and Recycling because it properly recycles recovered metal, plastic, and paper. It has an overall recycling rate of 61% in 2015. The rest of the unrecycled waste are properly incinerated at Waste-To-Energy (WtE) plants. Incineration ash is not recycled but landfilled at a managed landfill site.

Singapore manages an effective offshore landfill site which only accepts incineration ashes and treated non-incinerable waste. The site is estimated to last more than 20 years after which a new site would be identified. Singapore is currently looking into the development of a new landfill in the longer term.

Singapore scored three points for Hazardous Waste because separation collection and treatment of hazardous waste has been stipulated by legislation.

Singapore scored two points for E-waste because there was no organised collection of E-waste and recycling of E-waste has been predominantly carried out by the informal sector. Various voluntary recovery and recycling activities have been implemented by manufacturers of electrical and electronic equipment. However, a management framework covering recovery and reuse of electronic products has not been implemented.

Singapore also scored three points for Motor Vehicles and Construction waste. Recycling of motor vehicles is carried out by automobile companies and hazardous waste such as lead-acid batteries are regulated and required to be collected and disposed of by licensed Toxic Industrial Waste collectors. Most of the Construction and Demolition (C&D) waste in Singapore are also being collected for recycling and the recycling rate exceeds 90% in 2015.

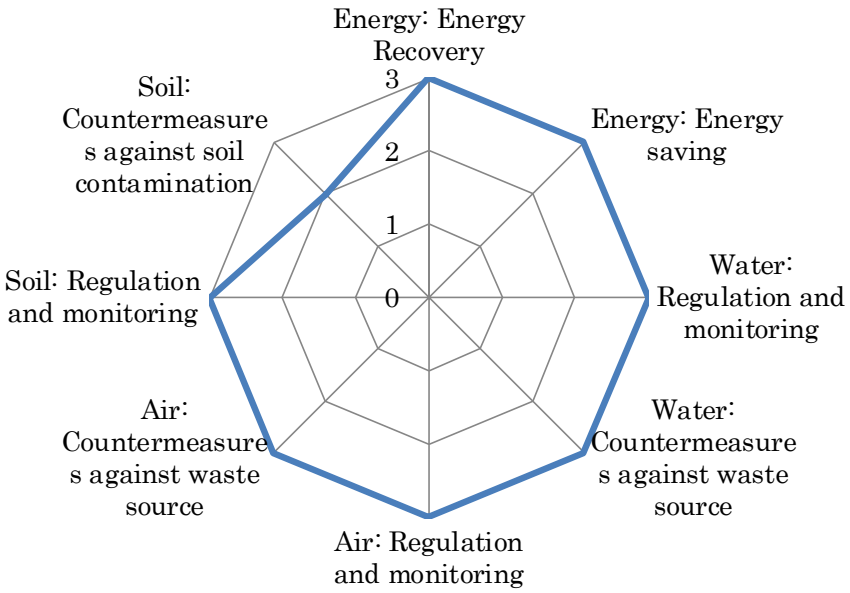


Figure Appendix 3-7　A radar chart of the evaluation results
for the relevant items of resource circulation and waste management sector

As shown in the radar chart above, most of the areas for the sub-sectors are highly evaluated. Singapore scored three points for both Energy Recovery and Energy Savings because energy recovery is carried out at incineration facilities, while there are electric packers used for waste collection. Energy consumption monitoring and energy saving activities are also carried out at incineration facilities.

In areas of water, air, and soil sub-sectors, monitoring and regulatory control measures are stipulated and enforced properly in Singapore. Singapore scored three points in all sub-sectors except for countermeasures against soil contamination which scored two points. This is because soil contamination in waste treatment and recycling facilities may be present but Singapore has measures in place to control the contamination of soil from such facilities and require the remediation of the soil if contaminated.

4. Individual technical sheets

Here is an information collection sheet used for collecting data of technologies and systems from a business operator. Please use the sheet when you ask a business operator about information on technologies and systems.

Category of technology or product in the Guidebook		
Name of technology or product		
Outline of technology or product		
Key word		
Details	Explanation of technology or product	*Describe the details of the technology or product*
	Feature	
	Expected effects	*Environmental issues to be solved, effects of reducing environmental load, effects of environmental improvement*
	Impact on other six area than resource circulation and waste management sector	
	Contribution to deterioration of natural environment and climate change issues	*Contribution to addressing global environmental issues, such as deterioration of natural environment and climate change issues*
Cost	Initial cost	*Estimate*
	Running cost	*Estimate (including maintenance cost)*
Quality	Economic efficiency	*Lifecycle cost, service life, final cost required for disposal after the end-of-life technology and products*
	Safety	
	Resilience to natural disasters	*Durability,promptness and easiness in recovery*
	Consideration toward environment and society	
	Contribution to local economy and communities	*Capacity building of local human resources, development of local industries, short-, mid- and long-term economic effects*
Introduction example		*・Name of city* *・Time of introduction* *・Actual record of operation* *・Rough schedule from discussion to operation* *・Legal system* *・Costs, etc.*
Points to consider in introduction		*The relation with the legal system, impact of geographical and climatic features, etc.*
Country capable of providing services (if specified)		
Operator name		
Contact person		

+Supplementary materials (Free form)

*The items for information collection are not limited to those listed in the information collection sheet.
Please consider addition, modification, as needed to meet your city's needs.