FY2017

City-to-City Collaboration Project for

Low Carbon City Development

Waste to Energy Plant for Yangon City in Myanmar

Final Report

March, 2018

JFE Engineering Corporation

Kawasaki City

Table of Contents

Abbreviation Collection

Abbreviation	Official Name
AE	Accredited Entity
FS	Feasibility Study
GCA	Government Contract Agency
GCF	Green Climate Fund
GDP	Gross Domestic Product
IPP	Independent Power Procedure
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
NDA	National Designated Authority
NEXI	Nippon Export and Investment Insurance
NLD	National League for Democracy
MONREC	Ministry of Natural Resources and Environmental Conservation Myanmar
ODA	Official Development Assistance
PCCD	Pollution Control Cleansing Department
PPP	Public-Private Partnership
SPC	Special Purpose Company
YCDC	Yangon City Development Committee
YESB	Yangon City Electricity Supply Board
WtE	Waste to Energy

1. Introduction

1.1. Background and purpose of the survey

Myanmar has maintained the GDP growth rate of around 7.5% (IMF estimate) since the inauguration of Thein Sein administration marking the transition to civilian rule in March 2011. With the rapid economic growth, improvement in living standards and development of commerce and industry, the country is attracting a growing number of companies from abroad as a place of business. With this backdrop, the volume of waste is steadily increasing each year and the trend is most obvious in Yangon, the former capital of Myanmar, which is driving the country's rapid democratization as economic center of the country. The city has a population of around 5.21 million and the amount of daily waste has reached around 3,000 tons in 2017 which shows significant increase from the daily amount of 1,550 tons in 2011.

Appropriate waste treatment has therefore become an urgent necessity.

The waste in the city of Yangon is currently managed by the Pollution Control and Cleansing Department (hereinafter "PCCD") of Yangon City Development Committee (hereinafter "YCDC") from the administration perspective. YCDC has also been operating the country's first waste to energy (hereinafter "WtE") plant commissioned to and designed, procured, locally engineered and constructed by JFE Engineering Corporation (hereinafter "JFE") in Shwe pyi tha Township in northern Yangon since June 2017. However, there is still plenty room for improvement in the waste treatment system of the city to respond to ever-increasing amount of waste and there are concerns about environmental pollution that may be caused by inappropriate treatment of waste.

In order to resolve the above situation, YCDC is planning and promoting construction of a large-scale WtE plant and is currently reviewing various options to establish a waste treatment system that is suitable to the city. There is therefore high expectation that Japanese technologies may be used for such plants, and Japan, as a country that has improved and developed advanced technologies for waste treatment and recycling system in the past should roll out its technologies to the countries that face difficulties in waste treatment/management so that low-carbon societies are established on a world scale. It is even more important in the context of Paris Agreement that was adopted by consensus at the 21st Conference of the Parties (or "COP") to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in December 2015, which will be fair and effective framework for all member countries. In Paris Agreement, it is declared that each country should determine plans to mitigate global warming promptly and to implement the actions to reduce CO2 emissions in a continuous manner. The emphasis has also been placed on the importance of intercity cooperation.

Kawasaki is one of the cities that are engaged in inter-city cooperation with the city of Yangon. After the survey of intercity corporation started in July 2015, the mayors of the two cities executed the "Memorandum of Understanding on Intercity Cooperation for Making the City of Yangon in Myanmar a Low-carbon Society" in March 2016 and the MoU was updated under the name of the new mayor of the city of Yangon in FY2017 and the associated efforts are implemented by top-down approach in which the related divisions and departments are involved. As a result of such efforts, two Joint Crediting Mechanisms (JCM) FS were implemented and two JCM facilities-support projects have been adopted, which is contributing greatly to establishment of the low-carbon society.

The purpose of this project, under such conditions, is to propose an appropriate urban waste treatment scheme to the city of Yangon to realize a low carbon society in collaboration with the city of Kawasaki that has accumulated know-how of this, and to evaluate feasibility of the scheme as business from the perspective of the country's development into the recycle-based society.

1.2. Survey items

1.2.1. Socioeconomic conditions of the subject area

The progress of economic opening and liberalization of the Republic of the Union of Myanmar has been accelerated since the historic power shift to the National League for Democracy (NLD) led by the chairperson Aung San Suu Kyi in March 2016 and the country is recording the economic growth rate at an average of more than 7.5% (average of the five years from 2012 to 2016). The Foreign Direct Investment (FDI) in Myanmar has also been growing significantly after the economic sanctions by the United States were largely lifted in September 2016 which widely improved the access to the country. Japan is also accelerating establishment of business relationship with Myanmar as exemplified by the opening of Thilawa special economic zone located 20 kilometers to the southeast of the city of Yangon, which is supported by Japan publicly and privately. While there were very high entry barriers for private-sector companies in Japan due to the above-mentioned financial sanctions by the United States that included virtual ban on electronic fund transfers denominated in US dollars to Myanmar, more and more Japanese banks are opening offices in Myanmar after the economic sanctions were lifted. As of 2017, large financial institutions in Japan (so-called mega banks) are obtaining a banking license in Myanmar one after another and this reflects high expectations of Japanese companies for future business opportunities in the country.

1.2.2. Legal system in the subject area

Regarding the waste-related laws, the Environmental Conservation Law was established at a national level in 2012 but no waste-related legal system exists in Yangon Region. On the other hand, the city of Yangon established the City of Yangon Development Law, the State Law and Order Restoration Council Law No.11/90 in 1990 and then revised the law for the first time in 23 years in 2013, into a new format as Yangon city Development Law, 2013. This shows the city's forward-looking efforts in waste management. The table below shows the waste-related legal system in Myanmar including the ones mentioned above.

Table 1-1: Waste-related legal system in Myanmar

Myanmar	
2012	Environmental Conservation Law
2014	Environmental Conservation Rules（Environmental Conservation Rules）
Yangon Region	
	No waste-related legal system exists
City of Yangon	
1990	The City of Yangon Development Law, The State Law and Order Restoration Council Law No.11/90
1992	The City of Yangon Municipal Act
1993	Development Committee Law, The State Law and Order Restoration Council Law No.5/93
1996	Cleansing Rules, Order No.3/96
1999	Pollution Control and Cleansing Rules, Order No.10/99
2013	The City of Yangon Development Law, 2013 *Revision of the City of Yangon Development Law in 1990

1.2.3. WtE plant planning

One WtE plant (hereinafter "WtE plant") is operating in the city of Yangon and construction of the second and subsequent ones is being planned currently. In this project, we will survey the areas suggested by the city of Yangon as possible location of WtE plant, identify equipment for each factor based on the design conditions that include specific construction sites and examine the facilities flow.

1.2.4. Public support and funding programs

One of the biggest challenges in construction of WtE plants is how to finance the cost of

construction. Financial support is indispensable to ensure success of public works and their feasibility as business. In this project, we will survey and examine the support programs of Ministry of the Environment (the government of Japan) and Japan International Cooperation Agency（JICA） as well as the support program of Green Climate Fund (GCF), the international fund.

1.2.5. Organization

In constructing a WtE plant, the costs of construction and post-construction operation need to be covered by the fees for garbage treatment (so-called tipping fee), expenditure by the municipal government and garbage treatment operators. In the WtE plant construction project for the city of Yangon, we will examine the opportunities of operating a garbage treatment business by establishing a special purpose company (SPC).

1.2.6. Feasibility study

We established a finance model comprised of economic indicators such as target internal rate of return (IRR) after setting assumptions for successful operation of waste treatment business by including the foreign exchange and other risks.

1.2.7. Plant-specific planning

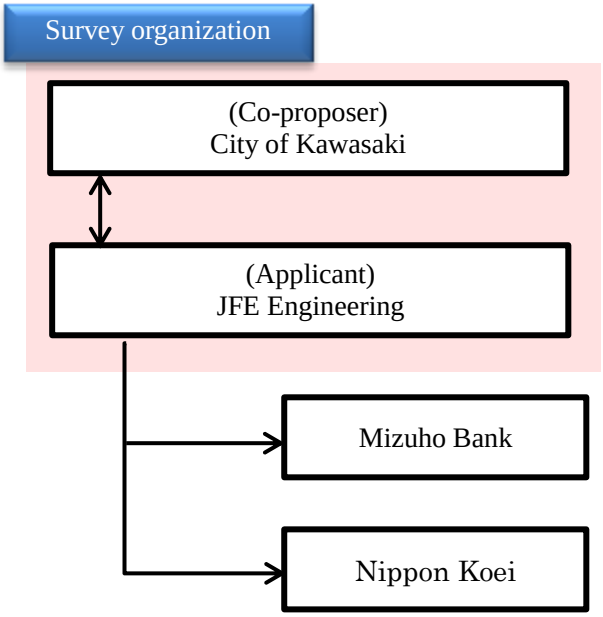
We will present a WtE plant proposal which is most appropriate for the future of the city of Yangon based on the above plan for plant construction and the result of business feasibility study.

1.2.8. Joint workshop of stakeholders

As part of the project activities, we had a kick-off meeting and subsequent workshops in the city of Yangon. In the workshops, we disclosed information that will help actual operations of the plants by the city of Yangon including the data of waste management administered by the city of Kawasaki.

1.3. Survey organization

We conducted the above-mentioned survey with the following Chart 1-1.

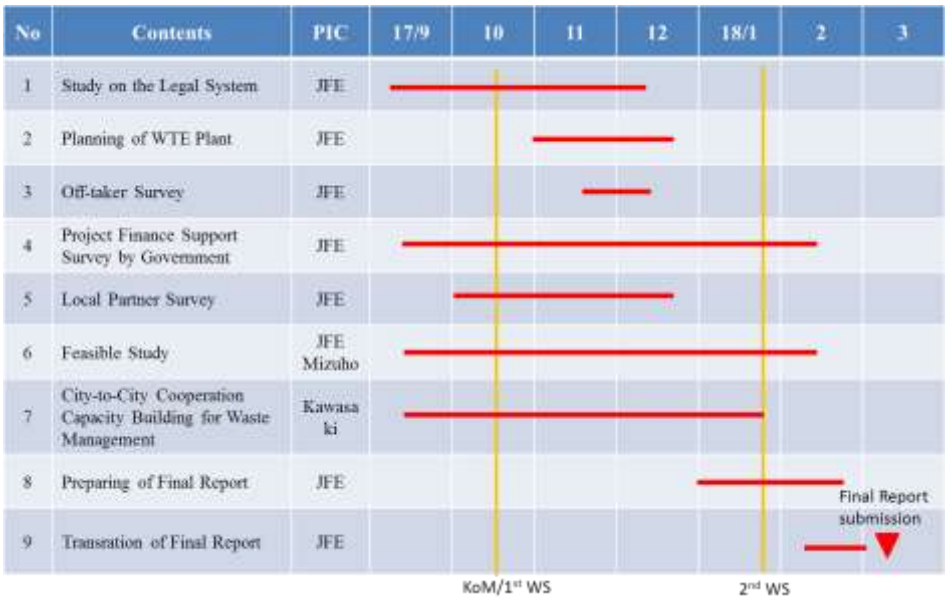


Source: Prepared by the survey team

Chart 1-1: Survey organization

1.4. Survey process

We implemented the survey in the following Chart 1-2.



Source: Prepared by the survey team

Chart 1-2: Survey Schedule

2. Socioeconomic conditions of the subject area

2.1. Outline of Myanmar

2.1.1. General overview of Myanmar

Myanmar, located at 22 degrees of north latitude and 98 degrees of east longitude, shares borders with Bangladesh, China, India, Laos and Thailand. The country has the largest land area in Southeast Asia, at around 680,000 km^2 which is approximately 1.8 times bigger than that of Japan. The country has the population of about 51.41 million (in 2014, announced by Ministry of Labour, Immigration and Population: DOL) and as for major cities, 5.21milion people live in Yangon, 1.46 million people live in Mandalay, and 1.16 million people live in Naypyidaw, the nation's capital. About 70% of the total populations are Bamars and there are many other ethnic minorities. In terms of religion, 89.4 % of the population is Buddhist and there are also Christian (4.9%), Muslim (3.9%) and Hindu (0.5%).

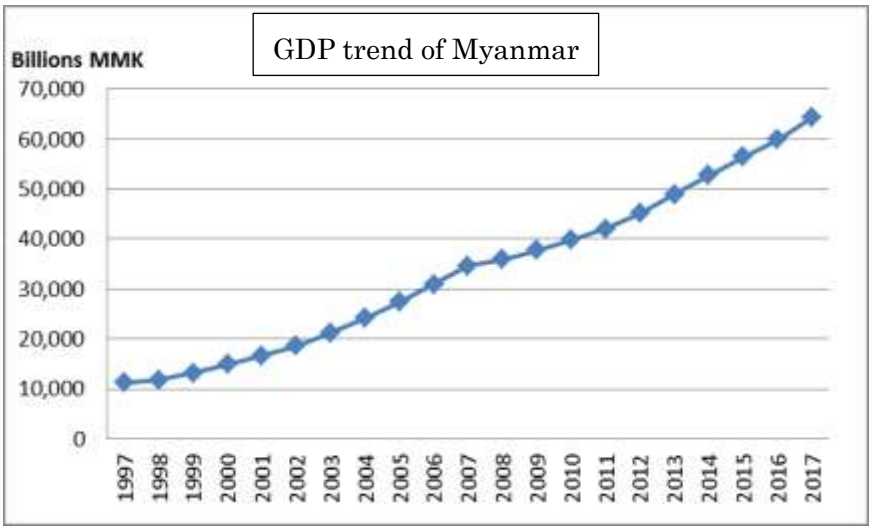
The country was ruled by the military since 1988, but the transition to civilian rule was finally realized in March 2011 with the inauguration of Thein Sein administration. Then in November 2015, National League for Democracy (NLD) led by the chairperson Aung San Suu Kyi had a landslide victory in the general election and the new administration with Htin Kyaw as a president was inaugurated in March 2016. The new administration which was established with a great majority of people in Myanmar for the first time in 50 years is implementing various measures to realize well-establishment of democratization, national reconciliation and economic development of the country.

Chart 2-1: Location of Yangon City

2.1.2. Economic overview of Myanmar

Although Myanmar maintained its economic growth at more than 7% since the transition to civilian rule in 2011, the real GDP growth rate in 2016 remained at 6.3% according to IMF. The main reasons are supposed to be the weak production of agricultural products due to the impact of floods that occurred in several areas of Myanmar in 2015 and the level of FDI that remained somewhat low. The year-on-year increase in consumer prices was 10.0% in 2015 and while it settled down to 7.0% in 2016, increase in food products and other commodity prices negatively affected the domestic consumer market and is considered to be one of the reasons for slower economic growth.

Even with this backdrop, the the real GDP growth rate of Myanmar is still strong and IMF forecasts the economic growth rate of Myanmar in 2017 to be 7.5%, which exceeds the 7% level again. The present administration announced its new economic policy in July 2016 showing the government's attitude to welcome FDI and its preference for deregulation. It also established a new investment law in the process of further promoting FDI. In September 2016, the United States lifted the economic sanction against Myanmar except for the arms embargo.



Source: IMF World Economic Outlook Database

Chart 2-2: GDP trend of Myanmar

The main industry of Myanmar is agriculture and GDP's breakdown by sector in 2017 shows Agriculture: 24.8%, Manufacturing industry: 35.4%, Service: 39.9% (2017). As for trade, the export amount in 2016 was 11,672 million US dollars and the import was 15,696 million US dollars. The main export items are needlework and beans and main destinations are China, Thailand, India, Singapore and Japan. On the other hand, the main import items are general transportation equipment, base metals and their products, petroleum products, electric equipment and plastic materials and they are mainly imported from China, Singapore, Thailand,

Japan and India.

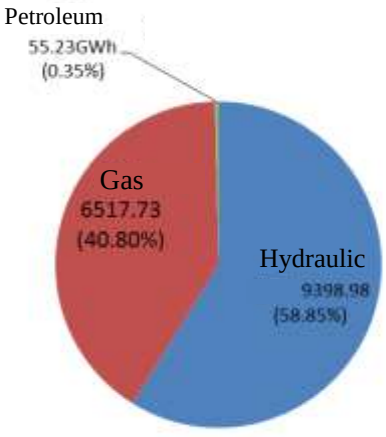
It is expected that, with the progress of Myanmar's democratization, FDI will increase and imports of capital goods as well as intermediate and consumable goods will also grow. On the other hand, while the exports of needlework are increasing, main export item of natural gas is suffering from decline in trade prices and therefore the country is expected to record trade deficit for some time in the future.

2.1.3. Power supply situations in Myanmar

Myanmar has seen significant economic growth and increase in electricity consumption since the transition to civilian rule in 2011. However, the power supply cannot keep up with the growing demand due to the lack in systematic efforts in power development and therefore the lack in electricity has prevented further economic growth.

Myanmar's current power production capacity is lower than other ASEAN countries and at only around 10% of that of Indonesia, Thailand, and Vietnam. The country's power generation facilities are heavily dependent on hydro power (58.58%) and gas (40.80%) and the power sources are not diversified like other countries that are also using coals and renewable energies. Moreover, the country's hydraulic power generation has such problems as power production capacity becomes lower than the installed capacity in a dry season due to shortage of water. The power production capacity of thermal power plants is also much lower than the installed capacity due to decline in output of aged facilities and insufficient gas distribution among the power plant of the country.

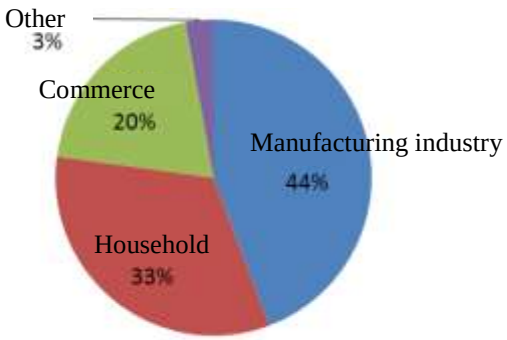
Electrical energy production



Source: Ministry of Electricity and Energy, Current Status & Opportunities for Myanmar Electricity & Energy Sector

Chart 2-3: Breakdown of power sources

Electrical energy consumption by type of users



Source: The Government of the Republic of the Union of Myanmar National Energy Management Committee

Chart 2-4: Electricity consumption by type of users

2.1.4. Overview of Yangon Region and the city of Yangon

Yangon Region is one of the seven administrative regions of Myanmar and is located near the mouths of Yangon River and Bago River and faces Andaman Bay. Yangon Regions consists of four districts under which there are 46 townships. The Region's area is 10,171km^2 and the capital of the Region is the city of Yangon, which has 33 townships and is located about 34 kilometers north (inland) of the mouth of Yangon River and almost at the center of Yangon Region. Yangon Region and has the population of 7.36 million, of which 5.21 million people live in the regional capital of Yangon city.

Chart 2-5: Map of Yangon Region

The city of Yangon is administered by Yangon City Development Committee (YCDC) and consists of four districts (Northern District, Eastern District, Western District and Southern District). The four districts are further divided into 33 townships.

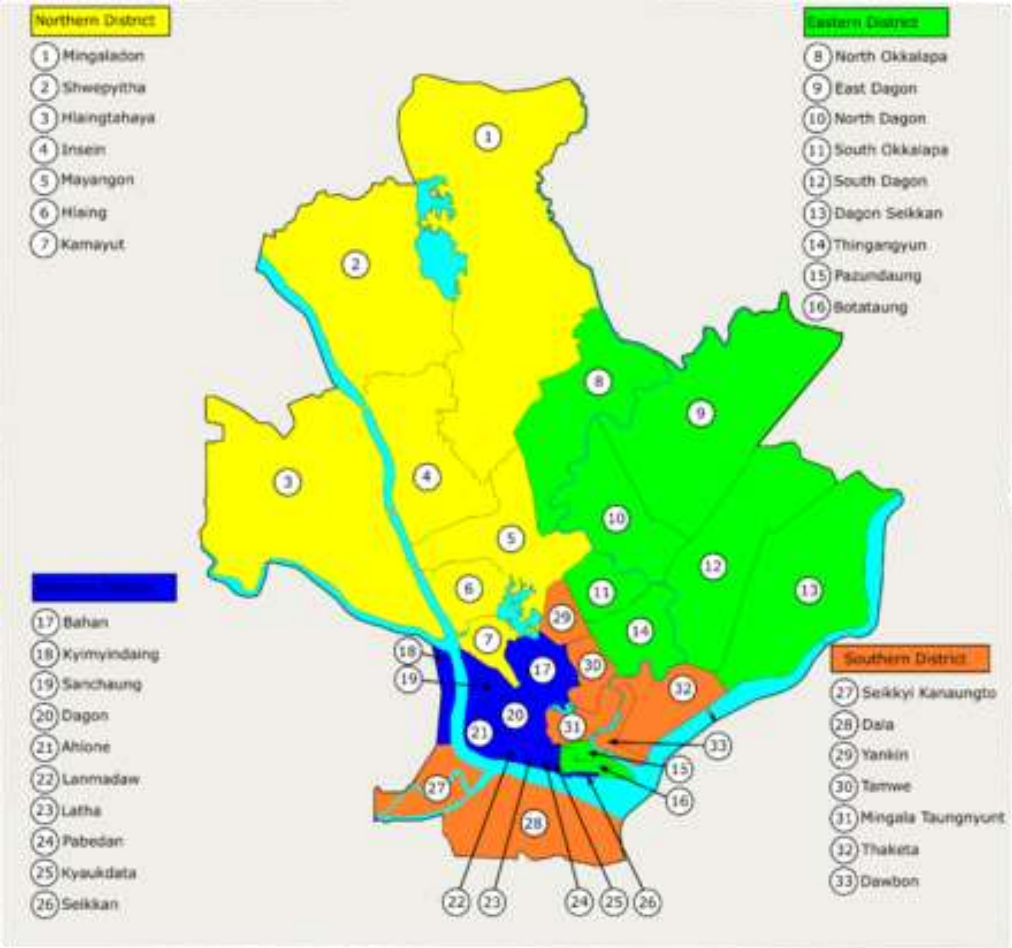


Chart 2-6: Map of the city of Yangon

2.2. Overview of Yangon City Development Committee

2.2.1. Duties and responsibilities

The Yangon City Development Committee (YCDC), established in accordance with the City of Yangon Development Law, the State Law and Order Restoration Council Law No.11/90 (1990), is in charge of construction and repair of buildings, construction and maintenance/management of roads and bridges, land management, traffic regulations, construction and management of parks, construction and initial management of the water supply system, construction and operation of markets, etc. as a main body to implement the city development law in Yangon.

YCDC is also designated as a main body to implement waste management (public health and hygiene) in the city of Yangon in accordance with the City of Yangon Municipal Act, the City of Yangon Development Law, the State Law and Order Restoration Council Law No.11/90, Development Committee Law, the State Law and Order Restoration Council Law No.5/93, and other related laws.

Chart 2-7 shows the organization chart of the city of Yangon and YCDC. YCDC is positioned under the Mayor, Secretary and Joint Secretary and consists of 20 departments and offices.

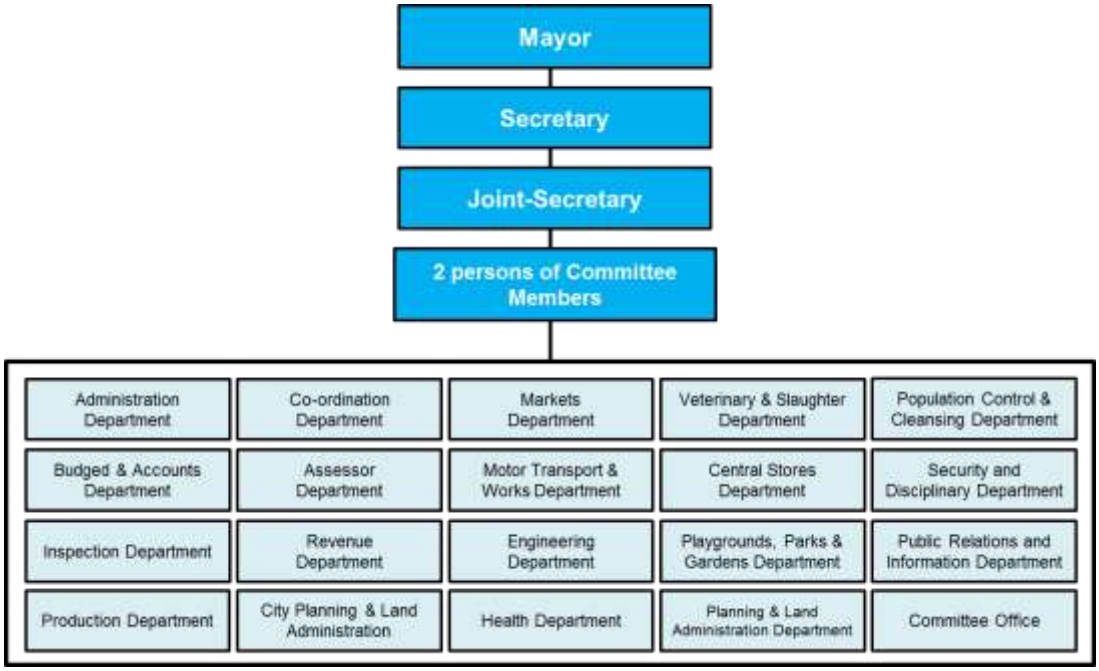


Chart 2-7: YCDC organization chart

2.2.2. Yangon City Pollution Control and Cleaning Department

The Pollution Control and Cleansing Department (PCCD) is responsible for waste management and control in the city of Yangon and is implementing the activities such as

collection and transportation of waste, management and administration of waste disposal sites and cemeteries, recycling activities and community awareness activities as described below.

Chart 2-8 shows the organization chart of PCCD. There are four deputy heads under the head of department, and under them there are departments in charge of final disposal site, each of four districts, pollution control, collection vehicle management and others. PCCD has approximately 5,300 employees in total and 4,200 of them are waste collection workers.

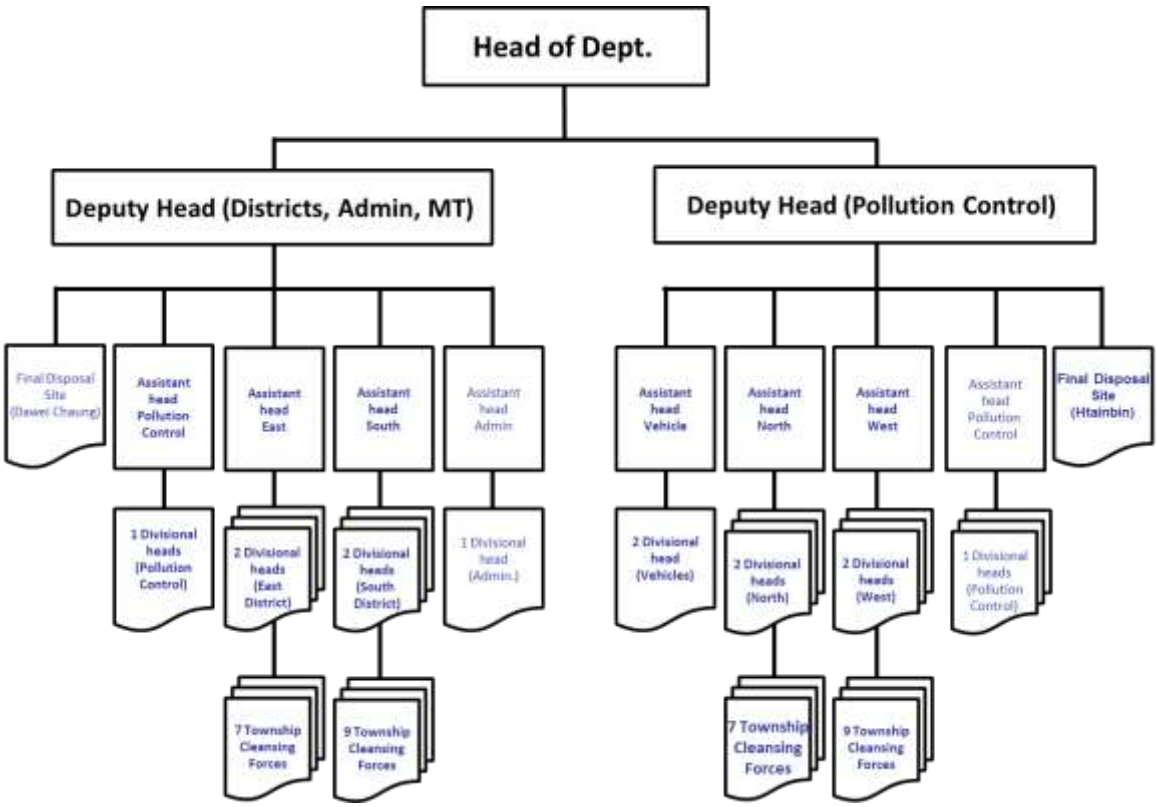


Chart 2-8: PCCD organization chart

2.3. Electricity-related situation in Myanmar

2.3.1. Ministry of Electricity and Energy

The Ministry of Electricity and Energy（MOEE）was established in 2016 through the integration of former Ministry of Electric Power (MOEP) which was governing the electric power sector and the former Ministry of Energy (MOE) which was governing the entire process of petroleum and gas (development and distribution). The Chart 2-9 shows the organization chart of MOEE. The power generation businesses other than hydroelectric generation are governed by MEPE, electric power distribution is operated by Yangon Electricity Supply Corporation（YESC）, Mandalay Electricity Supply Corporation, and Electricity Supply Enterprise (ESE）.

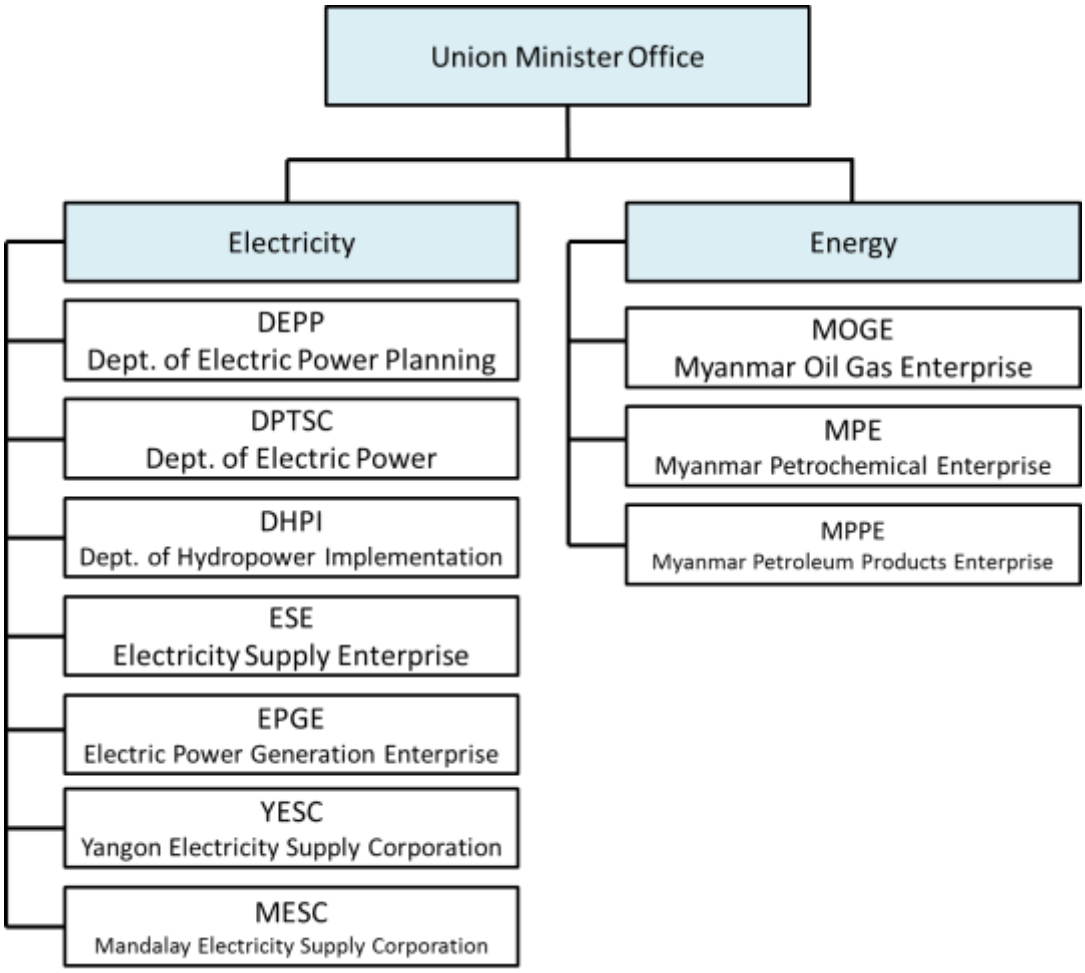


Chart 2-9: Organization chart of Ministry of Electricity and Energy

2.3.2. Current situation of IPP

There is no legal system regarding purchase of electricity from independent power providers (IPP) and how to decide electricity prices in Myanmar currently. The IPPs mentioned in Table 2-1 has already started the business but Max Power is the only plant where Japanese companies are involved in the project execution. Electricity prices are determined on a negotiation basis and there is no standard price list.

Table 2-1 List of independent power providers (IPP)

Name of power plant	Installed capacity (MW)	Operation-start year
Toyo Thai	121	2013
MCP	54	2013
Max Power	50	2013
UPP	52	2014
Myanmar Writing	230	2014
Total	6	2015
Semb Corp	225	2018

2.3.3. Price of electricity

Table 2-2 shows the list of electricity prices. According to the government, it is taking actions to revise the prices as the average sales price is lower than the power generation cost and the government is providing subsidy. The first WtE plant in Myanmar started to be operated in June 2017 and YCDC (facility owner) is offsetting the payment for electricity with the lowest price for industrial use (75MMK) based on the agreement with YESC.

Table 2-2 Price of electricity

	Monthly usage (kWh)	Price (MMK/kWh)
Industrial	1-500	75
	501-10,000	100
	10,001-50,000	125
	50,001-200,000	150
	200,001-300,000	125
	>300,001	100
Household	1-100	35
	101-200	40
	>201	50

3. Legal system in the subject area

3.1. Legal system relating to waste management in Myanmar

3.1.1. Environmental Conservation Law (2013)

The Environmental Conservation Law was enacted in March 2012 with the overview presented in Table 3-1. The matters concerning waste management prescribed by the Environmental Conservation Law include that the Ministry of Environmental Conservation and Forestry (currently the Ministry of Natural Resources and Environmental Conservation: MONREC) shall promote establishment of waste treatment facilities (Article 7), that environmental standards regarding waste management shall be established (Article 10), and performance of waste management shall be monitored (Article 13). Further, it was clearly documented in the Environmental Conservation Law that the Ministry of Environmental Conservation and Forestry shall organize and promote the facilities for waste treatment and shall establish the standards for hazardous waste (Article 7), that the Ministry shall establish the environmental standards for solid waste (Article 10), that the Ministry shall provide consultation for organizations relating to waste management in urban areas (Article 17) and other matters. The Law also prescribed obligations of operators that include obligations for disposal of waste without causing environmental pollution (Article 15) and bearing of cost relating to waste management in the Special Economic Zone (SEZ) (Article 16).

Table 3-1: Overview of the Environmental Conservation Law

Chapter	Summary of the provisions
Chapter 1: Title and terminology	Definition of the words used in the law
Chapter 2: Purpose	The purpose of the law is prescribed as establishment of basic policies and guidelines regarding environment conservation/protection and implementation of environmental policy measures
Chapter 3: Environmental Conservation Committee	Organization and authorities of the Environmental Conservation Committee
Chapter 4: Ministry of Environmental Conservation and Forestry	Responsibilities and authorities of the Ministry of Environmental Conservation and Forestry regarding the environmental protection
Chapter 5: Emergency situations	Emergency situations which may negatively affect public health and safety, environment or ecosystems if no actions are taken
Chapter 6: Environmental standards	Prescribed that the Ministry and the Committee shall establish environmental standards regarding water, air, noise, vibration, and solid and liquid waste
Chapter 7: Environmental protection	Prescribed that the Ministry and the Committee shall issue orders regarding use/transfer of hazardous substances and emission of wastes, etc. and obligate disposing parties to

Chapter	Summary of the provisions
	perform cleaning and disposal in accordance with the environmental standards
Chapter 8: Urban environment management	Prescribed that the Ministry and the Committee shall provide necessary advice to related institutions regarding the urban environmental issues including waste management
Chapter 9: Protection of natural resources and cultural heritage	Prescribed that the related institutions shall manage forests, land, water, minerals, agriculture, fishery, marine resources and diversity under the instructions of the government and the Committee, and the Ministry shall collaborate with related institutions engaged in protection of cultural heritage
Chapter 10: Pre-authorization	Prescribed that the Ministry mandates acquisition of licenses for operation of businesses that may negatively affect environment in advance, which shall be reviewed by the Ministry under the approval of the federation government
Chapter 11: Insurance	Prescribed the obligations of the pre-licensed operators to obtain insurance for incidents that may negatively affect environment
Chapter 12: Prohibited matters	Prohibited entry and construction in the business areas for which pre-approval is required and ban on transportation and sale of the products and substances that may negatively affect the designated environment
Chapter 13: Penalties	Prescribed the penalties that are applied to import/export, manufacturing, possession or transportation of prohibited substances if such business was started without prior approval
Chapter 14: Supplemental rules	Rules on administration and other matters of the provisions of the Law

Source: Report on the feasibility survey of the support for establishment of the recycling-oriented society and waste power generation in Greater Yangon in Myanmar (the Ministry of the Environment, Government of Japan in 2013)

3.1.2. Environmental Conservation Rules (2014)

The Environmental Conservation Rules, the detailed enforcement regulations of the Environmental Conservation Law enforced in March 2012, were promulgated on June 4, 2014. The Environmental Conservation Rules consist of 14 chapters and 74 articles as follows and the main contents of the Rules are clear statement of roles and responsibilities of the National Environmental Conservation Committee (currently renamed as National Environmental Conservation and Climate Change Central Committee: NECCCCC), the Ministry of Environmental Conservation and Forestry (MOECAF, currently MONREC) and Environmental Conservation Department (ECD) of the Ministry.

Chapter 1: Terminology (Articles 1-2)

Chapter 2: Establishment of environmental conservation policies (Articles 3-6)

Chapter 3: Environmental conservation (Articles 7-26)

Chapter 4: International/Inter-regional/bilateral cooperation on environmental conservation (Articles 27-28)

Chapter 5: Environmental management fund (Articles 29-35)
Chapter 6: Actions taken for environmental incidents (Articles 36-37)
Chapter 7: Environmental standards (Articles 38-39)
Chapter 8: Urban environment management (Article 40)
Chapter 9: Disposal (including emission water and gas) management (Articles 41–46)
Chapter 10: Conservation of natural resources and cultural heritage (Articles 47-50)
Chapter 11: Environmental Impact Assessment (Articles 51-61)
Chapter 12: Prior permission (Article 62-68)
Chapter 13: Prohibited matters (Article 69)
Chapter 14: Miscellaneous (Article 70-74)

The Environmental Conservation Rules also cover the matters concerning waste management. Such contents include the classification of hazardous substances (Articles 41 and 44), classification of business that may use hazardous substances, determination of business period and promotion of measures to introduce the facilities that treat hazardous waste, waste water and gas emissions through on-site inspections (Articles 42 and 45), establishment of the conditions concerning waste water treatment at industrial estates, special economic zones and other facilities (Articles 43 and 46 (a)), supervision of waste management of operators in storing, securing safety, transportation, import and export of hazardous waste (Articles 43 and 46 (b)), improvement of the method of disposal, storing, removal and transportation of waste (Articles 43 and 46 (c)), and promotion of cleaner production and recycling in business activities (Articles 43 and 46 (d)).

3.1.3. Other related legal systems

Regarding hazardous waste management, progress has been made in the areas including preparation of a draft notification on classification of hazardous waste based on the Basel Convention with the support of Ministry of Climate and Environment of Norway and establishment of export/import guidelines on hazardous waste. Other than the above, however, there is no movement towards establishment of specific regulations. The Environmental Impact Assessment Procedures (EIAP) and environment standards are described in Chapter 3.

3.2. The waste management legal system in the city of Yangon

3.2.1. The legal system on waste management before the establishment of the Yangon City Development Law, 2013

It is prescribed in the City of Yangon Development Law, the State Law and Order Restoration Council Law No. 11/90 established in 1990 and the Development Committees Law, the State

Law and Order Restoration Council Law No. 5/93 established in 1993 that the municipal government is responsible for public health management. Further, the City of Yangon Municipal Act established in 1992 prescribes that the municipal government is responsible for collection, treatment and disposal of sewage, human waste and general waste and the Act also determines basic matters concerning waste management.

There are some municipal rules that prescribe more detailed rules and systems regarding waste management, including the Cleaning Rules, Order No.3/96 established in 1996 which bans disposal of waste in public places and requires disposal of waste at designated places. Further, the Pollution Control and Cleansing Rules, Order No.10/99) established in 1999 (Table 3-2) prescribe the responsibilities of/restrictions on the municipal government, business operators and citizens regarding collection/transportation and treatment/disposal of waste.

The rules prescribe the matters relating to, in addition to those for solid waste management, cleaning of water drains, improvement of public toilets, public cemetery as well as prevention of typical pollution including water, air and land pollutions. However, the rules have yet to refer to promotion of recycling (3R).

Table 3-1: Overview of the City of Yangon Pollution Management and Cleaning Rules

Chapter	Summary of the provisions
Chapter 1: Title and terminology	Definitions of household waste, weeding/tree clipping waste, industrial waste, construction waste, commercial waste, medical waste, animal carcass, etc.
Chapter 2: Cleaning of waste	Municipal government's duties/responsibilities for installation and management of waste collection sites, waste collection and management of disposal site and citizen's responsibilities for discarding waste at designated locations
Chapter 3: Cleaning of drainage channels and roads	Municipal government's duties/responsibilities for cleaning drainage channels and roads
Chapter 4: Fees for cleaning and hygiene	Citizens' responsibilities for paying fees for cleaning/disposing of their waste and the municipal government's efforts to establish/improve public toilets
Chapter 5: Environmental conservation	Municipal government's duties/responsibilities for implementing management of land, water, air pollution, noise prevention and hazardous waste management in collaboration with the related government organizations
Chapter 6: Burial	Municipal government's duties/responsibilities for cemetery construction and maintenance
Chapter 7: Restriction	Prohibitions of waste disposal at the places other than designated site including on streets
Chapter 8: Supplemental rules	Rules on administration and other matters of the provisions of the Rules

Source: Reports Feasibility study of forming a recycling-oriented society and installation, Operation and Maintenance of Waste to Energy (WTE) Plant in Greater. Yangon (by Ministry of Environment, the government of Japan in 2013)

3.2.2. Legal system on waste management prescribed in the Yangon City Development Law, 2013

The Yangon City Development Law, 2013 took effect in 2013 and replaced the City of Yangon Development Law, the State Law and Order Restoration Council Law No. 11/90 mentioned above. The new law prescribes the matters regarding public health management in Chapter 22 in Articles 8 and determines that the municipal government is responsible for public health management in the city of Yangon in the same way as prescribed by the former City of Yangon Development Law, the State Law and Order Restoration Council Law No. 11/90. The following responsibilities are mentioned in the new Law while the detailed rules are in accordance with the above-mentioned City of Yangon Pollution Management and Cleaning Rules.

22 (a) Implementation of pollution management and services for environmental conservation
22 (b) Cleaning of streets in the city and weeding and clipping trees
22 (c) Removal of hazardous trees and vegetations, correction of collapses in land
22 (d) Removal of waste and cleaning of channels in the city
22 (e) waste management regulated in cleaning rules such as collection, transportation and recycling of waste and management of bids ad contract concerning waste management
22 (f) Installation of trash cans and appropriate maintenance and management
22 (g) Cleaning and waste collection at public accommodation facilities and residences
22 (h) Cleaning and waste collection at public facilities and events
22 (i) Construction and maintenance of public toilets as well as management of bids and contracts for them
22 (j) Management of hazardous waste including electronic devices waste
22 (k) Removal of animal carcasses
22 (l) Supervision and management of illegal waste dumping of each township

3.2.3. Other related legal systems

The draft version of By-law for the City of Yangon Development Law has been prepared and currently discussed by the City of Yangon Development Committee (YCDC). The by-law was supposed to be finalized by March 2017 according to the official of Pollution Control and Cleansing Department (PCCD), but the situation is unknown currently.

Incidentally, no waste-related legal system has been established at the Yangon Region level.

3.3. Environmental Impact Assessment system

3.3.1. Overview of the Ministerial Order on Environmental Impact Assessment (2015)

MONREC enforced the ministerial order on the Environmental Impact Assessment (Environmental Impact Assessment Procedures: EIAP) in December 2015, which consists of 11 chapters and 131 articles and prescribes the procedures for implementing Environmental Impact Assessment (EIA) or Initial Environmental Examination: (IEE) and Environmental Management Plan (EMP).

Chapter 1: Terminology (Articles 1-2)
Chapter 2: Establishment of procedures for Environmental Impact Assessment (Articles 3-22)
Chapter 3: Procedures for screening (decision on applicable business) (Articles 23-30)
Chapter 4: Procedures for initial environment evaluation (IEE) (Articles 31-43)
Chapter 5: Procedures for Environmental Impact Assessment (EIA) (Articles 44-70)
Chapter 6: Application for re-examination (Articles 71-75)
Chapter 7: Procedures for environmental management plan (EMP) (Articles 76-82)
Chapter 8: Environmental concerns at project approval (Articles 83-105)
Chapter 9: Monitoring (Articles 106-122)
Chapter 10: Strategic Environmental Impact Assessment (Strategic Environmental Evaluation (SEA) (Articles 123-124)
Chapter 11: Penalties (Articles 125-131)
Appendix 1：Businesses subject to EIA/IEE.
Appendix 2：Flow of procedures for EIA/IEE/EMP
Appendix 3: Penalty rules and description of penalties

3.3.2. Applicability criteria for EIA and IEE

The appendix 1 of EIAP prescribes businesses subject to EIA and IEE; 141 types of businesses in 8 categories (national project, energy development, manufacturing, agriculture/stockbreeding/forestry, waste or waste water treatment, groundwater development, infrastructure and services, transportation, mining) are subject to either EIA or IEE according to the size of business. Among them, the businesses relating to waste management are listed in Table 3-3.

Projects that do not fall under the criteria of the table below may be subject to IEE or EIA based on the decision of MONREC according to the location and characteristics of the project (EIAP Articles 25 through 29). For example, under the Article 27, the projects that may be implemented in or may affect the forestry/biodiversity conservation area, publicly owned forests, parks (including marine parks), mangrove forests, coastal areas that are fragile from the

perspective of environmental conservation, wildlife sanctuaries, scenic reserves, nature reserves, landscape reserves, and other nature conservation areas, cultural heritage conservation areas, ruins/remains protection areas and historically important areas designated by the Minister of MONREC are subject to EIA.

Table 3-3: Waste management related businesses subject to EIA or IEE

No.	Business	IEE	EIA
6	Waste-to-energy plant	Electricity generating capacity : 50MW or larger	Businesses determined by MONREC as subject to EIA
103	(Non-hazardous) Waste disposal site	1) Landfilling capacity: Smaller than 10 tons per day and the total landfilling capacity is smaller than 25,000 tons 2) Other: Daily tonnage of less than 50 tons	1) Landfilling capacity: 10 tons or larger per day and the total landfilling capacity is 25,000 tons or larger 2) Other: Daily tonnage of 50 tons or more
104	(Non-hazardous) Incineration facility	Processing capacity: Smaller than 3 tons/hour	Processing capacity: 3 tons/hour or larger
105	(Non-hazardous) Recycling and reuse facilities	Daily tonnage of less than 50 tons	Daily tonnage of less than 50 tons
106	(Hazardous) Waste disposal site	-	All businesses
107	(Non-hazardous) Recycling and reuse facilities	Daily tonnage of less than 10 tons	Daily tonnage of less than 10 tons

Source: Prepared by Myanmar Koei International based on the ministerial orders concerning the procedures for Environmental Impact Assessment

3.4. Environmental standards

3.4.1. Overview of the ministry orders on National Environmental Quality (Emission) Guidelines (2015)

It is prescribed in the Environmental Conservation Law and Environmental Conservation Rules that MONREC should establish environmental standards but they have not been established as of December 2017. MONREC however issued the ministerial order relating to the National Environmental Quality (Emission) Guidelines (NEQG) in order to control gas emissions, water emissions, noise and vibration in the Environmental Impact Assessment Procedures (EIAP) in December 2015.

NEQG was established based on the Environmental, Health and Safety Guidelines of International Finance Corporation and is applied to the projects that implement EIA, IEE or EMP in accordance with EIAP. NEQG is classified into the general guidelines and specific guidelines for 56 sectors/industry types. While the general guidelines have established the

guideline values for air, water, noise and odor, the specific guidelines mainly prescribe the guideline values for gas and water emissions. The 56 sectors/industry types prescribed in NEQG are as follows.

1. Energy and development sector (11 types)
2. Agriculture, stockbreeding, forestry development sector (6 types)
3. Manufacturing (27 types) * The breakdown is as follows:
   3.1 Food and beverage(8 types)
   3.2 Needlework, textile and leather (2 types)
   3.3 Wood products (4 types)
   3.4 Chemical products (5 types)
   3.5 Glass and ceramic manufacturing (2 types)
   3.6 Construction material manufacturing (1 types)
   3.7 Metal, machines, electricity (5 types)
4. Waste and emission management (2 types)
5. Water supply (1 type)
6. Infrastructure and services (8 types)
7. Mining (1 type)

3.4.2. Waste-related emission guideline values

The emission guideline values for the purpose of waste management include the guideline values for water leaching from the landfill disposal site, the guideline values for gas emissions from incineration facilities and the guideline values for amount of ingredients in the sludge reused for land improvements or agriculture. The following descriptions show the overview of guideline values mentioned above.

(1) Guideline values for water emissions (at disposal site)

Guideline values for water emissions (at disposal site) are the maximum values and the monthly average values separately established for hazardous waste disposal sites and general disposal sites as shown in Table 3-4. Some of the substances such as organic compounds including benzene cannot be analyzed in Myanmar and therefore handling of those analysis items need attention in the EIA procedures.

Table 3-4: Guideline values for water emissions (landfill disposal site)

Substance	Unit	Guideline value			
		Hazardous waste landfilling disposal site		Urban waste landfilling disposal site	
		Daily maximum	Monthly average	Daily maximum	Monthly average
5-day cultured biological oxygen demand	mg/l	220	56	140	37
Ammonia	mg/l	10	4.9	10	4.9
Aniline	mg/l	0.024	0.015	-	-
Arsenic	mg/l	1.1	0.54	-	-
αTerpineol	mg/l	0.042	0.019	0.033	0.016
Benzoic acid	mg/l	0.119	0.073	0.12	0.071
Total chromium	mg/l	1.1	0.46	-	-
Naphthalene	mg/l	0.059	0.022	-	-
p Cresol	mg/l	0.024	0.015	0.025	0.014
pH	S.U.[a]	6-9	6-9	6-9	6-9
Phenol	mg/l	0.048	0.029	0.026	0.015
Pyridine	mg/l	0.072	0.025	-	-
Total suspended sediment	mg/l	88	27	88	27
Zinc	mg/l	0.535	0.296	0.2	0.11

[a] Standard unit

(2) Guideline values for gas emissions (at incineration facilities and incineration facilities for medical waste)

Guideline values for gas emissions (at incineration facilities and incineration facilities for medical waste) are established for dust, heavy metals, dioxin, etc. as shown in Table 3-5 and Table 3-6. There are many items including heavy metals that are subject to the guidelines for incineration facilities for medical waste. Incinerated ash should be appropriately treated as hazardous waste unless confirmed as harmless.

Incidentally, while MONREC-ECD and some environment survey companies have equipment for measuring some substances in the dust (such as nitric oxide, sulfur dioxide, carbon monoxide, etc.) as of December 2017, there are still some substances that cannot be measured. Handling of such analysis items need attention in the EIA procedures.

Table 3-5: Guideline values for gas emissions (incineration facility)

Substance	Unit	Guideline value[a]
Cadmium	mg/m^3	0.05-0.1 (0.5-8 hours average)
Carbon monoxide	mg/m^3	50-150
Hydrochloric acid	mg/m^3	10

Substance	Unit	Guideline value[a]
Hydrogen fluoride	mg/m^3	1
Mercury	mg/m^3	0.05-0.1(0.5-8 hours average)
Nitrogen oxide	mg/m^3	200-400 (24 hours average)
Polychlorinated dibenzo, Dibenzofuran	ng TEQ^b/m^3	0.1
Sulfur dioxide	mg/m^3	50 (24 hours average)
Total metals	mg/m^3	0.5-1 (0.5-8 hours average)
Total suspended sediment	mg/m^3	10 (24 hours average)

[a]:) Can be applied to both incinerator for urban waste and that for hazardous waste

[b]:) Toxic equivalence factor

Table 3-6: Guideline values for gas emissions (incineration facility for medical waste)

Substance	Unit	Guideline value
Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, Vanadium	mg/Nm^{3a}	0.5
Cadmium, Thallium	mg/Nm^3	0.05
Carbon monoxide	mg/Nm^3	50
Hydrogen chloride	mg/Nm^3	10
Hydrogen fluoride	mg/Nm^3	1
Mercury	mg/Nm^3	0.05
Nitrogen oxide	mg/Nm^3	200-400[b]
Polychlorinated benzene p- dioxin	ng/Nm^{3c} TEQ[d]	0.1
Sulfur dioxide	mg/Nm^3	50
Total organic carbon	mg/Nm^3	10
Total particle matters	mg/Nm^3	10

a:) Amount of substance (milligram) per standard square meters under the specified temperature and pressure

b:) New facilities or the existing facilities with the capacity of over 6 ton per hour: $200mg/m^3$
Existing facilities with the capacity of 6 ton or less per hour: $400mg/m^3$

c:) Amount of substance (nanogram) per standard square meters under the specified temperature and pressure

d:) Toxicity equivalence factor

(3) Guideline values for sludge content (reused for land improvement or for agricultural

purposes)

Sludges discharged from waste water treatment facilities are dehydrated and disposed at the landfill disposal sites or incineration facilities in general. But the sludges with significantly low level of hazardous substances or microbe which fulfilled in Table 3-7 are permitted to be used for land improvement or as fertilizer for agriculture. In this regard, it is possible to analyze sludges in Myanmar except for some heavy metals.

Table 3-7: Guideline values for contents in sludges used for land improvement or agriculture

Substance	Unit[a]	Guideline value
Arsenic	mg/kg	75
Cadmium	mg/kg	85
Chromium	mg/kg	3,000
Copper	mg/kg	4,300
Lead	mg/kg	840
Mercury	mg/kg	57
Molybdenum	mg/kg	75
Nickel	mg/kg	420
Selenium	mg/kg	100
Total coliform group	g[b]	1,000
Zinc	mg/l	7,500

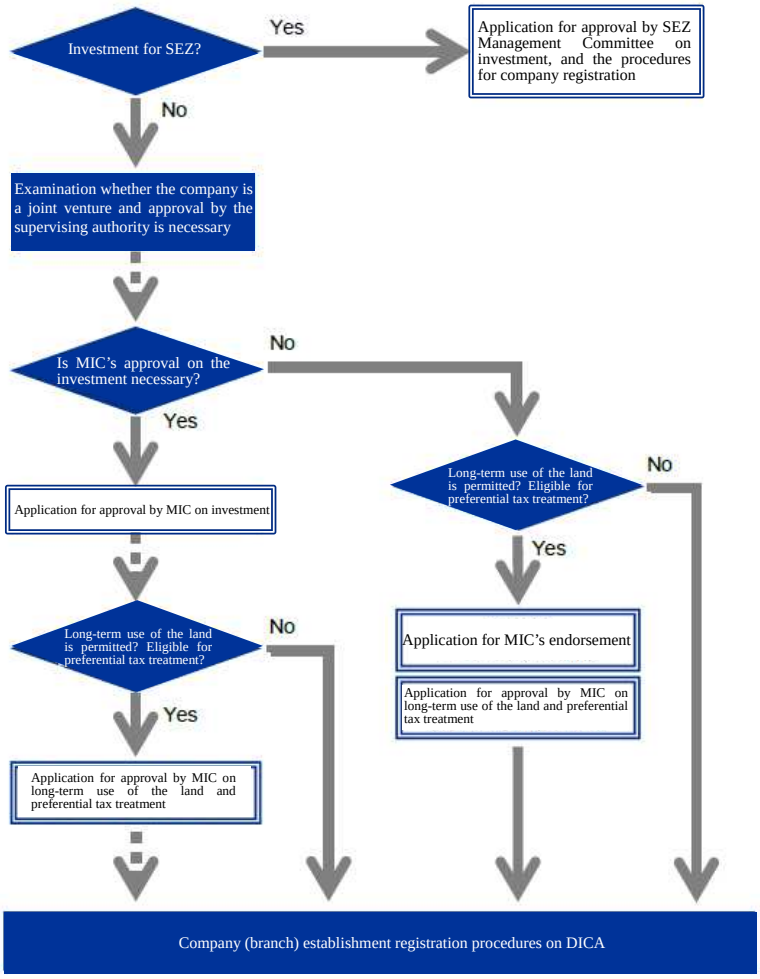
[a]:) Dry weight

[b]:) Total suspended amount dry weight) per gram

3.5. SPC establishment-related system

3.5.1. Myanmar Investment Law

In Myanmar, the administration of National League for Democracy (NLD) was inaugurated in 2016 and announced the new Myanmar Investment Law in order to promote investment of domestic and foreign capital. In April 2017, and the Ministry of Planning and Finance of Myanmar announced the Myanmar Investment Rules (Circular notice of Ministry of Planning and Finance of Myanmar No.35/2017) which are the detailed rules applied under the Myanmar Investment Law. Under the Myanmar Investment Law (new law), the points that were ambiguous previously were clarified and the fairness of investment is ensured by integration two separate laws (Foreign Investment Law and Citizens Investment Law). On the other hand, Myanmar has special economic zones (SEZ) and investments made in SEZ must follow the Myanmar Special Economic Zone Law or related laws and regulations, which mean the investments in SEZ shall be made under the laws and regulations that are not the Myanmar Investment Law. The Myanmar Investment Law establishes restrictions and systems regarding prohibited business, restricted business, permission for investment granted by the Myanmar Investment Committee (MIC) and endorsement (preferential treatment for long-term use of land by foreign investors and preferred tax measures). Chart 3-1 shows the flow of the system.



Source: KPMG "Myanmar Investment Guide FY2017/2018"

Chart 3-1: Investment procedures for foreign investors

The businesses for which investments by both domestic and foreign investors are prohibited include manufacturing of commodities for national defense and security, businesses that have impact on traditional cultures or customs of each ethnic group in Myanmar, and businesses that may have serious impact on natural environment or ecosystem. Table 3-8 below shows the businesses that must not be engaged by foreign investors.

Table 3-8: Foreign capital-prohibited businesses under the new Myanmar Investment Law

No	Description of business	Industry type
1	Publication and sale of periodicals written in Burmese and/or the language of ethnic minorities	Information and communications (media)
2	Freshwater fishery and related services	Fishery
3	Installation of quarantine facilities for import/execute of animals (quarantine itself is	Other

	executed by related authorities)	
4	Pet care services	Service (other)
5	Lumbering business using forest areas and government-managed natural forest areas	Forestry
6	Small to medium-sized survey of minerals, trial mining, business feasibility study and mining in accordance with the Mines Law	Mining
7	Small to medium-sized refining of minerals	Mining
8	Shallow-level oil well drilling	Mining
9	Printing and issuing of stickers for visas and residential permission certificates for foreigners	Other
10	Survey, trial mining and mining of jade and jewelries	Mining
11	Tour guide services	Service (travel)
12	Mini-mart and convenience store (Floor space not exceeding 10,000 square feet or 929 square meters)	Retail

Source：KPMG “FY2017/2018 Myanmar Investment Guide”

Under the new Myanmar Investment Law, businesses that require approval of related government agencies are also prescribed. Any WtE plant that has 30 MW or more power generation capability must obtain approval from the Ministry of Electricity and Energy. Further, the circular notice No.616/2015 by the Ministry of Environmental Conservation and Forestry (currently MONREC） has identified that WtE plant is a business that must go through the procedure of environmental impact assessment（EIA）.

3.5.2. Myanmar Companies Law

The current Myanmar Companies Law has not undergone drastic revision since its enactment in 1914 and therefore foreign investors in particular requested revision for some time. On December 6, 2017, the new Myanmar Companies Law was established and will be enforced from August 2018. In making the new Myanmar Companies Law, clarification of description as well as simplification and streamlining of procedures were promoted and on-line company registration procedures will be available. The legal revision allowed entry of foreign capital in a wide variety of business areas and this is expected to accelerate investment in Myanmar. the major changes in new Myanmar Companies Law are summarized in Table 3-9.

Table 3-9: Important points of the new Myanmar Companies Law

No	Item	Former Companies Law	the new Myanmar Companies Law
1	Number of stock shares	2 stock shares at minimum (and not permitted if a single shareholder has two shares)	One share at minimum
2	Number of shareholders	Two persons a t minimum	One person at minimum
3	Existence of director	Unclear	At least one of the directors must reside in Myanmar or stay in Myanmar at least 183 days/year
4	Definition of a foreign company	One stock share or more is owned by a foreigner or foreign company	35% or more stock shares are owned by a foreigner or foreign company
5	Incorporation procedures	Temporary certificate of incorporation existed (Due to long period of procedures)	Certificate of incorporation is issued immediately after submission of required documents to the Legal Affairs Bureau
6	Provisions in articles of incorporation	Negotiation with the official of investment company administration bureau is necessary if there is any deviation from the standard format	Provisions can be added with no restrictions
7	Revision of the articles of incorporation	Approval of DICA must be obtained (requiring a few months)	Possible by extraordinary resolution, registration with DICA only
8	Contract execution	Unclear	Clearly defined (Authorities, corporate seal, etc.)
9	Contract execution before the establishment of the company	Unclear	Possible to execute contracts before the establishment of the company
10	Class shares	Unclear	Clearly defined (Issuance of preferred, subordinate, without-voting-rights shares)

11	Contribution in kind	Unclear	Clearly defined (Details of capital contribution by no monetary means, etc.)
12	Payment of dividends	Unclear	Clearly defined (Payment rules, etc.)
13	Virtual board of directors' meting	None	Clearly defined (Rules for video conference)
14	Obligations of directors	Unclear	Clearly defined (Rights, obligations, etc.)
15	Collateral and security rights	Unclear	Clearly defined (Procedures, etc.)
16	Accounting obligations	Unclear	Clearly defined (Accounting books, rights and obligations of auditors, etc.)
17	Liquidation	Unclear	Clearly defined (Procedures by type of liquidation, etc.)

Source: Prepared by the survey group based on "Important points of the new Myanmar Companies Law" by Baker & McKenzie

3.6. Master Plan for Urban Development of the Greater Yangon by JICA

3.6.1. Overview of the Master Plan

Japan International Cooperation Agency (JICA) conducted a "Ex-post evaluation study for establishing a development program for the Greater Yangon" from August 2012 to March 2013 and established "Master Plan for Urban Development of the Greater Yangon, Myanmar" with the city of Yangon. The social basic infrastructure mentioned in the master plan is presented in Table 3-10 and waste management is one of them.

Table: 3-10 Social infrastructure in JICA's mater plan

Item	Description
Means of urban transportation, roads, railways	Establishment of mobility centered on urban railway system
Ports and logistics	Establishment of water transportation system with safety, mobility

	and credibility
Water supply	Supply of safe drinking water with appropriate volume, water pressure, and price
Sewage and rain water drainage	Creation of good water environment achieve a safe city without flood
Electricity	Achievement of stable and high-quality electricity supply to support advanced urban functions
Waste management	Formation of recycling-based society through the establishment and implementation of 3R policy
Information and communications	Achievement of advanced information and communications society

Source: Prepared by the survey group based on "Master Plan for Urban Development of the Greater Yangon, Myanmar" by JICA

This master plan is positioned as a core project leading to the "Comprehensive program regarding urban development of Greater Yangon" agreed by the Yangon government and JICA in May 2012 and further studies in various areas are expected based on the master plan.

3.6.2. Waste management plan

Although this is the waste management plan in the city of Yangon, there is no approved master plan in the city of Yangon. While Yangon Concept Plan 2040 is discussed at the city of Yangon, the agenda of discussion is facility plan only although the city of Yangon recognizes the necessity of examining such matters as transit stations for waste. WtE plant, final disposal site, composing facilities, methane fermenting facilities and renewal of vehicles for collection of waste that have mechanical functions for loading. The candidate sites for future waste-related facilities are mentioned in Table 3-11.

Table 3-11: Candidate sites for future disposal management-related facilities

Name	Township/area (District)	Area (ha)	Current status
Final disposal site			
Hlaw Gar	Mingalar Done / North	40	
Mingalar Done	Mingalar Done / North	7	Expansion of the existing temporary disposal site
Maso	East Dagon / East	75	
Kyi Su	Sekkikan Dagon / East	100	

Dagon Myo Thit	North Dagon / East	100	
Dala	Dala / South	240	Dala township has three candidate sites. The total areas of the three sites is approximately 240ha. One of the three sites is expansion of the existing temporary disposal site.
Transit station/incineration facility			
Hlaning Tha Yar	Hlaing Tha Yar / West	8	Application submitted for approval of the mayor of the city of Yangon on the use as transit station or incineration facility in August 2012
Ale Yea	Thaketa / South	20	Disposal site closed
Htein Bin	Htein Bin / North	61	Disposal site closed
Htawe Chaung	Htawe Chaung / East	60	Disposal site closed

Source: JICA ex-post evaluation study on establishment of urban development program for the Greater Yangon in Myanmar

3.6.3. Major challenges for waste management

JICA has identified the following items as major issues and challenges through this study.

1) Lack in plans for waste management

It is necessary to establish a plan based on the quantitative prediction regarding waste management which includes collection and transportation, final disposal and intermediate treatment.

2) Inefficient waste collection/transportation system

The mentioned activities are highly dependent on human resources and manual works. They therefore require significant amount of time in processing and waste is not removed from living environment sufficiently.

3) Aging of vehicles used for collection and transportation of waste

There are many old cars among the fleet used for waste collection and transportation, needing frequent repair and maintenance.

4) Inappropriate final disposal of waste

All final waste disposal sites are in the open dumping state and have chronic problems such as water and air contamination, generation of greenhouse gas and insanity.

5) Unclear waste management administration

Responsibility for hazardous waste management has not been regulated by law and YCDC rules have not prescribed this as well.

6) Unorganized legal system for waste management

Although YCDC has rules for environmental conservation and cleaning, a legal system for waste management is fragile at all level.

7) Inappropriate fee collection

The collection ratio of tipping fee (for waste management services) from households is very low and the service providers' expenditure exceeds revenue significantly.

As suggested by the above issues and challenges, JICA thinks there is much room for improvement in the efforts made in terms of waste in the city of Yangon.

3.6.4. Scenario of waste volume reduction

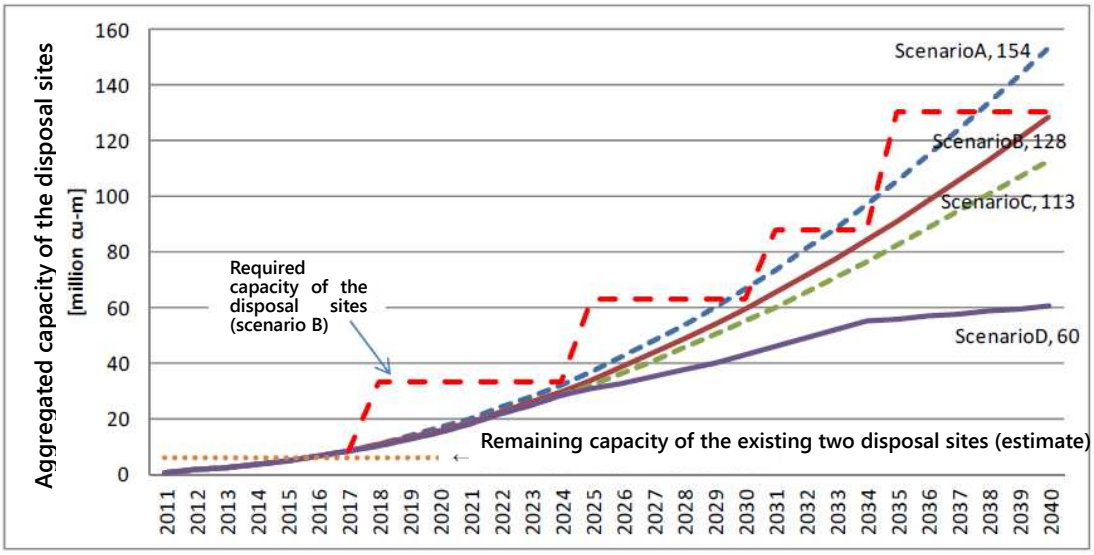
While the waste master plan has not been established yet, it is important to reduce the amount of waste generated and to take actions for volume reduction considering the capacity of the final disposal site. In JICA's study, several scenarios are set (Table 3-12) for prediction of capacity required for the final disposal site.

Table 3-12: Scenario of the impact on waste volume reduction

Waste generation unit:700g per person/day	A	B	C	D
Reduction in waste Collection of valuable articles: 10 % reduction、Utilization of organic substances: 8 % reduction (Current situation continued)	○	○	○	○
30 % reduction in waste generation volume by collection of valuable articles		○	○	○
20 % reduction in waste generation volume by utilization of organic substances			○	○
85 % reduction by incineration - Incineration of 50% of the waste collected (in and after 2025) - Incineration of 100% of the waste collected (in and after 2035)				○

Source: JICA ex-post evaluation study on establishment of urban development program for the Greater Yangon in Myanmar

Scenario D is the highest volume reduction scenario after collection of valuable articles, utilization of organic substances, and incineration are all achieved. The prediction of capacity required for the final disposal site is presented in Chart 3-2.



Source: JICA ex-post evaluation study on establishment of urban development program for the Greater Yangon in Myanmar

Chart 3-2: Capacity required for the final disposal site (for urban waste) until 2040 reflecting the reduced volume

As mentioned in the graph, if incineration is not performed, the capacity required for the final disposal site in 2040 will be twice as large as the cases where incineration is performed, even in the scenario where all other volume reduction methods than incineration are applied. Incineration of waste is apparently required in the urban planning of the city of Yangon.

4. WtE plant construction & implementation planning

4.1. Current situation of waste management

4.1.1. Amount of waste

Chart 4-1 shows the trend of waste emission intensity in the city of Yangon according to the survey conducted by PCCD every several years. While the amount of waste produced in the city was 0.396kg/day in FY2011, it increased to 0.450kg/day in FY2016. According to latest report by YCDC, by type of waste, household waste is 2,500~2,700 tons per day, industrial waste is 250 tons per day, and medical waste is 2.15 tons per day.

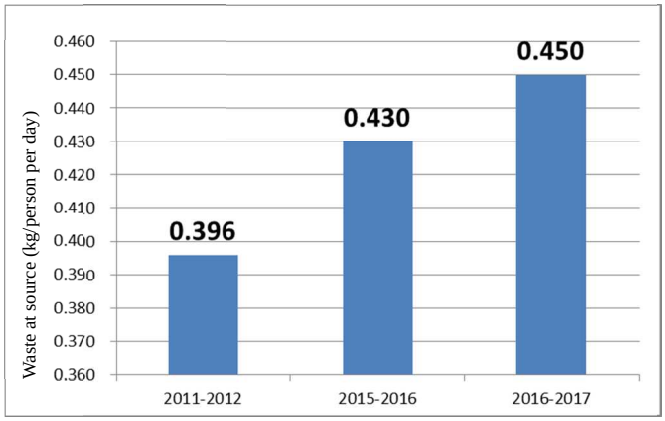


Chart 4-1: Waste emission intensity

Waste collection amount in Yangon city is as shown in Chart 4-2, the annual amount of waste produced in the city increased from 479,280 tons/year in FY2011 to 855,020 tons/year in FY2016. The amount is expected to increase further in the future due to increase in population and economic growth.

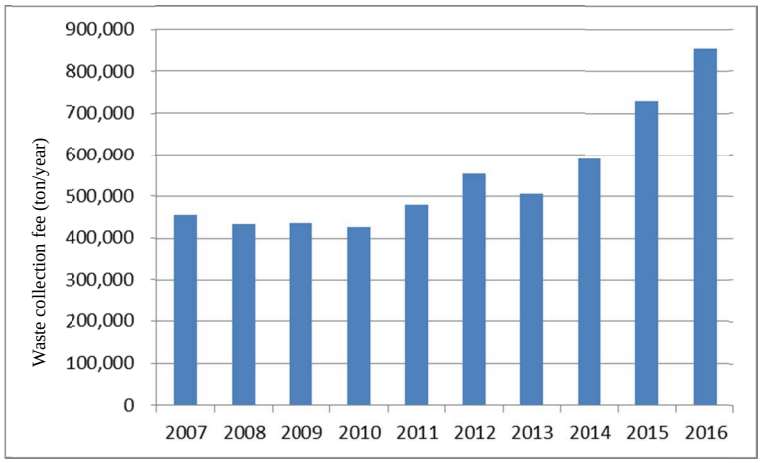


Chart 4-2: Waste collection amount in Yangon city

4.1.2. Definition of waste and flow of disposal/management

Waste is collected and transported by PCCD personnel and the process consists of the first collection (from the source of waste to the collection site/iron container) and the second collection (from the mentioned relaying facilities to the disposal site)（Chart 4-3）.

The first collection is performed by either so-called bell-collection, designated site collection or on-street collection. The bell-collection is performed in highly populated residential areas and the PCCD personnel directly visit households and offices by ringing the bell and collect waste by cart. The personnel is engaged in bell-collection every day from 6 to 11 a.m. every day. The waste collected by bell-collection is temporary deposited at the temporary waste tanks made of concrete or bamboo according to the population density iron containers. People can bring their waste from 6 to 11 p.m. The residents can also bring their kitchen waste to the plastic waste containers (with the capacity of either 660L or 240L) on the streets from 6 to 10 a.m. Waste discarded in the street container is transferred to the temporary waste tanks or iron containers by carts.

The second collection is performed from 6 p.m. and the waste temporarily stored at the above-mentioned temporary waste tanks are transferred to the disposal site by PCCD personnel by trucks with manual transshipment. Waste collected by the iron containers does not require transshipment and delivered as is to the disposal site. In addition to the above regular collection, there is an on-call collection (PCCD directly collects the waste in response to the request of business operators) and directly delivery to the disposal site by business operators.

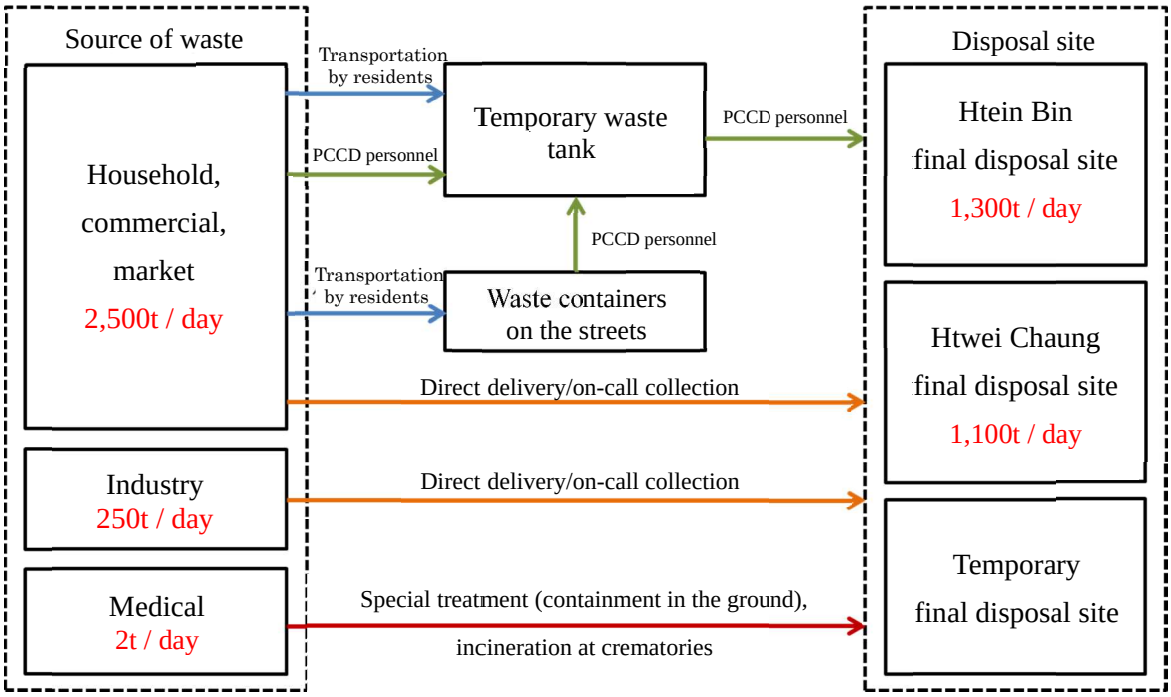


Chart 4-3: Waste collection flow

4.1.3. Treatment and disposal of waste

Waste produced in the city of Yangon is currently disposed as landfill directly at the final disposal site managed by PCCD. The Table 4-1shows the Final Disposal Sites (FDS) and Temporal FDS operated as of January 2018.

Waste produced in the city is mainly treated by Htein Bin Disposal Site to which waste from North and West districts are mainly delivered and Htawe Chaung Disposal Site to which waste from South and East districts are mainly delivered. Waste is received 24 hours a day at each site. As roads for delivery of waste to the final disposal sites are not constructed/organized appropriately, some townships in North and South Districts treat their waste within the township. There are two such Temporal FDS in the city and the land area of each site is around 0.1-1 ha. All disposal sites in the city of Yangon are open-dump type which does not have seepage control work or leachate treatment equipment and there is no coverage soil for the dumped waste.

Table 4-1: Final disposal site in Yangon city

Facility name	Type	Amount of waste accepted (ton/day)	Area (Acre)	In service (used up) area	Year started in service
Htain Bin	Disposal site	1287.75	150	70	2002
Htwei Chaung	Disposal site	1070.50	147	47.4	2001
Dala	Temporary	21.76	1.3	N/A	2003
Seikkyi Khanung To	Temporary	7.11	0.25	N/A	2003
Total		2387.12			

*Average amount during January to December in 2017, not included industrial and medical waste.

The waste of 1287.75 tons is delivered to Htein Bin every day from 15 townships in the North and West districts and 47% of the area is used up. On the other hand, the waste of 1070.50 tons is delivered to Htwei Chaung every day from 18 townships in the East and South districts. While the total land area is 147 acres, the developed area is only around 100 acres and rest of the land is secured for expansion in the future. The showed table is indicated the figures as 2012, so the rest of available area is tight. The latest current occupied area is under the survey by YCDC used up currently. Both disposal sites have truck scales for measuring waste since 2017 and they are in use currently.

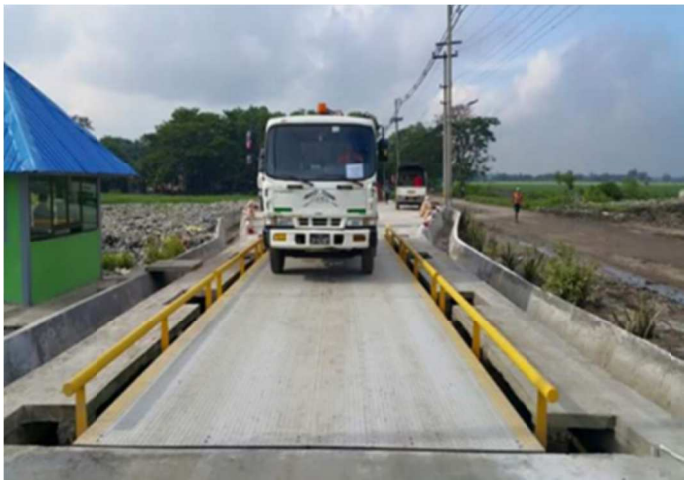


Chart 4-4: Track Scale (Htein Bin)

Chart 4-5: Open dumping (Htein Bin)

Chart 4-6: Occupied area situation (Htawei Chaung)

Chart 4-7: Unused area situation (Htawei Chaung)

4.1.4. Tipping Fee

YCDC is charging commission for cleaning（Cleaning Fee） from households and business operators and the amount of fee varies according to the areas as showed in Table 4-2. PCCD also performs On-Call Collection in response to the request of business operators and the fees vary according to the capacity of trucks.

Table 4-2: Tipping Fee for waste

Category		Tipping Fee （Household/month or track/unit）
Household	CBD area	600MMK
	Sub-urban area	450MMK
	Satellite area	300MMK
Business operator （On-call）	3 ton truck	70,000MMK
	5 ton truck	90,000MMK
	8 ton truck	105,000MMK

On-Call Collection is also performed for industrial waste and the fees is 5,000MMK for the first ton and 2,000MMK for every ton after that.

4.1.5. Medical/hazardous waste

Medical waste from medical institutions from the city of Yangon is collected and disposed by PCCD. Infectious wastes are burnt by cremation furnace and the ash is landfilled at the disposal site. Syringe injectors and needs are buried in the ground. The annual disposal amount is presented in Table 4-8

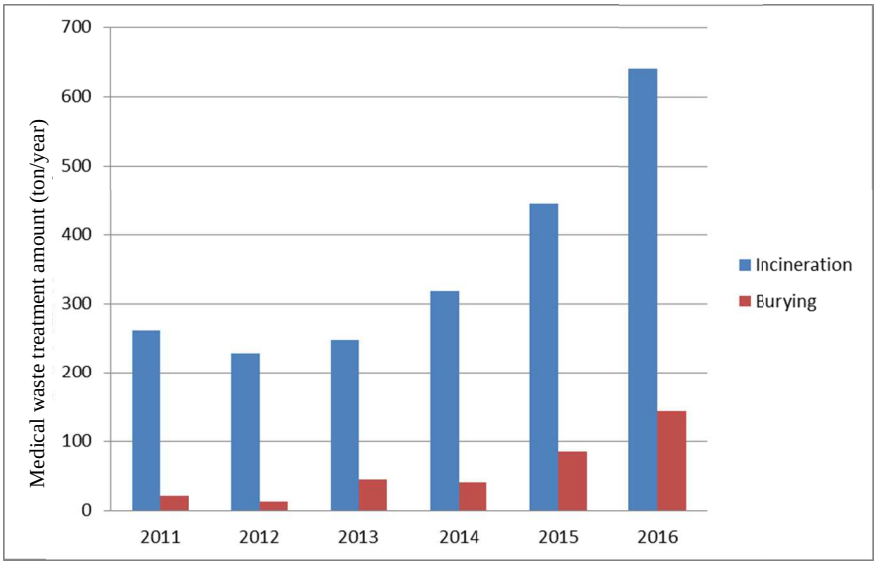


Chart 4-8: Amount of medical waste

Hazardous waste such as expired medicines, paints and mercury are discarded in the column-shape concrete bock buried 3-4 meters deep in the ground, and the doors are fixe for containment.

Chart 4-9: Collection situation of medical waste

Chart 4-10: Collection situation of medical waste

Chart 4-11: Situation of disposal under the ground-1

Chart 4-12: Situation of disposal under the ground-2

4.2. Waste to Energy plant basic plan

In this survey, Waste-to-energy plant (WtE plant) using stoker furnace is assumed for business feasibility evaluation. In this chapter, equipment constituting the plant is selected based on the design conditions and facility flows are examined.

4.2.1. Design conditions

The design conditions of the WtE plant plan this time are as follows.

4.2.1.1. Candidate site for construction

For this survey, YCDC suggested Hten Bin, Htwei Chaung, Kyi Su, and Thaketa as four candidate places for construction. “Chart 4-13” shows the location of each site.

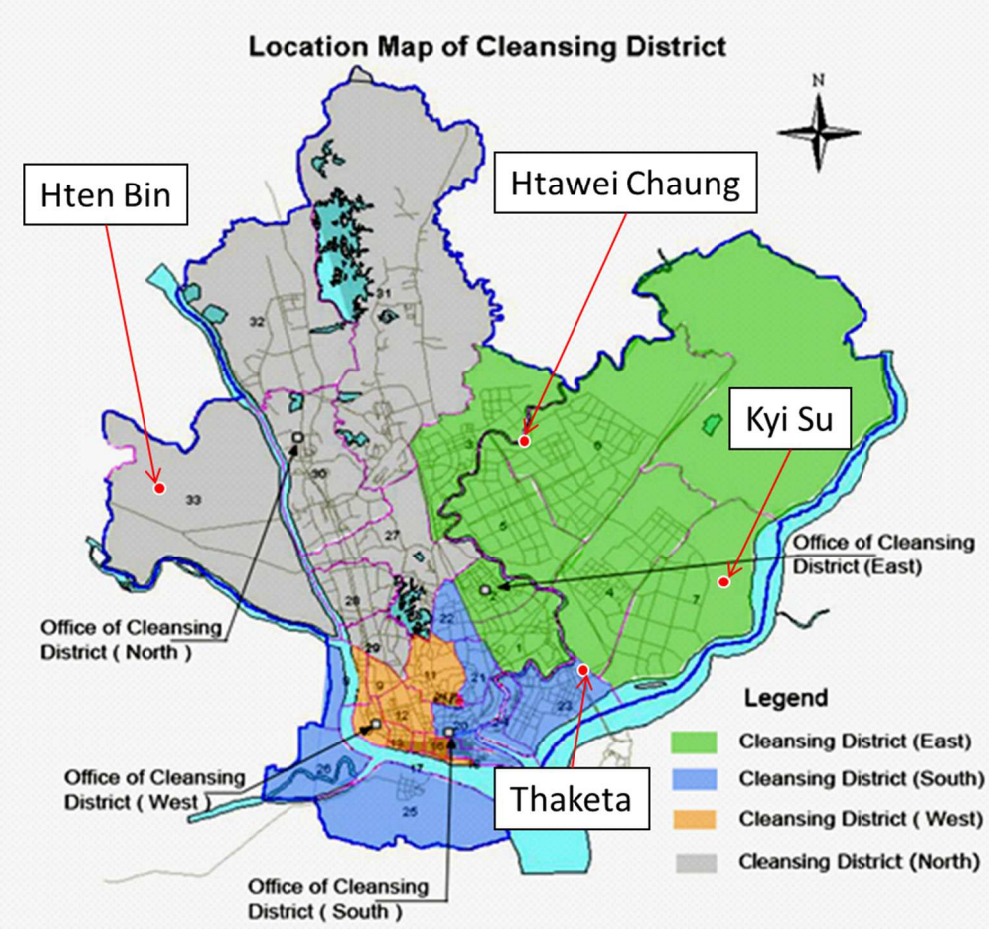


Chart 4-13: Candidate site for construction

As mentioned in Chapter 4.1.3, waste produced in the city of Yangon is delivered to Htawai Chaung Final Disposal Site and Htein Bin Final Disposal Site currently. As the capacity of

Htawai Chaung Final Disposal Site is reaching the maximum, the Htawai Chaung candidate site is assumed to be the construction site to extend the life of the current site.

The Htawai Chaung candidate site is part of the Htawai Chaung Final Disposal Site and was used as final disposal site of waste before and soil property survey is required to implement the plan.

4.2.1.2. Waste treatment capacity

As mentioned in the previous section, it is assumed in this survey that WtE plant will be constructed in Htawai Chaung and the treatment capacity of the WtE plant shall be determined accordingly. The purpose of the WtE plant is to prolong the life of Htawai Chaung Final Disposal Site, and therefore the plant is supposed to treat all waste delivered to Htawai Chaung Final Disposal Site.

In this case, the daily amount of waste shall be as follows:

$$\text{East Cleaning District} + \text{South Cleaning District}$$
$$= 527.05 + 418.56 = 945.61 \quad \text{[ton/day]}$$

Supposing that the suspension period of the furnace for maintenance is 55 days a year, the daily amount of waste accepted by the plant is as follows.

$$945.61 \times 365 \div (365 - 55) = 1113.38 \quad \text{[ton/day]}$$

Further, supposing that 5% of waste is segregated and eliminated and 10% is drained as waste water, the amount of waste to be incinerated per day will be as follows:

$$1113.38 \times \frac{100-(5+10)}{100} = 946.37 \quad \text{[ton/day]}$$

Accordingly, the treatment capacity of WtE plant is 500 [ton/day] x 2 lines, 1000[ton/day] in total.

4.2.1.3. Quality of waste

Quality of waste needs to be examined before the planning of WtE plant. YCDC is currently analyzing the quality of waste but sufficient data has not been collected. We therefore agreed with YCDC for this survey that the quality of the waste of the city shall be as presented in Table 4-3: Waste quality according to the achievement of WtE plants and JFE's experience in Southeast Asian countries.

It is assumed that the proportion of water in waste of the city of Yangon increases at certain time of the year mainly due to the rainy season. We therefore assumed that the proportion of

water in low quality waste to be 60% according to the local interview and the historical performance of WtE plants.

Table 4-3: Waste quality

Item		Unit	Low quality waste	Standard quality waste	High quality waste
Low-level calories		kcal/kg	1,300	1,800	2,200
		kJ/kg	5,400	7,700	9,200
Component	Flammable	%	26	34	40
	Moisture	%	60	55	53
	Ash	%	14	11	7
	Total	%	100	100	100

4.2.1.4. Standard values for gas emissions

In Myanmar, Ministry of Natural Resources and Environmental Conservation Myanmar (MONREC) issued a ministerial order on gas emissions in December 2015. It indicates in Table 4-4. It also indicates regulated values in Kawasaki city. To adapt the standard values regulated MONREC, construction cost of flue gas treatment system and operation cost become costly. Since the flue gas emission standard can discussed, we adapted standard values of Kawasaki city in this study.

Table 4.2.1.4-4: The acceptable level of gas emissions adopted by the survey[1]

項目	Regulated Value $O_2$11%, 0℃1atm		Standard value in Kawasaki city $O_2$11%, 0℃1atm
Cadmium	mg/Nm3	0.05 – 0.1 (0.5-8 hour average)	0.56
Carbon monoxide	mg/Nm3	50 – 150	-
Hydrochloric acid	mg/Nm3	10	36
Hydrogen fluoride	mg/Nm3	1	2.8
Mercury	mg/Nm3	0.05 – 0.1 (0.5-8 hour average)	0.06
Nitrogen oxides	mg/Nm3	200-400 (24 hour average)	120
Polychlorinated dibenzodioxin and	ngTEQ/Nm3	0.1	0.1

[1] [NATIONAL ENVIRONMENTAL QUALITY (EMISSION) GUIDELINES, 2015]

dibenzofuran			
Sulfur dioxide	mg/Nm3	50 (24 hour average)	48
Total metal	mg/Nm3	0.5-1 (0.5-8 hour average)	11(Lead)
Total suspended particulates	mg/Nm3	10 (24 hour average)	22

4.2.1.5. Landfill standard values

In Myanmar, MONREC has issued the ministerial order for water drain standards for landfill disposal sites in December 2015. However, unlike Japan, there are no specific standard values for elution of lead, cupper and mercury that relates to selection of heavy metal stabilization method. The following is the effluent level standards for landfills by MONREC.

Table 4.2.1.54-5 Effluent Levels (for landfills)[2]

Item	Unit	Standard value	
		Day maximum	Monthly average
5-day Biochemical oxygen demand	mg/l	140	37
Ammonia	mg/l	10	4.9
α-Terpineol	mg/l	0.033	0.016
Benzoic acid	mg/l	0.12	0.071
p-Cresol	mg/l	0.025	0.014
pH	S.U.	6-9	6-9
Phenol	mg/l	0.026	0.015
Total suspended solids	mg/l	88	27
Zinc	mg/l	0.2	0.11

4.2.2. Equipment constituting the plant

In this section, we will select the specifications of WtE plant based on the above Section 4.2.1.

4.2.2.1. Waste receiving system

We will apply the pit and crane method in order to process moist waste from the city of Yangon so as to drain and stir it in the pit. The facility will be designed so that the waste pit can store the received waste for more than 7 days to sufficiently drain it considering that the moisture level of the drain will reach as high as 60% in the rainy season.

[2] [NATIONAL ENVIRONMENTAL QUALITY (EMISSION) GUIDELINES, 2015]

4.2.2.2. Combustion system

We will introduce JFE Hyper Stoker System, the latest technology of the company, to the grate of stoker furnace. For the incinerator itself, we will use JFE's two exhaust passes type stoker furnace having an intermediate ceiling. The two exhaust passes type stoker furnace can treat a wide variety of waste and therefore is most suited to the use in Myanmar where the quality of waste is very much different between rainy and dry seasons and the waste calories are expected to increase with economic growth. The overview of the system is presented in Chart 4-14: Schematic diagram of the stoker furnace .

The main combustion chamber has boiler water-cooling walls to maximize collection of heat waste. The inside of the furnace is coated with highly heat resistant materials entirely and has water-cooling or air-cooling walls where clinker is easily attached.

The intermediate ceiling splits the flow of gas emissions into the main smoke path and sub smoke path, and the gases then confluent at the second combustion changer (gas mixing chamber). The turbulent mixing action of gas emissions promotes complete combustion and prevents generation of dioxins and nitrogen oxide (NOx). Accordingly, the as presented in "Table 4.2.1.4-4: The acceptable level of gas emissions adopted by the survey", reduction of NOx (as NO_2) and dioxins is achieved. Further, as the system can provide radiation heat effectively to the waste layer, good ash quality is ensured, and this can significantly reduce the environmental load to the final disposal site.

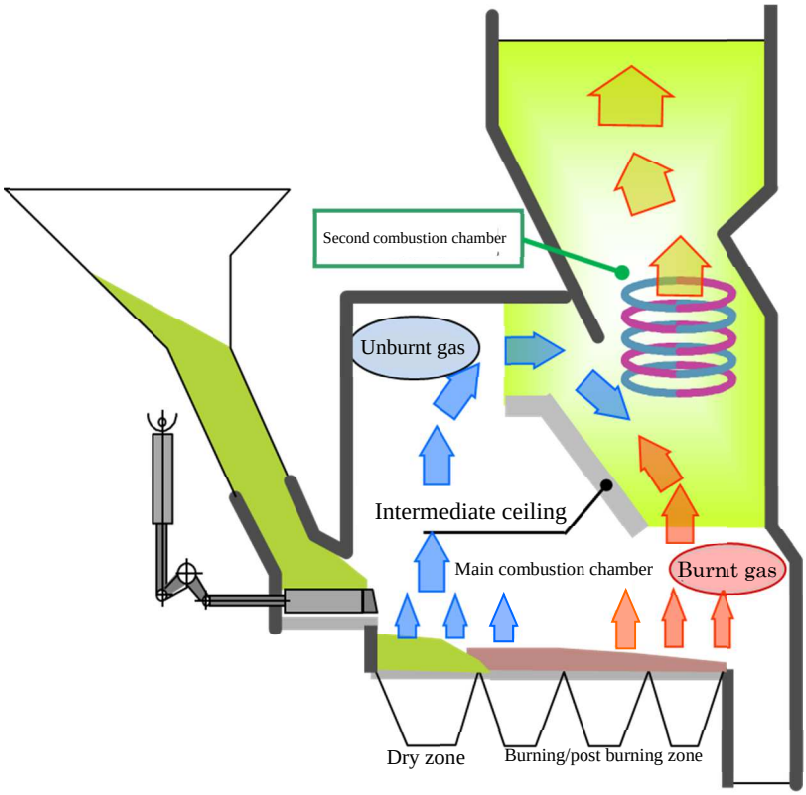


Chart 4-14: Schematic diagram of the stoker furnace

4.2.2.3. Combustion gas cooling system

The boiler is installed to cool down gas emissions from waste combustion and to use the heat waste effectively by changing the collected heat to steam. A monohull natural circulation boiler is planned to be used in this project.

This type of boiler is highly controllable as it has a three-factor controlling method based on the amount of water supply, drum water level, and amount of steam produced, which is most suitable to control a boiler for the furnace that is easily affected by the quality of waste. The control is performed automatically based on the pre-programmed steam yield. At main parts of the boiler heat transmission tube (superheater, economizer), dust blowers are installed to remove dusts on the heat transmission tube. As peripheral and accessory equipment of the boiler, deaerator、deionized water unit、chemicals feeder for the boiler, repetitive blower, boiler water monitoring equipment, etc. are installed.

Further, in order to achieve revenue from the WtE plant, we will use high pressure & high temperature boiler for the system. The steam conditions for the heater exist of the boiler are, pressure: 4.8[MPa(G)], temperature: 420[deg.C].

4.2.2.4. Flue gas treatment system

① Acid gas (hydrogen chloride (HCl) and sulfur oxide (SOx)) removal system

This survey has adopted the dry treatment method in which powder slaked lime is pressed out to/injected in the flue (gas duct) leading to the filtering-type dust collector, consisting of slaked lime silo, slaked lime volumetric feeder, injection blower, and others. The substances generated by reaction (such as calcium chloride [$CaCl_2$] and calcium sulfate [$CaSO_4$]) are collected by filtering-type dust collector in powder state.

② Dioxins removal system

In this survey, we will use the dry treatment method in which powder sodium bicarbonate to remove acid gas (mentioned above) and powder activated carbon are pressed out to/injected in the flue (gas duct) leading to the filtering-type dust collector. The injected powder activated carbon absorbs dioxin gas in the gas emissions. The powder activated carbon and granular dioxins are collected and removed by the filtering-type dust collector. Further, due to the above-mentioned positive effect of two exhaust passes method, JFE furnace can prevent generation of dioxins itself only by appropriate incineration management and therefore contributes greatly to reduce the amount of powder activated carbon used in the system.

③ Dust removal system

In this survey, filtering-type dust collector (bug filter) is used to remove fly ash in the combustion gas emissions generated by the furnace, substances produced in reaction to the above-mentioned powder chemicals, and granular dioxins from gas emissions. A pulse jet method is used to remove the dust from the surface of the filtering-type dust collector, and the dust on the filter cloth is removed by compressed air injected from the injected nozzle at regular interval. The removed dust collection ash is discharged from the hopper in the lower part by the dust collection conveyer, and then delivered to the fly ash silo by the fly ash conveyor.

④ Nitrogen oxide（NOx）removal system

In JFE's stoker furnace used for the survey, activity of nitrogen oxide（NOx）reduction (denitration) is enhanced due to the positive effect of above-mentioned two exhaust passes method, and it is possible to comply with the current emission standards by conducting appropriate combustion management. Therefore, nitrogen oxide（NOx）removal system is not planned to be installed in this program.

4.2.2.5. Heat recovery system

① Steam turbine

Heat waste (gas emissions) produced by waste incineration is collected by the boiler as steam, and the steam drives the steam turbine/generator to achieve power generation. In this program, extraction-condensing turbine is used and steam extraction is used as the steam to process the deaerator, etc.

② Low-pressure steam condenser

This is the equipment that cools down and condenses the entire amount of steam used by the steam turbine. We will use the air-cooling type condenser that does not need a large amount of water as utility conditions of Htawai Chaung (candidate location) are not determined.

4.2.2.6. Ash handling system

① Bottom ash (incinerated ash）

Bottom ash from complete combustion falls into the ash cooling system via the bottom ash chute where fire is extinguished, and moisture is added before the ash is temporality stored in the container. The ash is then brought to the final disposal site by trucks regularly. In this program, the half-moist ash cooling system is used.

② Fly ash

As mentioned in Section 4.2.1.5, the city of Yangon has not established any standards for metal elution relating to the election of equipment for fly ash treatment. Therefore, in this program, it is assumed that no heavy metal stabilization processing by such substances as chelate is made to treat fly ash. Fly ash collected by the filtering-type dust collector is delivered to the container by the fly ash conveyor and store temporary there, and then discharged to outside the site regularly (by external detoxifying treatment or delivery to the final disposal site for hazardous waste).

4.2.2.7. Specification of major equipment

The specifications of major equipment constituting the plant are determined according to the above Sections, エラー! 参照元が見つかりません。and as presented in “Chart 4-6 Major equipment spcifications.”

Table 4-6: Major equipment specifications

Equipment	Item	Unit	Specification
Receiving	Waste pit		7 days
	Waste crane	unit	2
Furnace	Model		JFE hyper stoker furnace
	Capacity	Ton/day/unit	500
	Number	Unit	2
Flue gas cooling	Model		Heat recovery boiler
	Steam pressure for constant use (Heater outlet)	MPa(G)	4.8
	Steam temperature for constant use (Heater outlet)	deg.C	420
Flue gas treatment	Acidic gas removal	-	Dry treatment (Injection of powder slaked lime)
	Dioxins removal	-	Dry treatment (Injection of powder activated carbon)
	Dust removal	-	filtering-type dust collector (Bug filter)
	nitrogen oxide removal	-	Combustion management
Heat recovery	Model		Extraction-condensing turbine + Synchronous generator
	Number	Unit	1
	Steam pressure for constant use (Turbine inlet)	MPa(G)	4.6
	Steam temperature for constant use (Turbine inlet)	deg.C	415
	Emission pressure	kPa(A)	25

Equipment	Item	Unit	Specification
	Generator output (for standard waste)	MW	20.0
Ash removal	Bottom ash (incineration ash)		Semi-dry type ash cooling system

4.2.3. Facility flow

The Facility flow is presented below as " Chart 4-14: WtE plant flow" based on the equipment constituting the plant mentioned in Section 4.2.2

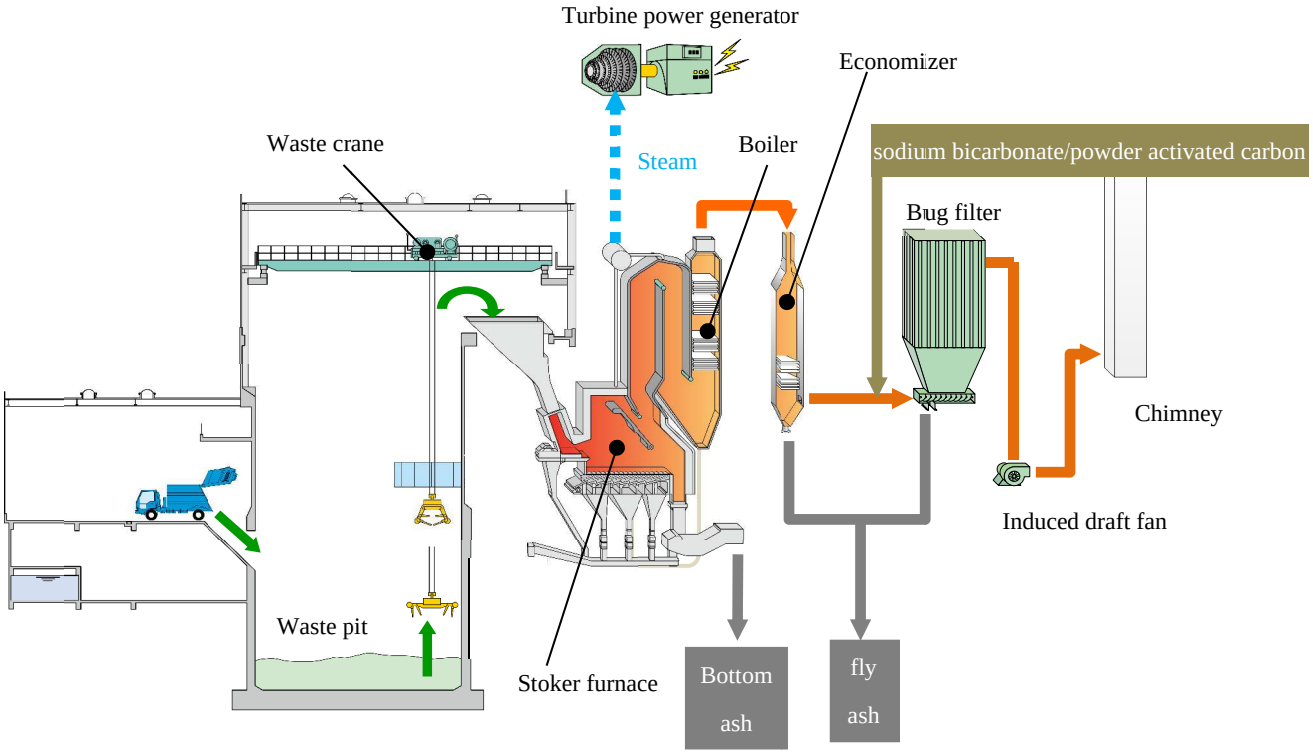


Chart 4-1: WtE plant flow

4.2.4. Layout planning

In terms of the plant layout plan, the overall layout needs to be determined based on the consideration of the result of geological survey of the construction site and utility facilities, operational factors such as vehicle traffic line and manageability/easiness of maintenance of the equipment. It is assumed in this survey that a WtE plant is constructed at planned construction site of Htawai Chaung. Layout planning is assumed below items.

Layout overview

① Waste is accepted by the ramp way method and efforts to lower the construction cost are made by reducing the level of waste pit excavation.

② The waste pit shall have the capacity to store 7 days' amount of waste at maximum to be treated.

③ Bottom ash and fly ash shall be stored in the yard and discharged by the loader to lower the equipment cost such as cranes.

④ Outside plant to lower the construction cost.

4.2.5. Master construction plan

The master construction process assumed for construction planning and construction cost calculation is presented in "Chart 4-15: Master construction process (draft) Master construction process (draft)" below. However, the following matters that could impact the engineering process are not considered.

・The period required for Environmental Impact Assessment of the country

・Variation in design period due to the amount of time needed to obtain permission/license for construction of the facilities in the country

・Variation in design period due to the amount of time needed to obtain consent of the customer to diagrams and documents

・Variation in design period due to the amount of time needed to adopt the latest laws, specifications and standards

・Variation in civil engineering work due to the information on geographical features of the area (such as shape of the land and foothold)

・Risk of delay due to force majeure

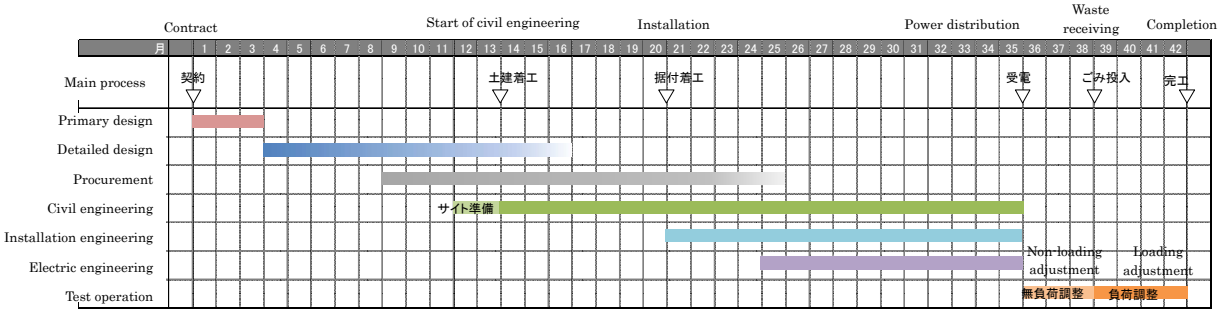


Chart 4-15: Master construction process (draft)

4.2.6. Construction cost of the plant

"Table 4-7: Construction cost" shows the aggregated amount of construction cost of WtE

plant based on the above plant planning. Utilities are assumed to be connected at the border of the site.

Table 4-7: Construction cost

Item	Cost（USD）
Construction cost	115,000,000

4.3. Plant implementation plan

4.3.1. Operation plan

In order to establish a plant operation plan, we assumed the annual days of operation at 310 days. This considers the maintenance period that is required to achieve long-term operation of the plant. It is also assumed that waste is accepted by the existing final disposal site during the maintenance period of each furnace and if delivered amount exceeds the new plant's capacity. Further, as mentioned in the previous section, bottom ash is regularly delivered to the final disposal site and fly ash is discharged outside the plant system without heavy metal stabilization processing. The expense of delivery to outside the plant system is outside the scope of SPC.

4.3.2. Operation cost

1) SPC personnel

In order to implement a WtE plant, appropriate personnel organization is necessary. Although we assume that the plant is implemented by locally-hired employees, it is very important to educate locally-hired employees from our experience in the construction of an incinerator in Yangon. We therefore consider that we will provide operation SVs and maintenance SVs (12 employees in total) for the first two years to provide adequate education to ensure appropriate local implementation so that local staff acquire the knowledge necessary for implementation of the plant in two years and can manage implementation of the plant by themselves. We will further improve the quality of education by conducting training and education in Japan through intercity cooperation.

The plant is operated 24 hours a day and therefore we recommend a 4-group structure with each group's hours of operation for 12 hours a day. Day-shift maintenance workers will also be assigned. As WtE plant has boilers and turbines, the maintenance of which requires special skills, technical experts will be assigned to the plant. Further, the cost of administrative work relating to the project implementation is also counted in the operation cost of the plant. Table 4-8 shows the personnel involved in the implementation of the incineration WtE plant based on the above assumptions.

Table 4-8: Operation resource plan

Title	Number of people	Duties
Representative director of the company	1	Business management
Facilities manager	1	Management of the entire facility Safety management
QA/QC manager	1	Quality control Obtainment and maintenance of ISO standards
Safety personnel (SHE manager)	1	In charge of safety
Secretary	1	Secretary to the company representative
Head of accounting	1	Business management accounting
Accounting staff	1	Accounting
HR & GA staff	1	Human resources and genera affairs activities
PR & education staff	2	Publicity and educational activities
General admin staff	3	Admin activities
Security staff	8	Facility security
Cleaning staff	1	Cleaning
Head of operation	1	Plant operation activities
Head of maintenance	1	Plant maintenance activities
Plant operators		
Shift leader	4	Plant operation management
Shift sub leader	4	Plant operation management (sub)
Operator	16	Plant operation
Technician/expert	4	Steam overall, turbine related, boiler related, electricity related security
Platform monitoring personnel	6	Waste acceptance monitoring
Ash delivery personnel	3	Delivery of incineration ash to landfill site (by truck)
Admin staff	3	Admin for operation
Maintenance personnel		
Maintenance leader	1	Maintenance activities management
Maintenance staff	3	Maintenance activities (Staff)
Operation & maintenance SV	12	SV for operation and maintenance (dispatched from JFE, for the first two years only)
Total	77	

2) Utilities cost

We calculated the amount of utilities required for WtE plant implementation based on the plat operation plan. The usage of each utility is a design value for the standard waste.

Table 4-9: Utility List

Items	
Water system	Water supply
	Sewage
Fuel	Light oil
Chemical for boilers	Drum cleaner
	Deoxidizing agent
Water purification system	Hydrochloric acid
	Caustic soda
	Sulfurous soda
	Cation exchanger resin
	Anion exchanger resin
Flue gas treatment system	Activated carbon
	Slaked lime
Drainage system	Hydrochloric acid
	Caustic soda
	Flocculant
	Flocculant auxiliary agent
Grease and oil	Hydraulic pressure oil
	Lubricant
	Grease
	Turbine oil

3) Maintenance cost

Supposing that the project period is 25 years, appropriate equipment maintenance will be necessary to lower the life cycle cost. Annual inspection and pre-scheduled parts replacement as well as renewal of instruments will be necessary.

4) Cumulative operation cost

The following table shows the average annual operation cost of the plant for 25 years of operation. The personnel cost is contained at very low level as we reflected the level of salary of locally hired employees based on our experience. As for utility cost, calcium hydroxide is

used for emission gas treatment. While sodium bicarbonate needs to be used according to the emission gas standard values, the cost for acquiring sodium bicarbonate is very high and if it is required, USD 1 million will be added to the total cost every year.

Table 4-10: Operation cost

Item	Cost (USD/year)
Personnel expense	550,000
Utility cost	1,200,000
Maintenance/management cost	2,700,000
Other expenses	350,000
Total	4,800,000

4.3.3. Power generation plan

In the plant, the waste treatment fee (Tipping Fee） and sale of electric power will be the main source of income. Sale of electric power is indispensable factor for business feasibility. In this survey, heat recovery efficiency is planned to be improved by using the heat recovery equipment of high-temperature high-pressure boiler of 4.2MPa 、480 ℃ and extraction-condensing turbine. The following table shows the balance of electricity in the project plan.

Table 4-11: Balance of electricity

Item	Unit	Value
Days of operation (annual)	Days/year	310
Electricity generated	MWh	20.0
Electricity used	MWh	4.0
Electricity sold	MWh	16.0
	MWh/year	119,040

5. Stakeholders

5.1. Central government's ministries of Myanmar

The central government's ministries of Myanmar are presented in Table 5-1. The new administration inaugurated in 2016 reorganized more than 30 ministries existed previously in order to 21 improve efficiency and reduce costs.

Table 5-1: Organization of central government's ministries of Myanmar

No.	Ministries and Titles
1	Ministry of President's Office
2	Ministry of Foreign Affairs
3	Ministry of Home Affairs
4	Ministry of Defense
5	Ministry of Border Affairs
6	Ministry of Information
7	Ministry of Religious Affairs an Culture
8	Ministry of Agriculture, Livestock and Irrigation
9	Ministry of Transport and Communication
10	Ministry of Natural Resources and Environmental Conservation
11	Ministry of Labour, Immigration and Population
12	Ministry of Industry
13	Ministry of Commerce
14	Ministry of Health and Sport
15	Ministry of Planning and Finance
16	Ministry of Construction
17	Ministry of Social Welfare, Relief and Resettlement
18	Ministry of Hotels and Tourism
19	Ministry of Ethnic Affairs
20	Ministry of Electricity and Energy
21	Ministry of Education

The ministries that play important roles in executing WtE plant projects are as follows:

1) Ministry of Natural Resources and Environmental Conservation

The ministry, established in 2016 by integrating the Ministry of Environmental Conservation and Forestry and the Ministry of Mines, is in charge of implementation of environmental protection policies, establishment of national and regional plans relating to environmental

management, and stipulation of laws, guidelines, emission standards, EIA, etc. concerning environment.

2) Ministry of Electricity and Energy

The ministry was established in 2016 through integration of the Ministry of Electricity and the Ministry of Energy as mentioned in Section 2.3.1. As main source of revenue of the project is sales of electricity, the license for business needs to be obtained through the negotiation with the Ministry. Further, as it is highly probable that the Ministry becomes an off-taker of the project, the conditions mentioned in Section 6.1.1 must be negotiated with the Ministry as well.

5.2. Yangon City Development Committee（YCDC）

As mentioned in Section 2.2, YCDC is the implementing body of the development of the city of Yangon and the Pollution Control and Cleansing Department (PCCD) is in charge of such activities as collection and transportation of waste/garbage, management and operation of the waste treatment sites and cemeteries, recycling activities and community awareness/enlightenment activities.

On the other hand, as mentioned in Chapter 4, the amount of waste/garbage has been increasing due to the population increase and economic growth and therefore there is concern about the remaining capacity of the current final disposal sites. The city has high motivation for introducing WtE plant to address the issue and constructed Myanmar's first WtE plant from FY2016 to FY2018. JCM scheme was used for the construction works of the plant and JFE Engineering Corporation performed the design, procurement and construction works of the plant. The construction was completed in May 2017 and the facilities were delivered to YCDC. After the delivery, the plant is operated and managed under the leadership of YCDC, the owner of the facilities.

While the project is considered to be operated by the BOT scheme, YCDC intends to engage in the project as organization that controls waste in the city of Yangon, YCDC is expected to be the off-taker of the project and the main party to execute the project at the same time.

5.3. Local supporting companies

5.3.1. Investors

According to the current study, YCDC expects that the project will be established in PPP (BOT scheme). While negotiations with Japanese government and financial institutions written in Chapter 6 need to be continued regarding the use of the subsidy, it is highly probable that investment by private companies will also be needed. If execution of the project is difficult by investment from one company, joint investment with local company (companies) in Myanmar

will be required. Therefore, we need to establish the structure in which the project is jointly executed by more than one company. We have explained overview of the project to the local large companies mentioned in Table 5-2 up until this stage and several of them showed their interest. However, in Myanmar, there have been not many IPPs in which local companies are involved and therefore we will continue discussions with general trading companies in Japan and companies in Myanmar that have good experience in investment.

Table 5-2: Local partner candidates

Company	Business area
Kanbawza	Banking, jewelry, tobacco, edible oil, aviation
SPA (Surge Pan Associates)	Banking, real estate development, manufacturing, construction, import and sale of automobiles, hospital, agriculture, golf course
Max Myanmar	Construction, resort hotel, import/export of heavy machineries, palm/gum cultivation, beverage, jewelry, cement
Dagon	Construction, roads, heavy machineries rental, ﾊﾚ, lumber sawing, agriculture
Yuzana	Construction, marine products, residence and housing, agriculture, hotel, sightseeing
Eden Group	Construction, hotel/resort development, rice milling, import and sale of petroleum
Aye Yar Hinthar	Construction, rice milling
IGE Group	Import and sale of petroleum, construction, banking

5.3.2. Local construction companies

In order to execute construction works at the candidate site without delay, involvement of the local construction companies that have adequate level of experience and capability in Myanmar is absolutely necessary. JFE Engineering Corporation has more than 20 years' business experience in Myanmar and will select local partners based on previous joint work experience. Most of the companies mentioned in Chart 5-3 have construction companies in the group and are interested in the construction work for the project.

Table 5-3: Local construction companies

Company	Business area/Previous coworking with JFE
TRIANGLE LINKS ENGINEERING CO.,LTD.	● Expert in machine/electricity engineering work for plants in general (including power generation plant), civil engineering feasible 【Major coworking with JFE】 ● Civil engineering work for WtE plant ● Civil and machine/electricity engineering work for experimental proof water purification equipment ● Machine/electricity engineering work for plants of JFE group
CAPITAL CONSTRUCTION LTD.	● Commercial building construction, elevated bridges and roads in the city of Yangon, etc. 【Major coworking with JFE】 ● Elevated bridges and roads in the city of Yangon （Serving as main contractor, JFE was engaged in superstructure work）
KT CONSTRUCTION GROUP	● Civil engineering, building construction, pipeline construction, etc. 【Major coworking with JFE】 ● Thilawa port jacket construction (Thilawa) ● Plant infrastructure/building frame works for JFE group companies

6. Official assistance and financial support programs

6.1. Joint Crediting Mechanism（JCM）

6.1.1. Overview of JCM

The Joint Crediting Mechanism, led by the Ministry of Environment of Japan (MOEJ), is a scheme of providing subsidies to the projects that contribute to reduction of greenhouse gases. Projects are assessed according to the level of contribution to reduction of greenhouse gases based on which the supported projects are decided. Japan and Myanmar agreed on the establishment of JCM in September 2015. MOEJ also has allocated budget for a feasibility study conducted on the presumption that JCM is applied, which ensures consistency between the FS and JCM project. As mentioned in Table 6-1, 10 JCM projects including FS have been established between Myanmar and Japan since 2013.

Table 6-1: JCM Adopted Projects in Myanmar

No.	Project title	Category	Year	Implementing body	Field
1	Introduction of solar power and diesel hybrid system	FS	2013	Mizuho Bank	Renewable energy
2	Binary thermal power production	FS	2013	Nippon Koei	Renewable energy
3	WtE power generation in the city of Yangon	FS	2014	JFE Engineering	Waste/biomass
4	Use of fermented methane from the waste water form palm oil (POME) and improvement of environment	FS	2014	Nikken Sekkei Civil	Waste/biomass
5	WtE power generation in the city of Yangon	Equipment assistance	2015	JFE Engineering	Waste/biomass
6	Rice-chaff-burning power station at rice-milling plant in Ayeyarwady	PS	2015	Fujita	Waste/biomass

7	Introduction of energy-saving brewing equipment at the beer factory	Equipment assistance	2016	Kirin Holdings	Energy saving
8	Introduction of highly-efficient through flow boiler at the instant noodle plant	Equipment assistance	2016	Acecook	Energy saving
9	Rice-chaff-burning power station at rice-milling plant in Ayeyarwady	Equipment assistance	2016	Fujita	Energy production
10	Introduction of energy-saving freezing system at the logistics center	Equipment assistance	2016	Rhobi Holdings	Energy saving

Note)FS: Feasibility study, PS: Project Planning Study

Source：JCM official website by Global Environment Centre Foundation (GEC)

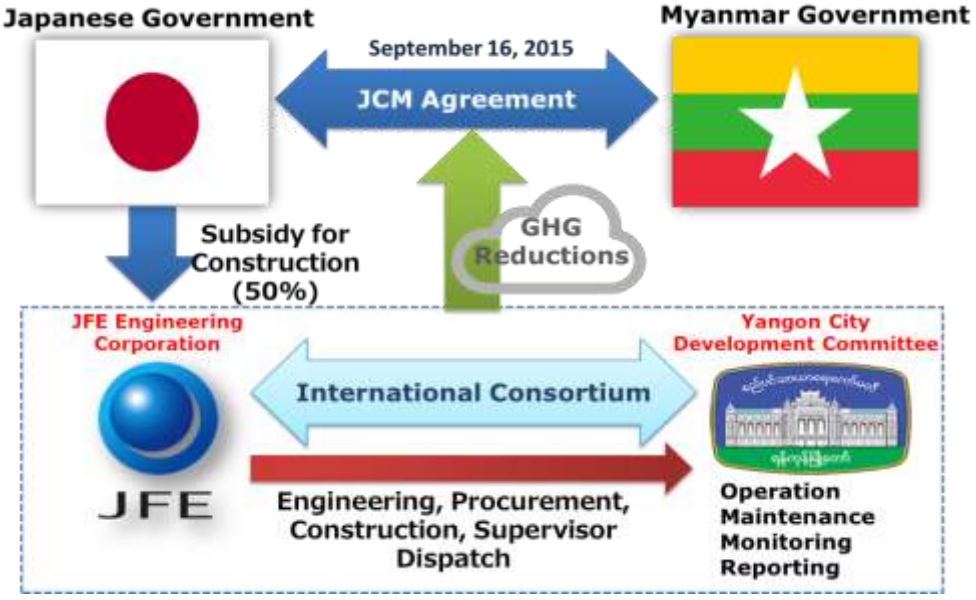
The following conditions in Table 6-2 are also applied to JCM equipment assistance project and independence at the side of development country is one of the objectives.

Table 6-2: JCM equipment assistance project: conditions for adoption (in the same country and business field)

Number of projects	Equipment assistance amount
1	50% at maximum
2 - 4	40% at maximum
5 or more	30% at maximum

While the budget of approximately JPY 6 billion (three years' total) is secured for the projects starting in FY2017 under the JCM equipment assistance project, a rough standard maximum amount is JPY 1 billion per project. Although it is not exaggerated to say that construction of the first WtE plant in Yangon mentioned above was not feasible without JCM, large portion of the initial cost of the currently planned large-scale WtE plant cannot be covered by JPY 1 billion/project and the plant is not feasible as business. We therefore hope that the maximum limit of support is abolished for JCM scheme.

The following chart 6-1 shows the scheme of JCM application to the WtE plant established by us, which is the first JCM project in Myanmar.



Source: Prepared by the survey team

Chart 6-1: JCM scheme of the first WtE project in the city of Yangon

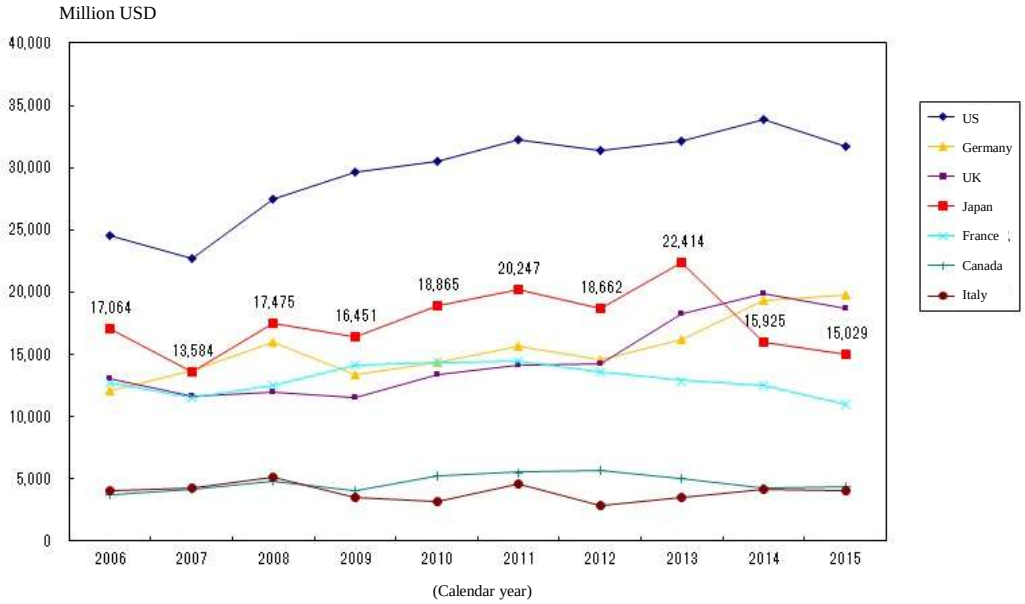
6.1.2. Government's move for JCM

Regarding credit issuance, the joint committee consisting of government institution personnel of the two countries determines the amount of credit after the implementation of MRV（Measuring, Reporting, Verification） and then the government issues the credit. However, as of January 2018, Myanmar has not established the guideline procedures which are required to implement MRV. As 10 JCM projects in Myanmar have already adopted as mentioned above, we expect the necessary procedures to be completed promptly for credit issuance.

6.2. Japan International Cooperation Agency（JICA）

6.2.1. Assistance by JICA

JICA is one of Japan's leading organizations for international cooperation and has provided financial assistance to various countries for many years. JICA is one of the organizations implementing official development assistance（ODA）, where Japan ranked 4th after the US, Germany and UK in FY2015 by contributing USD 14,029 million. It ranked 2nd after the US from 2008 to 2013. (Chart 6-2)



Source: Ministry of Foreign Affairs of Japan based on the ODA record

Chart 6-2: Trend of ODA by major supporting countries
(based on the amount contributed)

A large amount of financial and technical assistance has been made to Myanmar in the past as suggested by the Table 6-3 below but there have not been ay financial cooperation regarding WtE plant up until now. The main reason is considered that the master plan focusing on waste management positioned under the Yangon urban area development master plan (by JICA, mentioned in Section 3.6) has not been established.

Table 6-3: ODA to Myanmar by Japan by the form of assistance
（based on the OECD/DAC reporting standards）

Calendar year	Loan aid	Grant aid	Technical cooperation	Total
Before 2011	1310.72	1396.72	421.7	3129.14
2011	－	19.70	26.81	46.51
2012	0.00	54.82	37.96	92.78
2013	－758.78	3,238.45	48.65	2528.32
2014	11.14	119.68	83.10	213.92
2015	95.71	202.11	53.31	351.13

Cumulative total	658.79	5031.48	671.53	6361.80

Source: Prepared by the survey team based on the "Country Data 2016" by Ministry of Foreign Affairs of Japan

6.2.2. Overseas loans and investment

6.2.2.1. Overview of overseas loans and investment

Interest-bearing financial corporation mainly consists of so-called yen loans and overseas loans and investment. We describe the overview of the overseas loans and investment here. The overseas loans and investment is a method with which the developing businesses operated by private companies in the developing areas are supported. The assistance was suspended in 2001 due to special corporation reform by Japanese government, but it was decided to be resumed under the "Realization of the New Growth Strategy" (approved by the cabinet on January 25, 2011) based on the "New Growth Strategy" (approved by the cabinet on Jun 18, 2010). Overseas loans and investment supports the projects by the private sector in developing countries that have high development impact and if it is difficult to finance the projects only from the finances provided by general financial institutions. The supported in provided in the form of "equity" and "loans" and the fields in scope are (1) Infrastructure and growth acceleration, (2) MDGs and poverty reduction, and (3) Actions to address climate change. The following conditions are also applied to be approved as a project for overseas loans and investment.

Table 6-4: Conditions to be approved as a project for overseas investment finance

・In accordance with the development policy of the country' government and has high development effect
・The business plan is appropriate and the achievement of the business is expected
・Support by JICA is necessary for establishment of the business
・Business is not considered to be established only with the loans or equity investment by the existing financial institutions
・Value-addedness achieved by the support by JICA such as reduction of country risks of the country where the business is operated and stimulation of private investment is considered be indispensable for the establishment of the business, etc.

Source: JICA "Overview of overseas investment finance"

Further, the operation flow towards the approval of a new project in overseas loans and investment is as follows.

1. Receipt of application for investment finance from a company
2. Disclosure of the result of environmental category classification
3. Review by JICA internal project examination committee including the discussion with related functions
4. Explanation to environmental society consideration advisory committee
5. Explanation to three ministries: Project overview and review policies
6. Overseas loans and investment Committee (Note): Explanation of the project and review policies
7. 1st review (by the function in charge of the project): External advisors are involved
8. 2nd review (by the personnel in charge of credit in the review function): External advisors are involved
9. Three-ministries discussion: Result of the review is explained by JICA and discussed by three ministries
10. Overseas loans and investment: Discuss the adoption of the project
11. JICA Board: Review the adoption of the project
12. Contract execution and disbursement
13. Result of preliminary evaluation is disposed after the project is approved

Source: JICA "Overview of overseas investment finance"

The conditions for loans are as follows.

Table 6-5: Overview of the loan system

Loan percentage	70% of the total business cost principle. 80% may be approved if deemed absolutely necessary (the necessity is individually examined in accordance with the characteristics of the project)
Repayment period	Up to 20 years in principle (25 years at maximum). Grace period is up to 5 years in principle (10 years at maximum)
Interest scheme	The interest rate is determined based on the loan interest rate of financial administration plus the credit standing of the debtor so that the grant element (GE) becomes 25% or higher including the

	repayment period, which is the government's requirement for ODA.
Currency	Denominated in yen, local currency (Indonesia rupia, Philippines peso, etc.) Considering to offer in US dollars

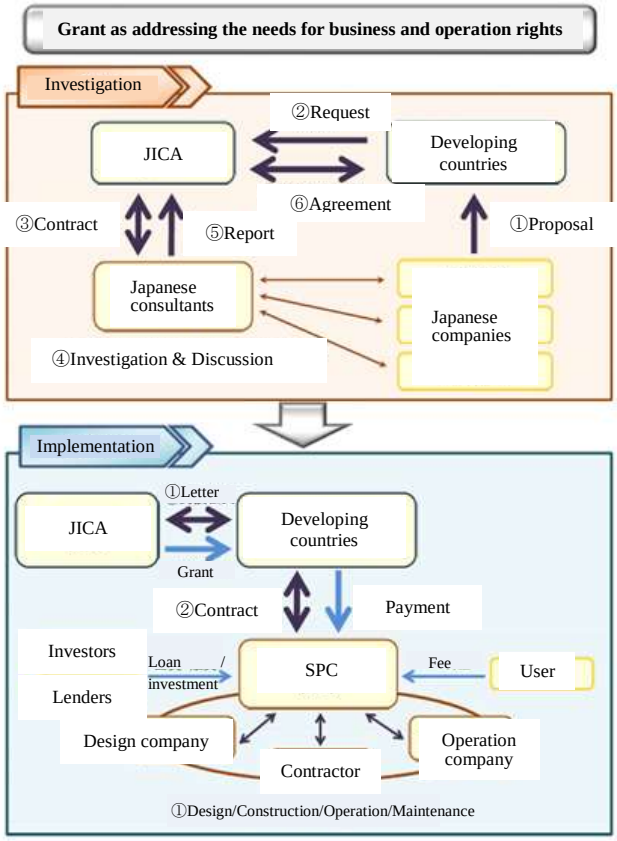
Source: JICA "Overview of loan and equity"

6.2.2.2. Trend of overseas loans and investment

Although there is good foundation for overseas investment finance as shown above, overseas investment finance for Myanmar still have some obstacles to be cleared such as income from selling of electricity and chipping fees that are the main sources of WtE plant business are still unstable and existence of the master plan. These issues are expected to be examined and solved one by one after this.

6.2.3. Overview of grant assistance addressing the needs for business and operation rights

The purpose of this assistance, one of the support scheme presented by JICA, is to promote acquisition of business and operation rights by Japanese companies by providing grant assistance to the public works that implements construction to operation and maintenance of facilities in a comprehensive manner with the involvement of private sector and thereby achieve effective use of the advanced technology and knowhow of Japan to help developing countries. The scope of this system is to help infrastructure projects in developing countries that cannot be achieved only by commercial finance and equipment, equipment/materials and other services required for the project are granted. The fund is paid to SPC operating the company through the country's government. The following chart shows the concept of the grant assistance cases implemented by JICA.



Source: JICA Grant assistance addressing the needs for business and operation rights

Chart 6-3: Grant assistance addressing the needs for business and operation rights – Project phase (implemented by JICA)

Execution of this system is basically determined by the general competitive bid. It is also required that SPC is in charge and responsible for the entire business from the construction of facilities to operation and maintenance/management in the medium to long-term. Projects implemented under this scheme already exist, including the "Plan for reducing illegal use of water supply in the city of Yangon" in Myanmar and the "Plan for construction of legitimate waste disposal facilities for medical and hazardous waste in the city of Nairobi" in Kenya.

6.3. Green Climate Fund（GCF）

6.3.1. Overview of GCF

Green Climate Fund is a multinational fund to provide financial support to developing countries implementing action to address climate change, establishment of which was

decided by the 16th Conference of the Parties of the United Nations Framework Convention on Climate Change in 2010（COP16）. This is a financial mechanism based on United Nations Framework Convention on Climate Change (UNFCCC) designed to support developing countries' efforts to reduce greenhouse gases and to address (respond to) the impact of climate change.

The source of income for the fund is contribution by 43 industrialized and developing countries totaling to USD 10.3 billion, among which Japan has contributed USD 1.5 billion. There four types of assistance method, those are (1) grant, (2) loan, (3) guarantee and (4) equity. The size of assistance by the type of method is presented in Chart 6-4. The project size is also classified into four categories that are (1) Micro：Smaller than USD10 million, (2) Small：USD10 million - USD50 million, (3) Medium：USD50 million - USD250 million and (4) Large：USD250 million or larger. 50% or more adopted projects are in the size of USD10 million – 50 million. (Chart6-5)

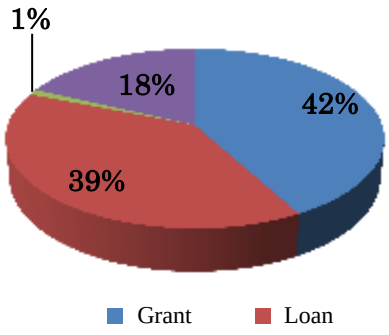


Chart 6-4: Size of support by method

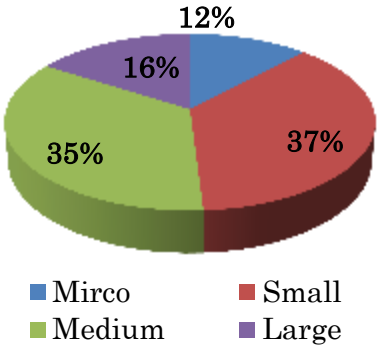
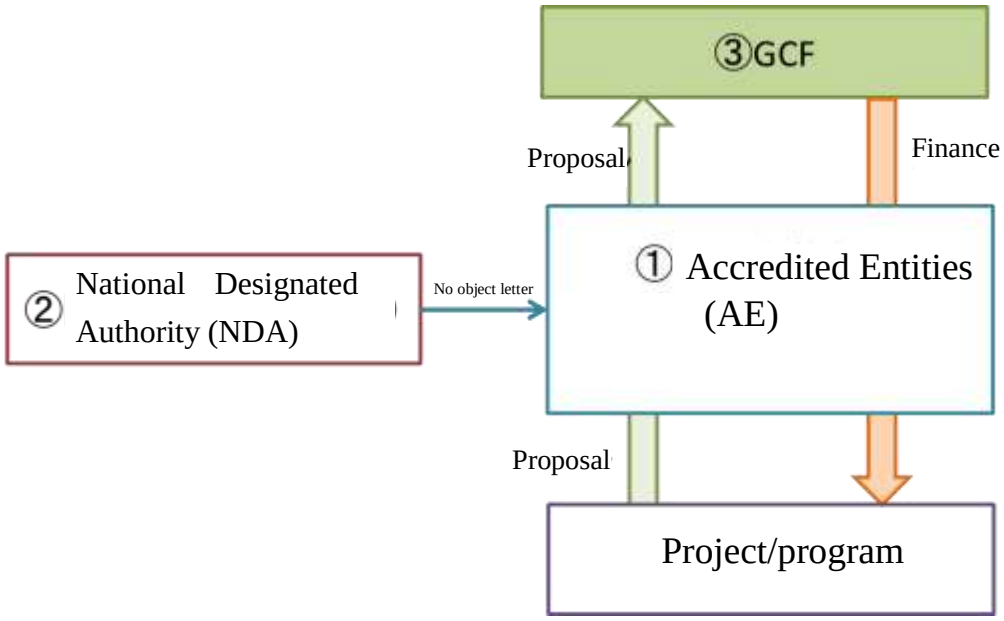


Chart 6-5: Size of support

For provision of GCF, proposal for financing must be submitted from a different entity from the GCF board (the separate organization is called Accredited Entities (AE)). Any nomination as AE must be accredited by GCF board and in addition to the international, regional and national organization, private companies and NGO can apply for AE status. In Japan, JICA and the bank of Tokyo Mitsubishi, UFJ are the first entities that were accredited as AE in July 2017. The review for project to be financed is delegated from GCF board to AE practically and the project financing rules are supposed to follow the AE's rules. AE has two main accesses, one is direct access such as national and regional organization and the other is international access such as private banks.

When AE submits a proposal to GCF, No Objection Letter of the organization that serves

as contact between the developing county and GCF (National Designated Authority: NDA) must also be submitted. NDA is designated by the mystery of environment or ministry of finance in each country and MONREC is appointed as NDA in Myanmar (See Table 6-6: Examples of Designated National Authority) Not only the names of ministries/agencies, but also focal point person is disclosed. After receiving the No Objection Letter from NDA, AE submits the proposal to GCF and financing is implemented after the proposal is approved The following chart shows the major flow but practically additional procedures need to be followed before/after submission of a proposal from AE to GCF. Details will be described later.



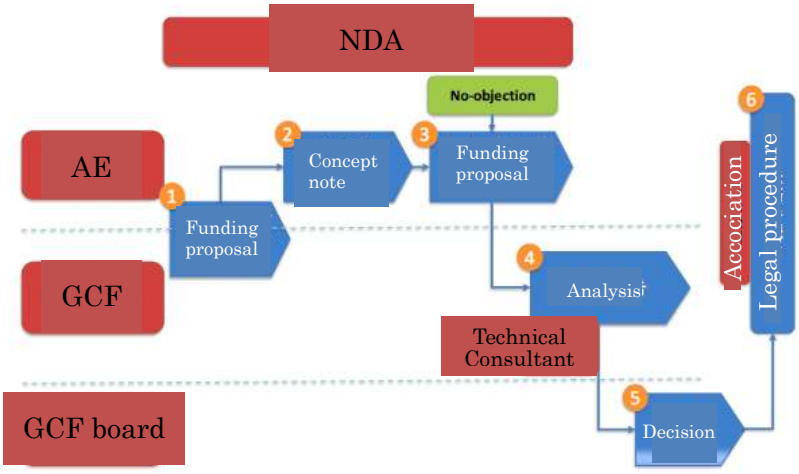
Source: Prepared by the survey team from Mizuho Information & Research Institute "Overview of GCF system and procedures February 28, 2017" (Disclosed document)

Chart 6-6： GCF fund allocation scheme

Table 6-6　Examples of Designated National Authority

Country	Institution & person in charge and contact
India	MINISTRY OF ENVIRONMENT, FORESTS AND CLIMATE CHANGE /Mr. Ravi S. Prasad (Joint Secretary)
Indonesia	FISCAL POLICY AGENCY, MINISTRY OF FINANCE /Dr. Suahasil Nazara (Chairman)
Thailand	OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING /Dr. Phirun Saiyasitpanich（Director of Climate Change Management and Coordination Division）
Vietnam	MINISTRY OF PLANNING AND INVESTMENT /Dr. Pham Hoang Mai (Director General, Department of Science, Education, Natural Resources and Environment)
Myanmar	MINISTRY OF ENVIRONMENTAL CONSERVATION AND FORESTRY /Mr. Hla Maung Thein (Deputy Director General, Environmental Conservation Department)

The following 6 steps should be taken from proposal submission by AE to determination of financial support.



Source:　Prepared by the survey team from Mizuho Information & Research Institute "Overview of GCF system and procedures February 28, 2017" (Disclosed document)

Chart 6-7：　Flow of capital proposal and support decision

The evaluation criteria of the project are the following 6 points in Table 6-7 and the paradigm shift is placed great emphasis.

Table 6-7: Project evaluation criteria

1	Impact	Whether there is any probability that the support project contribute to achievement of the purpose and result of GCF
2	Paradigm shift	Whether the support activity can have impact beyond the project or investment
3	Potential sustainable growth	Whether there is bigger benefit or priority item
4	Need of the supported country	Whether there is fragility and needs for finance of the recipient country and recipient entity
5	Country ownership	Whether the recipient country has ownership and the capability to implement the project
6	Efficiency and effect	Whether the subject project is healthy in terms of economy and finance

Source: Ministry of Foreign Affairs of Japan "Green Climate Fund: GCF"

6.3.2. Trend of GCF

Three years have been passed since the establishment of GCF, but there has been no project in which a Japanese company is involved although the Japanese government contributes approximately 15% of the total GCF contribution. MOEJ and Ministry of Economy, Trade and Industry (METI) have commissioned FS survey for the formation of GCF projects to multiple Japanese institutions in 2017, which is a move towards the situation where the companies in the country which has contributed USD 1.5 billion can enjoy benefit. Financial institutions other than JICA and the Bank of Tokyo-Mitsubishi UFJ have been making applications for AE certificate, which is another forward-looking moves by the Japanese government and private sector for GCF utilization. According to GCF documents, it takes at least 8 to 11 weeks from the submission of a funding proposal to the approval by the board but the longest time is spent on creation of a proposal and preparation of a concept note leading the submission of funding proposal. This process is considered to be the key process of GCF utilization.

7. Project execution scheme

7.1. Organization

The city of Yangon is considering execution of the WtE project by the BOT scheme with a special purpose company (SPC) invested by the city itself. Chart 7-1 shows organization for the project execution.

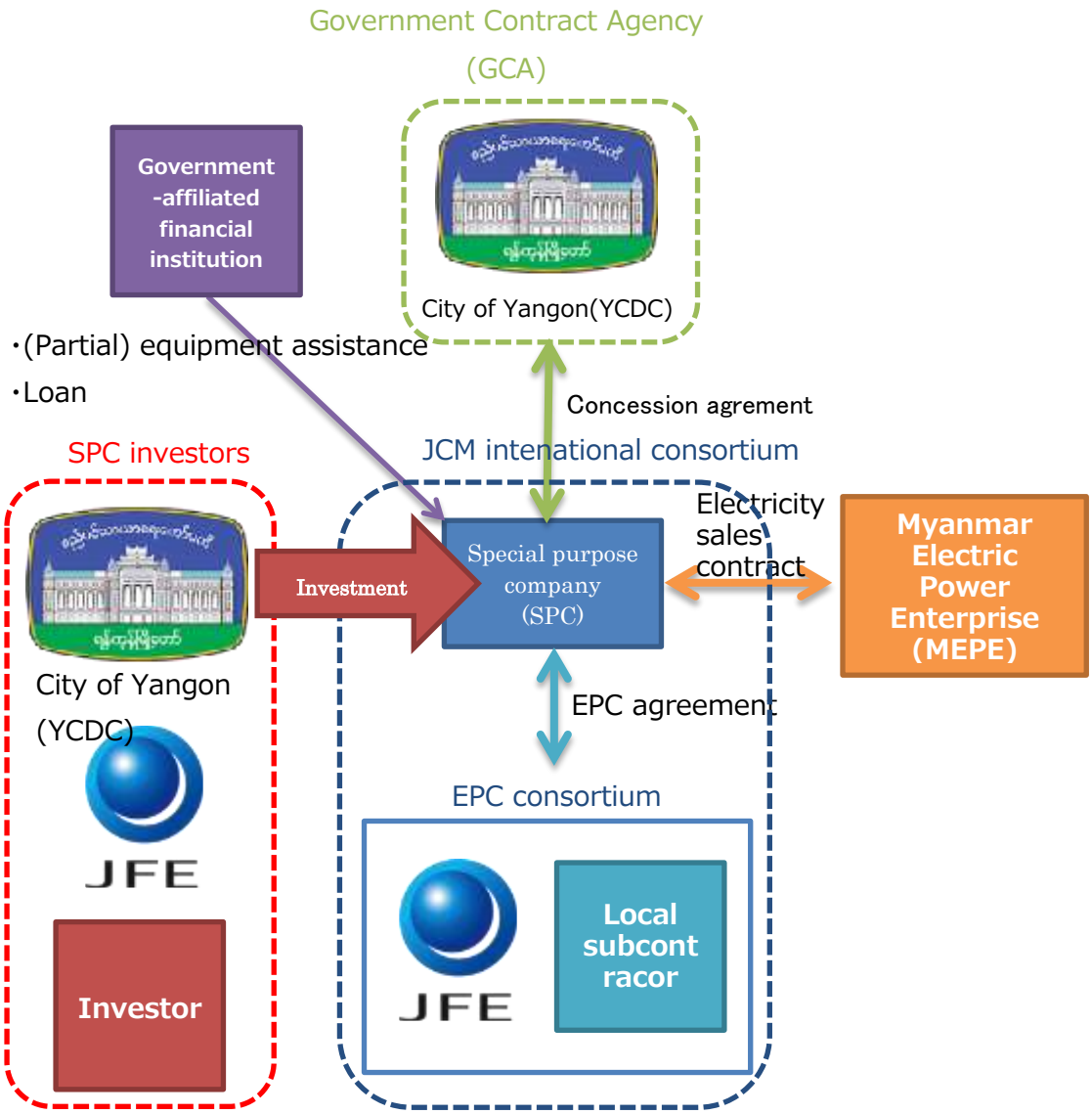


Chart 7-1: Organization for the project execution (Draft)

The following is the roles of each party concerned.

1) Government Contract Agency (GCA)

The contract agency that grants the right of executing the project to the special purpose company (SPC). The regional government serves as GCA in the case of WtE plant and therefore the city of Yangon shall be GCA.

2) Special Purpose Company (SPC)

The special purpose company (SPC) of this case is established to own, operate and maintain the WtE plant.

SPC will determine with GCA the project period, roles and responsibilities of SPC, and operational conditions such as tipping fees. SPC further will execute the Power Purchase Agreement (PPA) with Myanmar Electric Power Enterprise (MEPE, Myanmar's electric power company), based on which SPC will sell excess electricity from the WtE plat and execute the project by earning revenue from the sales of electricity.

That is, during the operation period of the WtE plant, (1) the facility receives waste/garbage and and earns waste treatment (tipping fee) and (2) generates electricity by heat from incineration and provide the electricity to the existing grid and earns revenue from sales of the electricity. Transpiration of waste/garbage and incineration ash will be performed under the responsibility of the city of Yangon and that is outside the scope of SPC.

Chart 7-2 shows the scope of SPC's activities.

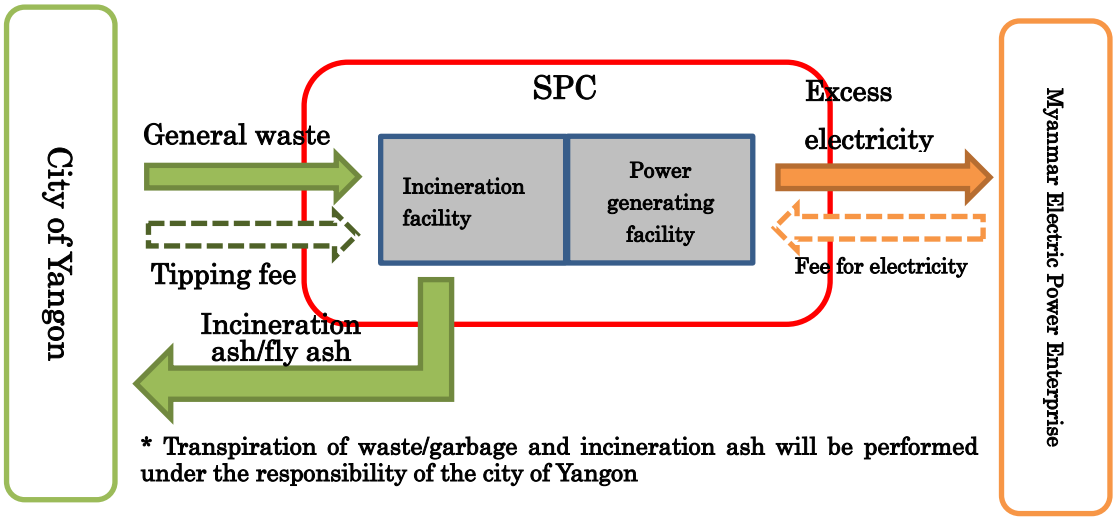


Chart 7-2: Scope of the activities of the Special Purpose Company (SPC)

3) EPC consortium

EPC consortium shall perform the WtE plant construction activities commissioned from SPC. For this project, the consortium is assumed to be established between JFE engineering and a major engineering company in Myanmar that has extensive knowledge of local laws and construction industry.

4) JCM international consortium

Formation of JCM international consortium between Japanese business operators and the business operators in the counterparty country is requested if a WtE plant is constructed as JCM equipment assistance project. In this case, the Japanese business operator is JFE Engineering Corporation and the business operator of the counter party country is SPC. JCM equipment assistance project mandates MRV (Measurement, Reporting and Verification), which is the report on the amount of GHG reduction through operation of the plant during the statutory durable years of the equipment.

5) Myanmar Electric Power Enterprise (MEPE)

MEPE is Myanmar's state-owned electric power company will execute PPA with SPC and pay for the excess electricity provided by SPC.
However, as described in Chapter 2, Section 3.2, Myanmar has not established the FIT system yet ad therefore the electricity transaction price needs to be negotiated with MEPE individually.

6) SPC equity investors

We have not reached the discussion regarding SPC constituents and capital structure yet, but we assume that the following entities will be equity investors of SPC.

① The city of Yangon

The city of Yangon has expressed its expectation for participating in WtE plant project and also the intention of making equity investment.

② JFE Engineering

Equity participation by the company that knows operation know-how is desired to executing the project without encountering a bottleneck. JFE Engineering has extensive experience not only in plant construction but also operation and maintenance of the plant. The know-how is considered to support SPC in its project execution and therefore JFE is considering equity investment currently.

③ Other

As mentioned in Chapter 5, Section 3.1, we are interviewing thecandidates about their

intention of investing in this project currently and we will negotiate with other interested companies as well.

7) Government-affiliated financial institutions

As mentioned in Chapter 6, we surveyed the possibilities of loans from government-affiliated institutions and public financial assistance. As a result, we assume that the project will be eligible for grant and loans from (partial) equipment assistance by ODA.

7.1.1. Conditions for SPC's project execution

Table 7-1 shows the conditions for JFE Engineering to be engaged in SPC and project execution.

Table 7-1: Conditions required for project execution (in relation to Myanmar)

No	Item	Description of conditions
①	Payment guarantee by the central government of Myanmar	Guarantee by the central government of Myanmar for the waste treatement fee (Tipping Fee) and eletricity sales revenue
②	Guarantee for the amount of waste/garbage	Guarantee for revenue (tipping fee, electricity sales revenue) in the case where the delivered waste is smaller than the guaanteed or agreed amount
③	Guarantee for the quality of waste/garbage	Guarantee for revenue due to the plant's suspension or reduced operation ratio due to the delivery of not acceptable waste/garbage (inflammable, big, hazordous waste)
④	Guarantee for the minimum calories from the waste/garbage received	Guarantee for revenue if the monthy average calaries of waste measure at the incineration plant is lower than the lowest calories agreed in advance
⑤	Guarantee for purchase of electricity at a fixed price	Guarantee for purchase of entire electricity generated in the individual project period
⑥	Contract execution	Consession agreement and PPA for waste incineration covering the project period
⑦	Securing of the project site	Securing of project site and base infrastructure (water suply, sewage, gas, electricity, roads, etc.)
⑧	Electricity transmission route	Securing of Right-of-Way to the substation and sufficient transmission capacity
⑨	Payment based on the "Available Capacity Payment"	Payment for electricy is made as long as installed capaity of the plant is available

① Payment guarantee by the central government of Myanmar

This is the request for the central government of Myanmar to guarantee the payment by the city of Yangon that is under the general waste treatment service agreement with SPC. That is, if the city of Yangon is unable to make the payment, the central movement of Myanmar will make the payment on behalf of the city of Yangon to SPC in accordance with the general waste

treatment service agreement.

Likewise, we request the central government of Myanmar that it will guarantee the payment by MEPE under the power purchase agreement (PPA) with SPC. That is, if MEPE is unable to make the payment, the central movement of Myanmar will make the payment on behalf of MEPE to SPC in accordance with PPA.

This is considered to be the mandatory guarantee for the establishment of the project, as such guarantee is required by government-affiliated financial institutions providing (partial) equipment assistance by ODA in many cases

However, the central government of Myanmar has not established any fund for compensation to guarantee GCA's contract execution and reduce the risks of private business operators. We therefore have to negotiate with the central government of Myanmar for individual cases.

② Guarantee for the amount of waste/garbage

This is the request for payment of waste management fees (Tipping Fee) for the entire amount of waste prescribed in the agreement even if the designated amount of waste is not delivered to SPC from the city of Yangon that is under the general waste treatment service agreement with SPC. Further, as reduction of incineration amount causes reduction in the amount of power generated, guarantee/compensate for the reduced revenue from the sales of electricity due to the reduction in the amount of waste/garbage will also be requested.

As SPC's revenue is dependent on the tipping fee and sales of electricity, this matter will be negotiated with the city of Yangon as guarantee indispensable for project business continuity.

③ Guarantee for the quality of waste/garbage

SPC and the city of Yangon that is under the general waste treatment service agreement with SPC must jointly define the "delivery not accepted" type of waste/garbage and the city of Yangon will be requested to guarantee/compensate for any suspension of the plant's operation and/or reduction in sales revenue due to the lower operation rate as a result of delivery of "delivery not accepted" type of waste/garbage.

④ Guarantee for the minimum calories from the waste/garbage received

The city of Yangon that is under the general waste treatment service agreement with SPC will be requested for guarantee/compensate for any reduction in electricity sales revenue in the case where the monthly average garbage/waste calories measure in the incineration plant is lower than the pre-agreed lowest calories.

As SPC's revenue is dependent on the tipping fee and sales of electricity, this matter will be negotiated with the city of Yangon as guarantee indispensable for project business continuity.

⑤ Guarantee for purchase of electricity at a fixed price

Myanmar does not have electricity purchase system at a fixed price (Feed in Tariff). However, the revenue of SPC is dependent on the waste management fee (Tipping Fee) and sales of electricity, negotiation with MEPE will be made for guarantee of the purchase of the entire amount of electricity for the entire individual project period as indispensable guarantee for the project business continuity.

⑥ Contract execution

A concession agreement and PPA regarding waste/garbage incineration that cover the entire project period need to be executed. In the agreements, risk sharing between the city of Yangon (GCA) and SPC must be clearly prescribed and negotiation shall be made with the city of Yangon.

⑦ Securing of the project site

The request for securing project site and basic infrastructure (water supply, sewage, gas, electricity, roads, etc.) Securing of project site shall include removal of illegal residents in the candidate site such as waste pickers in advice.

Regarding the basic infrastructure management, connection points and responsibilities for engineering works shall be discussed based on the survey conducted later.

⑧ Electricity transmission route

Securing of the Right-of-Way to the substation and sufficient power transmission capacity.

That is, securing of the land and candidate land for engineering is within the responsibility of the city of Yangon or MEPE. Further, the city of Yangon or MEPE shall be responsible for transmission lines that have sufficient transmission capacity.

⑨ Payment based on the “Available Capacity Payment”

The request for payment of the price of electricity as long as the installed capacity of the power plant can be operated. That is, as long as the WtE plant can transmit electricity, guarantee for its electricity sales revenue is requested even if transmission is not feasible due to the reasons at the side of MEPE.

Although not all nine requirements above are mandatory for project execution, the details of the above need to be thoroughly discussed and agreed among GCA, MEPE and SPC as matters for which risks are shared appropriately. As private companies constituting SPC evaluate the

quantity of risks involved in the requirements not accepted and satisfied and reflect it in the cost of project, higher waste/garbage treatment fee (Tipping Fee)/electricity price will be charged to ensure appropriate profitability of the project as a result. We therefore need to have continuous discussions to explain to the counterparts such as the city of Yangon and MEPE that appropriate risk sharing will eventually lead to smooth project execution at appropriate cost.

7.2. Utilization of project finance

As mentioned in Section 7.1, the WtE plant project for the city of Yangon is assumed to be executed by the BOT scheme with SPC. Loan from the government-affiliated financial institution is incorporated in the finance scheme, and it is necessary to use project finance to raise money.

In this section, and issues in the use of project finance will be examined ad considered.

7.2.1. What is project finance?

Project finance is the financial scheme in which the cashflow from the project is the source of repayment for loans in principle. The main loan methods for project finance are therefore non-recourse loans (investors do not have recourse obligations even if the project failed) or case-limited recourse loans (only part of the risk is accepted by investors), which are different from corporate finance in which the money is raised based on the credit standing of the corporation. The main body executing the project is mostly SPC in the case of project finance and the project itself raises money as independent company. From the perspective of financial institutions that providing finance, collateral for the loan can be all assets owned by SPC such as assets used by the project (equipment) and the rights to execute the project, which are quite limited as SPC is usually established only to execute the project, and this necessitate very strict assessment (due diligence) by the financial institution to review the profitability and sustainability of the project as mentioned below.

1) Profitability of the project

   Financial institutions that provide finance have risks of non-performing loans as project finance is a non-recourse loan if the project business is not profitable and repayment becomes impossible. Therefore, project cashflow is the biggest collateral for the lenders and the most important matter in project finance syndication is to sufficiently examine if the project can secure sufficient amount of profit that are the source of repayment. Further, as the project is an activity performed within the limited period of time, careful examination must be made to see if the loaned amount can be repaid within the project period.

2) Sustainability of the project

Project finance assumes continuation of the project for the entire repayment period. It is therefore important how to ensure precondition for project continuation (going concern) in the project contract in terms of rights and obligations of SPC. Details will be mentioned later.

3) Risks involved in the project

Risks involved project business continuity must be analyzed appropriately, based on which Business Continuity Planning ("BCP") and Business Continuity Management ("BCM") need to be established. Action plan must be established in order to resume the business promptly in the event of emergency and the amount of money required to continue the project must be secured by insurance when the business is suspended by force majeure. Sponsor support by the investors may be necessary in some cases.

Differences between project finance and corporate finance are summarized in Table 7-2.

Table 7-2: Differences between project finance and corporate finance

Item	Project Finance	Corporate finance
Business entity	SPC	Borrower
Business in scope	Project in scope only	Overall business activity
Borrower	SPC	Each company
Source for repayment	Cashflow from the project	Operating revenue of the company
Repayment period	Within 10-20 years in general*	Short tern/long-term
Review points	All risks relating to the project	Credit standing of the company
Collateral	All assets and contracts possessed by SPC	Properties owned by the company

*Depending on the risk of the project itself

7.2.2. Advantage of utilization project finance

The following are the advantage of using a project finance scheme for borrowers and lenders.

1) Advantage at the side of borrower

1.1 ） Diversification of project risks

In case of project finance, investors will not have performance obligation (i.e. not be liable for repayment) even if the project is not profitable in principle. Therefore, in many cases, private business operators can participate in the projects such as WtE plant ones which may not be feasible with corporate finance. It is also possible to diversity and mitigate project risks if project parties equally share risks of the project after segmenting them.

1.2 ） Lower financial burden

If money is raised by using the corporate finance approach, the debt ratio increases in the balance sheet and this may lead to weaker financial health of the company and the cause trouble when the company applies for new financing. However, by using project finance, each investor in SPC can receive the advantage of lower financial burden. However, whether the debt is booked on the balance sheet of investor is determined in consideration of multiple factors such as contribution ratio and influence on SPC. There are some cases the debt is recorded in the financial statement of the investor either in the balance sheet or in the note as contingent liabilities.

2) Advantage at the side of lender

2.1) Higher profitability

Project finance usually take more risks than corporate finance does, and therefore the interest is higher and higher profit for lenders is expected as compensation.

2.2) Competitiveness

Among the financial institutions aiming to increase international competitiveness, a financial institution that arranged a project finance in infrastructure business is granted very high evaluation. Therefore, financial institutions can enjoy the benefit of improved international competitiveness by participating in syndication of project finance.

7.3. Establishment of the security package

7.3.1. Overview of the security package

As mentioned above, steady repayment of obligations from the project cashflow generated by execution of the project is necessary for the syndication of project finance and the business scheme that ensures repayment of the loans needs to be established. Therefore, the “security package” is established under the leadership of financial institutions in preparation for the syndication of project finance to ensure continuity of the project. The security package is a

collateral-based mechanism of project finance which establishes the cases where all assets and contracts of the project may be transferred to lending banks in a foreclosure and as a result the lending banks may have a right to intervene (step in) the project.

As such, financial institutions that are the lenders of project finance establish a structure before loan execution to secure their rights to continue the project and to collect the loan amount while ensuring their smooth intervention in the project. Project finance by financial institutions is formed on condition that project risk management is optimized as mentioned above wherever possible.

7.4. Analysis of risks involved in the syndication of project finance

As mentioned above, it is necessary for financial institutions to create security package before conducting project finance and importance of risks and contract can never be overemphasized in project finance. Risks must be allocated to the parties that can most appropriately handle them in genera and therefore precise understanding of risks is necessary.

Further, as the business projection (revenue and expenditure) of the project assumes that the project is operated with the planned performance for the planned period of time within the planned budget, delay in completion of the plant due to such reasons as suspension of construction may give serious impact on project cash flow and project sustainability may be greatly doubted. It is also necessary for a WtE plant to start commercial operation in the "planned period of time" with the "planned performance" just like other power generation/production plants.

Therefore, we first identify risk items involved in completion of the construction of facilities and commencement of commercial operation at the WtE plant in the city of Yangon and consider mitigation plans for the risks.

7.4.1. Risks caused by investors

(1) Risk profile

a) Investor and credit risks

b) Investors' business execution (performance) capabilities and their involvement in the project

This is the risk that investors may not make capital contribution for the establishment of SPC or not perform their obligation for project execution in accordance with the previous agreement.

(2) Risk mitigation plan

In order to reduce capital contribution and credit risks, pre-study of the investee is necessary in the selection process of investors and it is also necessary to (1) check the

financial situation of the investors and to (2) full-fledged due diligence of the investors through third-party research companies such as Duns＆Bradstreet and COFACE including the project execution framework. If there is any concern about credit standing of SPC investors, it may be necessary to establish an additional scheme such as obtaining B/G (Bank Guarantee) and/or Stand by L/C from the investing banks as a pre-agreement for SPC establishment to mitigate financial risks of the investing companies. “Equity First”, which mandate capital contribution before the loan is another risk mitigation plan.

7.4.2. Risks caused by project owners

(1) Risk profile

a) Default risk

The city of Yangon and SPC shall execute the project contract regarding the intermediate treatment of waste using the WtE plant. If the city of Yangon, the project owner is in material default of any terms or condition of the project contract, it is highly expected that the breach causes significant impact on the operation cash flow (project business continuity) of SPC. The examples of the material breach that have impact on

The following are the examples of material breach in obligation that has impact on SPC’s project business continuity.

① Suspension of provision of waste/garbage or insufficient amount of waste/garbage supplied

In the WtE business contract, it is the responsibility of the city of Yangon (project owner) to provide the amount of waste predetermined in the project agreement executed between the project owner and SPC. As SPC suffers lost profits (loss from sales of electricity) if the supply of waste is suspended or the supplied amount is less than the capacity of the plant. This will seriously affect the project cash flow and therefore may have impact on project business continuity.

② Late or non-payment of tipping fees

SPC’s expense for plant operation is covered by the electricity sales revenue and waste treatment fees and the revenue from them are the source of repayment for loans (on project finance). Therefore, if the said fees are not paid appropriately, this will seriously affect the project cash flow and therefore may have impact on project business continuity.

③ Removal of inappropriate waste/garbage

If delivery of the waste/garbage which is not in the scope of waste/garbage prescribed in the project agreement and the waste/garbage damaged the pant equipment which causes additional cost or trouble to plant operation, this will seriously affect the project cashflow and therefore may have impact on project business continuity.

(2) Risk mitigation plan

a) Clarification of Risk sharing plan

Reduction of business risks caused by project owners is fundamental philosophy of PFI projects. It is important that the parties identify and confirm all types of risks and their contents for the entire period of PFI project and then share the risks appropriately with the concept of "the parties who can most appropriately manage risk should share the risk".

b) Execution of the project contract based on the risk sharing plan

In PFI project, in general, it is important to identify all risks that may occur during the project period and distribute the identified project risks among the stakeholders in accordance with the management capability of each stakeholder, and then each stakeholder to perform risk management under their responsibility. This is based on the above-mentioned concept of "the parties who can most appropriately manage risk should share the risk" in order to reduce the risk cost of the entire project. Inappropriate risk sharing may lead to increase in project costs and therefore prevent a bankable project which may make syndication of the project finance itself difficult. It is also true for the WtE plant project in the city of Yangon and the risks relating to the project must be shared appropriately and preconditions and assumptions for SPC's going concern need to be secured in details in the project contract for the purpose of the project finance syndication.

c) Guarantee by the government

Even if SPC's rights are guaranteed in the project agreement, SPC's business continuity will be in trouble if the project owner does not fulfill its financial obligation in a timely manner due to the credit issue based on their financial condition. Therefore, such non-payment will have serious impact on going concern of SPC if "late or non-payment of the fees" or "insufficient or failure in waste supply" occurs. In order to reduce such risks, while it is most important to set the disbursable amount of the city of Yangon based on the close study of the city's financial situation of economic growth trend, it is also necessary to establish a guarantee scheme so that the central government of Myanmar, which is the government organization superior to city of Yangon, guarantees the performance of obligations under the project agreement on behalf of the city of Yangon. Incidentally, as there is no sovereign guarantee scheme is established or executed in Myanmar, execution of such guarantee may be in the form of Letter of Support or their official document. Having said that, if it is impossible to accept a country risk, insurance policy purchased by ECA (Export Credit Agency) of each country is required in many cases ((E) PRI, CRI).

7.4.3. Risks caused by EPC contractors

In this Section, we will consider the profile and mitigation plan of the risks caused by EPC

contractors that are involved in the WtE plant construction.

(1) Risk profile

a) Risk of delay or failure in completing the construction of plant or low performance risk

The scheme of construction contract of the project is called EPC contract and it covers the entire elements of construction such as design, material sourcing and construction engineering works. In the case of WtE plant, a single contractor completes the project for the entire EPC usually and takes over the plant to SPC (Taking Over) when the commercial production becomes available after the commissioning.

On the other hand, in the field of power generation plants, EPC contractors are mainly selected based on the full turnkey "lumpsum contract method" in which the total EPC cost in the construction contact is fixed. This means, if delay or failure of construction work is caused by a contractor, it gives impact on plant operation and may seriously affect the project cash flow. However, under the EPC contract, the amount of damage compensation due to delay or failure of construction work is limited and contractors are not liable for lost profits due to failure of plant operation. The liability amount on EPC also has the maximum limit and therefore, if the risk of failure in plant construction occurs, SPC's cash flow will be worsened and it is highly probable that the situation will have serious impact on project business continuity.

(2) Risk mitigation plan

In order to reduce the risk or failure in completion of construction or insufficient performance, it is absolutely necessary to select established technology and to see if the EPC contractor has sufficient experience and achievement through the adequate due diligence of the technology in scope. The most prevalent equipment in the world using MSW as fuel in the field of WtE is stoker furnace, which has extensive operation records and is an excellent technology who can perform intermediary treatment of household garbage in a stable manner (as mentioned in Chapter 3). As there are many failed waste treatment project in the world due to the use of inappropriate technology/company, it is important to execute the EPC contract with EPC contractors that have applicable technology in scope and sufficient construction capability in order to prevent cost overrun (i.e. excess of budget) from the perspective of SPC cashflow.

7.4.4. Facility management risk

(1) Risk profile

Facility management risk is a risk involved in the management of continued operation of

the facility. To address the risk, SPC should establish the organization that can maintain the operation of the facility for the period agreed in the project contract. The project contract assumes the project period of 25 years and the business projection (revenue and expenditure) of the project is prepared on assumption that the plant is operated with the rated output for the entire project period and therefore involvement of the company that has plant maintenance/operation technology is necessary. In developing countries, there are many cases where the operation ratio of the plant is declined or operation is suspended (including incidents) after the introduction of plant equipment due to malfunctioning or shortened usable life of them as a result of poor operation/maintenance management. The major reason for occurrent of plant operation risks may be malfunctioning or defect due to lack in the knowledge of plant operators about plant operation/maintenance management. In the event of such situation, loss of revenue may occur due to decline in electricity sales with lowered plant operation ratio and increase in expenses to respond to the malfunction or defect. It is highly probable that this kind of situation will significantly increase the cash flow of SPC.

(2) Risk mitigation plan

It is necessary to establish an appropriate framework for operation maintenance management of the WtE plant to prevent lowering of the operation rate and to maintain operations in accordance with the business plan for the project period agreed by the project contract. In this regard JFE Engineering Corporation has extensive insight, technology and achievement in establishment of framework for operation maintenance management of the WtE plant and has served as operation/maintenance contractor for more than 50 projects in Japan. We are also commissioned by the city of Yangon in SSIP and are engage in plant maintenance and operation.

By applying JFE's preventive maintenance technology that has been developed by our long years of achievement and experience through the engagement as operation/maintenance contractors for WtE plants and our knowhow learned through the maintenance/operation environment in the city of Yangon, credibility of the plan will be enhanced and the life of the plant will be prolonged with the highly accurate projection of life/life expectancy of the equipment constituting the plant. The highly accurate prediction will allow replacement of parts of equipment used by the plant at appropriate timing and this will prevent incident due to malfunctioning or failure of the equipment. Effective operation of the plant will therefore be achieved and this will greatly contribute to the improvement of SPC's cash flow.

7.4.5. Country risk

(1) Risk profile

Country risk is a risk about the country where the project is executed and is a big challenge for SPCs in developing countries. There may be a risk not controllable by SPC in the projects executed in the developing countries, which may be classified as follows.

a) Political risk

Political risk may be classified into two types; one is due to changes in policies such as mandated abolition or condemnation of business or nationalization and the other is emergency risks such as war, revolution and civil commotion

b) Economic risk

Major economic risk incudes inflation and foreign exchange risk. It may also include increase in plant operation costs due to rapid inflation and deterioration of SPC's profitability due to the collapse of foreign exchange rate.

c) Legal risk

Legal risk may include deterioration of SPC's profitability due to the revision of laws or change in the tax accounting system.

(2) Risk mitigation plan

Prior confirmation should be made with Nippon Export and Investment Insurance (NEXI), private insurance companies, or International Finance Corporation (IFC) that are providing insurance products for overseas private sector investment finance to see if certain types of loss caused by the risks mentioned above are covered by the insurance benefit. Then, regarding the risks that may be covered by insurance policies, it is important to execute a business contract stipulating that SPC shall not accept such risks and the loss incurred by SPC due to such situation shall be promptly covered by the project owner or the central government. There may be cases where syndication of project finance may become difficult if the business contract prescribes that SPC shall accept uncontrollable risks, as it is considered that there is doubt in project business continuity.

7.4.6. Risk sharing plant

Based on the above risk consideration, the risk sharing proposal for the WtE project is submitted as described in Table 7-3.

Table 7-3: risk sharing proposal for the WtE project

Phase	Risk type	Risk profile	Accepted by:		
			Owner	Investor	Other
Common	Commodity price increase	Increase in SPC'S cost due to increase in personnel cost, fuel cost and other commodity prices	○		
	FX fluctuation		○		○
	Interest change	Increase in SPC'S expense due to the increase in the interest			○[1)]
	Legal revision	Increase in SPC'S cost due to change in the design or the construction period, improvement in equipment, abolition of plans, etc. as a result of revision of the local law	○		
	License and permission	Increase in SPC'S cost due to delay in owner's obtainment of license and/or permission	○		
		Increase in SPC'S cost due to delay in SPC's obtainment of license and/or permission		○	
	Community	Actions of objection to the project	○		
	Force majeure	Additional cost due to change in the design or the construction period, repair of equipment as a result of force majeure	Δ[2)]	Δ[2)]	○[2)]
Planning & construction phase	EIA	Cost incurred up until the time when execution of the project becomes impossible as a result of EIA	○		
	Measurement survey	Cost generated by inappropriate measurement survey		Δ[3)]	○[3)]
	Design	Any cost generating from inappropriate or error in design		Δ[4)]	○[4)]
	Design change	Increase in SPC's cost due to design change by owner's instruction on	○		

Phase	Risk type	Risk profile	Accepted by:		
			Owner	Investor	Other
		valid reason			
		Increase in SPC's cost due to design change without valid reason			○[5)]
	Process change	Increase in SPC's cost due to process change by owner's instruction on valid reason	○		
		Increase in SPC's cost due to process change without valid reason			○[6)]
	Delay in completion of construction	Increase in SPC's cost due to due to delay in completion of construction caused by owner	○		
		Increase in SPC's cost due to delay in completion of construction caused by owner			○[7)]
		Delay due to force majeure	Δ[8)]	Δ[8)]	○[8)]
Operation	Plan change	Change of contents of project business caused by owner	○		
	Late payment	Non/delayed payment of tipping fees	○		
	Performance	Insufficient plant performance		Δ	○[8)]
	Insufficient waste supply	Economic loss due to insufficient waste supply	○		
	Change in quality of waste	Increase in maintenance/management cost or operation cost due to change in waste quality	○		
	Removal of inappropriate waste	Increase in SPC's cost due to delivery of waste not suitable for incineration	○		
	Equipment renewal	Malfunctioning of equipment after replacement			○[10)]

Phase	Risk type	Risk profile	Accepted by:		
			Owner	Investor	Other
	Damage in facility	Damage of facilities due to deterioration			○[11)]
	Third part compensation	Compensation to the third party for the event caused by operation of the plant (noise, smell)		△	○[12)]
	Fire	Damage of facilities due to fire	△	△	
Migration	Migration procedure	Cost due to facility migration procedures		○	
	Repair and mending	Repair and mending due to facility migration		○	

Note: Paid by: ○Main payer △Sub payer

1) Interest risk is usually covered by interest swap contract
2) Covered by insurance policy. If not feasible, appropriate risk sharing by owner and sponsor support will be required
3) Paid by EPC. If not feasible, sponsor support should be provided in general
4) Paid by EPC. If not feasible, sponsor support should be provided in general
5) Paid by EPC in general
6) Paid by EPC in general
7) Paid by EPC in general
8) Covered by insurance policy. If not feasible, appropriate risk sharing by owner and sponsor support will be required
9) Paid by EPC. If not feasible, sponsor support should be provided in general
10) Paid by equipment providing company or EPC in general
11) Covered by the general cash flow or paid by O&M company in general
12) Covered by insurance policy or O&M company. If not feasible, sponsor support should be provided in general

8. Feasibility study

8.1. Preconditions for the business

8.1.1. Preconditions for the business

Preconditions applied in the feasibility study of WtE plant project in the city of Yangon are as follows.

① The total project period will be 28.5 years (Breakdown: Construction period: 3.5 year, operation period: 25 years)
② The project contract period will be 25 years.
③ The period of electricity sales will be 25 years.
④ Commodity price fluctuation risk during the operation period will be accepted by SPC.
⑤ Foreign exchange fluctuation risk will not be accepted by SPC.
⑥ Regarding the power generation equipment for WtE plant, the most advanced power generation efficiency owned by JFE Engineering as of February 2018 will be applied.
⑦ The project site is provided to SPC for free of charge during the entire project period and SPC can use the site at no cost and no lease fees for land, etc. will be incurred.
⑧ The risk of significant fluctuation of waste calories will not be accepted by SPC and therefore not considered in the feasibility study.
⑨ Regarding the taxes for establishment of SPC and its execution of WtE power generation project in the city of Yangon, corporate income tax (25％) and withholding tax (15%) are considered for business operation by SPC.
⑩ The risk of removal of materials not suitable for incineration will not be accepted by SPC.
⑪ Treatment of residual matters from incineration (such as pre-processing, transportation and landfilling) will be within the responsibility of the city of Yangon.
⑫ The depreciation period of the plant equipment will be 15 years and that of plant building will be 30 years.

8.1.2. Conditions for financing

The method of financing the WtE plant project in the city of Yangon is planned to be a loan from government-affiliated financial institutions and (partial) equipment assistance from ODA.

The loans from government-affiliated financial institutions are considered to be overseas investment finance by JICA basically and the cost of financing is assumed to be what is mentioned in Table 8-1.

Among the total operating expenses, the amount of debt by each investor of SPC is subject to the "70% at maximum" condition (general condition of JICA's investment finance) and the remaining 30% will be covered by equity. Joint financing is also the JICA's standard approach for investment finance and therefore we need to examine the possibility of other finance providers.

As mentioned above, we are still in the middle of finalizing the method of financing for the project. Preconditions for the consideration mentioned in this Chapter are therefore temporary values

calculated by JFE Engineering Corporation by itself based on the interview of the overseas investment finance section of JICA and private financial institutions.

Table 8-1: Financing cost

Item	Period/percentage	Note
Repayment period	15 years	
Grace period	4 years	Construction period 3.5 years ＋0.5 years
Interest rate	5.5%	Base Rate: 2% Lon Margin: 3% Swam Margin: 0.5%
Upfront fee	1%	On Total Debt
Arrangement fee	1%	On Total Debt

8.1.3. Specs of WtE plant equipment

The equipment for WtE plant introduced in the WtE power generation project in the city of Yangon will be those presented in Table 8-2 as detailed by Chapter 4.

Table 8-2: Specs of WtE plant equipment

Item	Specs	Note
Amount of general waste treated	1,000 tons /day	500 tons x 2 units
	310,000 tons /year	Annual aggregated waste amount treated
Days of operation per year	310 days	Regular inspections: 1.5 months x 2 units/year
Output of power generator	20MWh	20MWh x 1 unit * At rated operation for standard waste
Electricity used in the plant	4MWh	* At rated operation for standard waste
Electricity sold	16MWh/day	* At rated operation for standard waste
	119,040MWh/year	* At rated operation for standard waste

8.1.4. Quality of fuel (waste)

Regarding the definition of fuel (quality of waste) for WtE power generation project in the city of Yangon, as detailed in Chapter 4, the values mentioned in Table 8-3 will be applied based on the actual values of Yangon WtE plant and the experience of JFE in the countries in Southeast Asia.

Table 8-3: Fuel (quality of waste)

Item		Unit	Low quality waste	Standard waste	High quality waste
Low-level calories		kcal/kg	1,300	1,800	2,200
		kJ/kg	5,400	7,700	9,200
There major ingredients	Flammable	%	26	34	40
	Moisture	%	60	55	53
	Ash	%	14	11	7
	Total	%	100	100	100

8.1.5. Costs of construction and infrastructure connection

Cost of construction of WtE plant in WtE power generation project in the city of Yangon and the period of depreciation will be as mentioned in Table 8-4 below. It is assumed that utilities are connected at the site border.

Table 8-4: Construction cost of WtE plant

Item	Cost (USD)	Depreciation
Plant equipment cost	103,500,000	15 years
Plant building cost	11,500,000	30 years

8.1.6. Costs relating to operation, maintenance and repair

Personnel expenses, utility expenses, maintenance and management expense, and other necessary expenses for WtE plant in WtE power generation project in the city of Yangon are presented in Table 8-5. Transportation of general waste and incineration ash will be within the responsibility of the city of Yangon and are not included in maintenance/repair cost of the operation.

Table 8-5: Maintenance and repair cost for operation

Item	Expense (USD/year)
Personnel expenses	550,000
Utility expenses	1,200,000
Maintenance/repair	2,700,000
Other expense	350,000
Total	4,800,000

8.1.7. Costs relating to environment impact assessment

In establishing a WtE plant in the city of Yangon, environment impact assessment that is considered to be appropriate under the conditions of the subject area must be implemented in accordance with the related laws of Myanmar. Also, environment impact assessment is within the responsibility of business operators in general and the associated cost needs to be borne by the project.

The environment impact assessment relating to construction of a WtE plant in Myanmar was previously made when Yangon WtE plant was built and USD200,000 is booked as miscellaneous expenses by referring to the amount expensed that time.

8.1.8. Advisory fee

In concluding agreements/contracts, use of the services of lawyers and consultant is necessary. The cost is considered to be USD 400,000 for this project.

Table 8-6: Advisory fee

Item	Cost (USD)
Attorney fee, etc.	400,000

8.1.9. Insurance cost

Insurances for execution of the WtE plant is not considered in this feasibility study. Close examination of the type of insurance policies and premium rates will be included in future considerations.

8.1.10. Taxes

Regarding the execution of the WtE plant project, only the taxes mentioned in Table 8-7 will be considered and business tax, fixed property tax, and other taxes are not considered in this feasibility study. Incidentally, the withholding tax is considered in this feasibility study although it is planned to be abolished on April 1, 2018 according to the 2018 Federation Tax Law. Close examination of tax costs will be included in future considerations.

Table 8-7: Taxes

Type of insurance	Rate
Corporate income tax	25%
Withholding tax	15%

8.2. Profitability assessment

8.2.1. Preconditions for profitability assessment

The major preconditions for profitability assessment mentioned in the preceding section are summarized in Table 8-8 below.

Table 8-8: Preconditions for profitability assessment

Item	Condition	Note
Construction period	3.5 years	(3 years for construction and 0.5 years for test operation)
Operation years	25 years	
Shareholders' equity	30%	
Borrowed capital	70%	In the case of JICA overseas investment finance
Financing method	Project finance	
Repayment period	15 years	Grace period：4.5 years
Repayment method	Equal repayment	
Interest for borrowing	5.5%	
Interest	Not considered	Interest on deposit of earned surplus
Taxes	Corporate income tax：25% Withholding tax：15%	
Forex	1.358MMK/USD	Forex fluctuation risk not considered Source: The prevailing rate of MMK and USD in the first half January 2018
Inflation rate in Myanmar (CPI)	2017：6.9% 2018：6.7% 2019：6.5% 2020：6.4% 2021：6.3% 2022 and after：5.7%	Source: IMF data
Land leasing fee	None	
DSCR	1.5	
PIRR	10%	

8.2.2. Project cash flow analysis

As indicators to evaluate profitability of WtE plant project in the city of Yangon, DSCR and PIRR, which are used for project finance syndication and decision on equity investment in private companies, have been analyzed. The overview of these two indicators are as follows.

1) DSCR

DSCR is an abbreviation of Debt Service Coverage Ratio and shows how much ratio of debt is covered by revenues. It shows the capability of repaying debt principal and interest that must be paid in the financial year for the given year during the given year in the project period. As repayment of debt principal and interest is a basis of business continuity, "DSCR > 1.0 times" is the minimum requirement for loans. In this regard, a SPC is requested to maintain a certain level of DSCR in many cases. While the level of DSCR requested varies according to the characteristics of the project receiving the loans, "1.5 times or higher on average of the entire project period" is set to be an investment-grade level in this feasibility study according to the interview of private financial institutions. The calculation formula of DSCR is as follows.

$$\text{DSCR} = \frac{\text{Cash flow before the repayment of debt principal/interest of the financial year}}{\text{Debt principal/interest of the financial year}}$$

2) PIRR

PIRR is an abbreviation of Project Internal Rate of Return, which is an internal rate of return on the entire investment amount generated from project's financial activities (paid-in-capital amount, dividend payment, borrowing from banks, and repayment for principal/interest are not included). This indicator is used when a yield on the total investment amount disbursed is calculated. As it is mandatory for projects to ensure financial feasibility and profitability, it can be said that the higher PIRR is, the higher project profitability is. Project finance is planned to be used for the WtE plant project and it is preferable that PIRR exceeds the cost of finance and is higher than the market rate. In this feasible study, PIRR of 10% or higher is set to be a investment-grade level.

8.3. Sensitivity analysis

We conducted a sensitivity analysis on the electricity sales revenue and waste treatment fees (tipping fees) that are the sources of revenue of this project in accordance with the conditions mentioned in Section 8.1 and 8.2 for each case to which different financial assistance is applied. The current unit tipping fee is set from 600MMK/household per month to 12,000MMK/ton (assuming that the monthly garbage weight of each household is 50kg) as mentioned in Section 4.1.4. The price of electricity is set

from 75MMK/kWh (actual SSIP electricity sales price) to 150MMK/kWh (the highest electricity price for industry).

8.3.1 Cases where no subsidy is used

In this section, sensitivity analysis of the cases without subsidy is conducted.

Table 8-9: Impact of fluctuation of price of electricity (without subsidy)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Waste treatment fee (Tipping fee) (MMK/ton)	89,300	79,700	60,500
Capital contribution (USD)	38,400,000		
Loan amount (USD)	89,700,000		

We also conducted the sensitivity analysis of the cases not considering the inflation risk of Myanmar.

Table 8-10: Impact of fluctuation of price of electricity (No subsidy, no inflation risk considered)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Tipping fee (MMK/ton)	84,800	75,200	56,000
Capital contribution (mil. USD)	38,400,000		
Loan amount (mil. USD)	89,700,000		

8.3.2 Cases where JCM equipment assistance is applied

As mentioned in Section 6.1.1, JCM is the subsidy system applied to the businesses that contribute to reduction of greenhouse gases that is promoted under the leadership of the Ministry of Environment, Japan (MOEJ). Projects are evaluated and determined as eligible for the subsidy according to the level of contribution to the reduction of greenhouse gases. The maximum subsidy is considered to be JPY 1 billion per case in principle.

In this section, sensitivity analysis is conducted for the case where USD 10 million is applied as JCM equipment assistance to the project.

Table 8-11: Impact of fluctuation of price of electricity (Assistance of USD 10 million applied)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Tipping fee (MMK/ton)	81,400	71,800	52,600
Capital contribution (mil. USD)	35,100,000		
Loan amount (mil. USD)	81,900,000		

We also conducted the sensitivity analysis of the cases not considering the inflation risk of Myanmar.

Table 8-12: Impact of fluctuation of price of electricity (Assistance of USD 10 million applied, no inflation risk considered)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Tipping fee (MMK/ton)	76,800	67,200	48,000
Capital contribution (mil. USD)	35,100,000		
Loan amount (mil. USD)	81,900,000		

8.3.3 JCM equipment assistance and grant assistance of project business rights

As mentioned in Section 6.2.3, this system, one of the support scheme presented by JICA, is to promote acquisition of business and operation rights by Japanese companies by providing grant assistance to the public works that implement construction to operation and maintenance of facilities in a comprehensive manner with the involvement of private sector and thereby achieve effective use of the advanced technology and knowhow of Japan to help developing countries. This scheme may be applied to this project. We also confirmed from the interview with related institutions that it is possible regulation-wise to utilize the system in relation to JCM equipment assistance.

In this section, we made the sensitivity analysis by supposing that the project receives USD 10 million USD from JCM equipment assistance and USD 40 million grant assistance for business/operation rights acquisition.

Table 8-13: Impact of fluctuation of price of electricity (Assistance of USD 50 million applied)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Tipping fee (MMK/ton)	49,400	39,800	20,600
Capital contribution (mil. USD)	21,800,000		
Loan amount (mil. USD)	50,900,000		

We also conducted the sensitivity analysis of the cases not considering the inflation risk of Myanmar.

Table 8-14: Impact of fluctuation of price of electricity (JCM + no charge for project execution rights applied, no inflation risk considered)

	Unit price of electricity (MMK/kwh)		
	75	100	150
Tipping fee (MMK/ton)	44,900	35,300	16,100
Capital contribution (mil. USD)	21,800,000		
Loan amount (mil. USD)	50,900,000		

8.3.4 Comparison of cases

The result of comparison of sensitivity analysis mentioned in Section 8.3.3 is summarized in Chart 8-1.

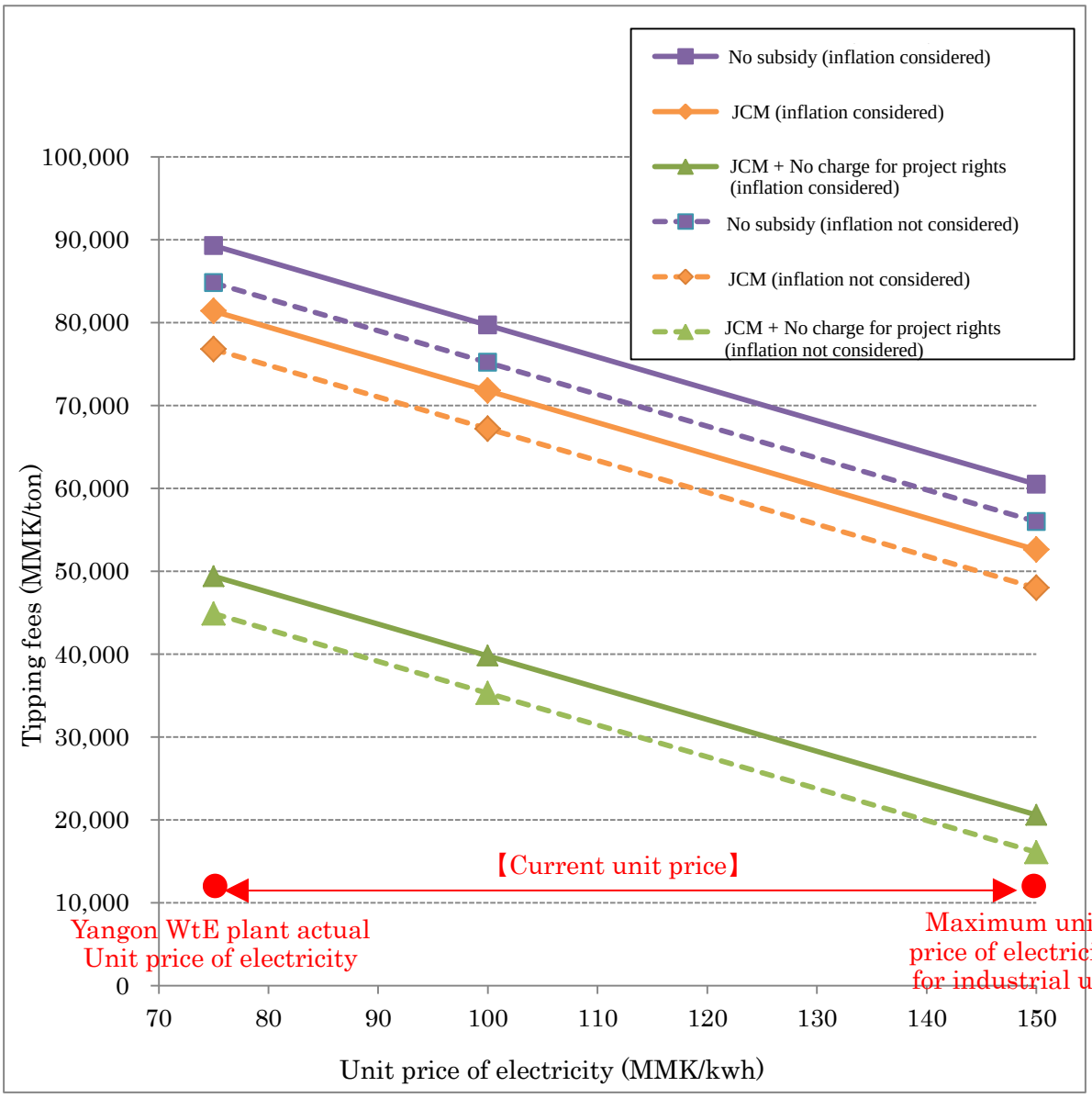


Chart 8-1: Impact from fluctuation of unit price of electricity and tipping fees

9. Project plans

The project is considered to be feasible according to the sensitivity analysis conducted in Section 8.3, if equipment assistance and the current maximum unit electricity price for industry are applied. The conditions are still in the survey stage and studies to achieve a higher level of profit from the project and negotiation with counterparts need to be continued.

In this chapter, we need to review plans and examine the matters to achieve higher profit from the business.

9.1 Plans to increase profit

In order to increase profit from the project, higher-level operating revenues must be earned. The following are the methods that may increase operating revenues.

9.1.1 Improvement in general waste treatment fees

The tipping fees currently charged in the city of Yangon is among the lowest of those charged in other cities in Southeast Asia. Capacity building by the city of Kawasaki has been implemented in the intercity cooperation workshop but recommendation to the city of Yangon needs to be continued.

9.1.2 Improvement in unit electricity prices

A fixed purchase system has not been established in Myanmar and the unit price of electricity is determined by negotiation with each electricity provider. In this regard, negotiation for the unit price of electricity needs to be continued.

9.1.3 Origination of new revenue sources

Power outage happens frequently in the city of Yangon due to power shortage and demand for electricity remains high. Pursuit of new revenue sources will therefore be continued including the opportunities of securing new sources of revenue through direct electricity sales to private companies and industrial estates as well as acceptance of industrial waste.

9.2 Plans to reduce operating expenses

Along with the increase in operating revenues mentioned in Section 9.1, actions to reduce operating expenses need to be considered as mandatory initiative. Major operating expense items requiring reduction include reduction of EPC and O&M expenses, application of low-interest loans and appropriate risk sharing.

9.2.1 Reduction of EPC and O&M expenses

It is also necessary to establish and implement plans to reduce EPC and O&M expenses in a continuous manner, by making plant designs and establishing organization for plant operation that are most suitable for this project through close examination of actual SSIP values and analysis of quality

of waste/garbage that was not made this time.

9.2.2 Application of low-interest loans

Although we considered possibility of applying for overseas investment finance of JICA in Chapter 8, the loan conditions are still in the study phase and need to be closely examined after this. Study of other financial institutions will also be necessary.

9.2.3 Appropriate risk allocation

As mentioned in Chapter 7, appropriate risk sharing will lead to smooth project execution at the appropriate cost. It is therefore necessary to continue discussion on this matter with counterparts such as the city of Yangon and MEPE.

Attachment Related parties workshops

Attachment 1

Kick-off meeting / 1st Workshop

Feasibility Study of Waste to Energy Plant Project for Yangon City in Myanmar

17th October, 2017

川崎市 KAWASAKI CITY

JFE

Overall Agenda of F/S

Meeting	Contents	Presenter
Kick off Meeting/ Work Shop-1	• Outline of Feasibility Study	JFE
	• Municipal Solid Waste Management in Kawasaki(1)	Kawasaki-city
	• Discussion	YCDC/ Kawasaki-city/JFE
Work Shop-2	• Municipal Solid Waste Management in Kawasaki(2) • Introduction of 3R Activities	Kawasaki-city
	• Requirements of Project Finance	JFE
Final Report/Work Shop-3	• Introduction of Waste Management Know-how	Kawasaki-city
	• Project Scheme Proposal • Conclusion	JFE

Time Schedule of F/S

Kick off Meeting / Work Shop-1

Outline of Feasibility Study "Waste to Energy Plant Project for Yangon City in Myanmar"

17th October, 2017

JFE Engineering Corporation

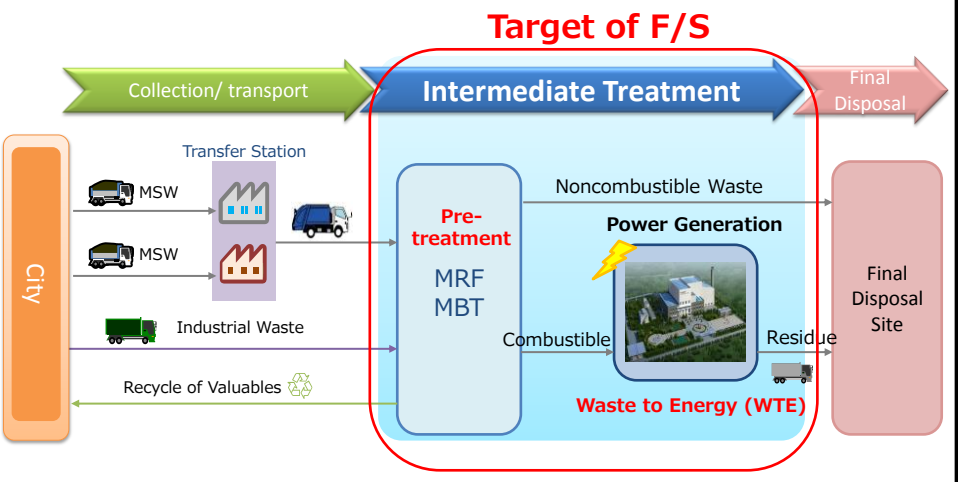
1 *Purpose of Feasibility Study*

Purpose

- Development of Large Scale of Waste to Energy Plant to create low carbon society
- City to city collaboration for Proper Waste Management

2 Concept

To create "Low carbon society"
where waste is used as renewable energy



・MSW(Municipal Solid Waste) ・MRF（Material Recovery Facilities）・MBT（Mechanical Biological Treatment）

3 Achievement in F/S

Current Concern	Achievement in F/S
1) Proper waste treatment technology	・Study of waste intermediate treatment (WtE, pre-treatment etc.) ・Proper WtE plant scale and trains
2) Financial difficulties	・Survey of funding sources (Grant from governments, Loan from Investors and banks etc.)
	・Study of financial arrangement procedure
3) Tipping Fee and FIT	・Verification by developed financial model
4) Knowledge of waste management	・Capacity Building by Kawasaki-city

4 Outline of Yangon Large-Scale WTE Project

Project Outline

	Contents
Owner	Yangon City Development Committee
Generated Waste	2,500tpd
Furnace	JFE Stoker Type Incinerator
Capacity	800tpd (400tpd × 2)
Area	250m × 300m
Collected Waste	South Part of Yangon City

Planned Project Site

5 Organization Chart for JCM F/S

Yangon City Development Committee
Myanmar

City-to-City Cooperation

(Applicant)
JFE Engineering Corporation

(Co-Applicant)
Kawasaki-city

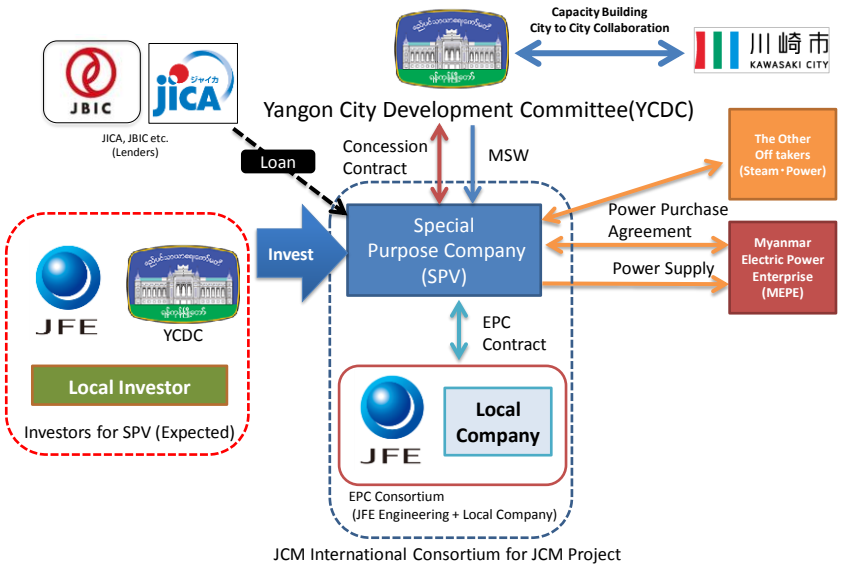
- Control Overall
- Project Finance Study
- Summarize F/S

- Capacity Building for Waste Management

Mizuho Bank, Ltd.

- Development of Financial model

6 Expected Project Scheme



7 Contents of JCM F/S

	Contents		Previous F/S	To do
1	Social and Economic Situations		✓	Update
2	Study on the Legal System		✓	
3	Planning of WTE Plant	Outline Design CAPEX and OPEX Calculation	✓	Update
4	Feasible Study	Project Scheme	✓	Restudy
5		Project Finance	✓	Study
6		Feasibility Study	✓	By Financial Model
7	Project Planning (for Thaketa)		-	Study
8	City-to-City Cooperation Capacity Building for Waste Management		-	Buildup

8 Schedule

	Contents		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	Meeting Schedule			Kick-off/WS*(1)			WS(2)	Final Report/WS(3)	
1	Social and Economic Situations								
2	Study on the Legal System								
3	Planning of WTE Plant	Outline Design CAPEX and OPEX Calculation							
4	Feasible Study	Project Scheme							
5		Project Finance							
6		Feasible Study							
7	Project Planning (for Thaketa)								
8	City-to-City Cooperation Capacity Building for Waste Management								
9	Preparing of Final Report								

Today

Submission to Ministry of Environment Japan

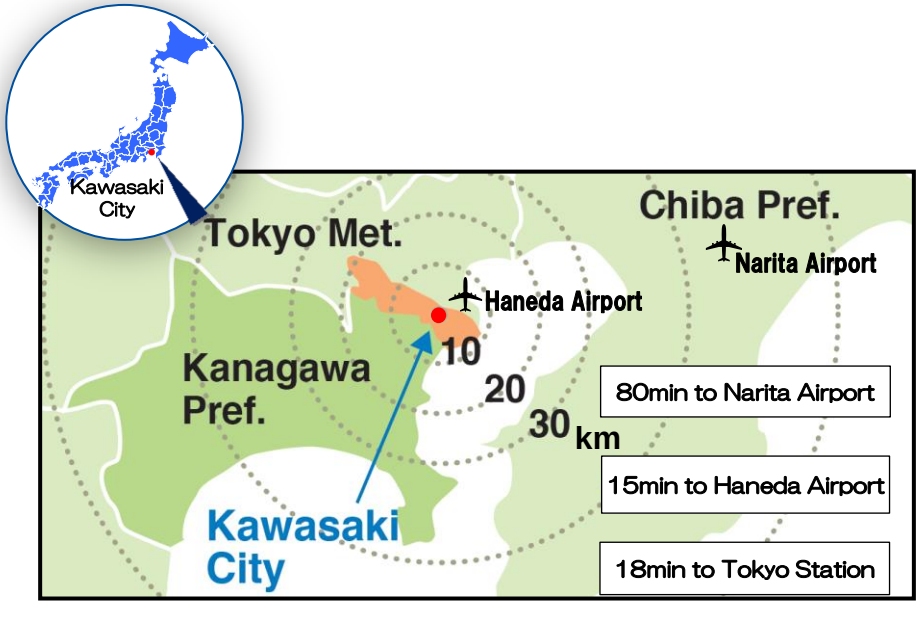
*WS:Work Shop

~ City-to-City Collaboration with Yangon and Kawasaki ~

Municipal Solid Waste Management in Kawasaki

Economic and Labor Affairs Bureau
Kawasaki-city

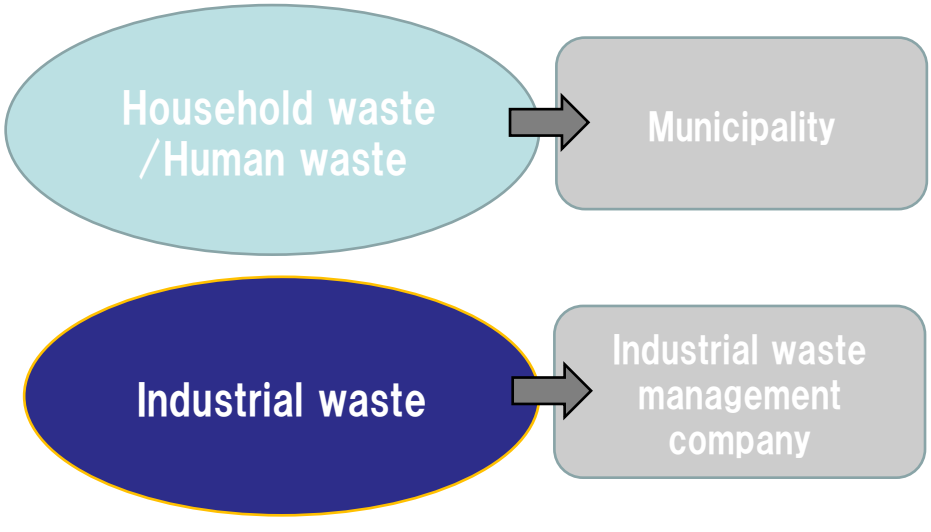
Location of Kawasaki-city



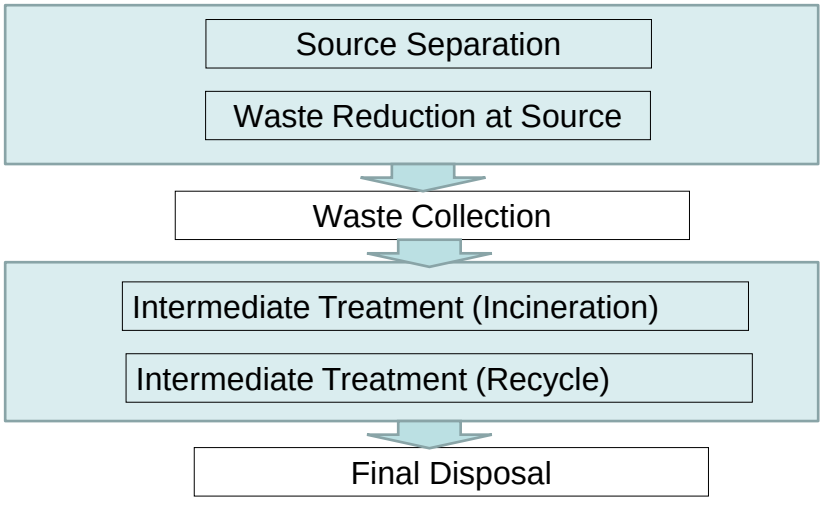
Problem of illegal dumping in the past (1960)

Solid Waste Management System in Kawasaki

Category of Waste



Basic Flow of Municipal Solid Waste Management



History of Solid Waste Management in Kawasaki

- Municipal solid waste collection started from 1938.

- Waste incineration started from 1961.

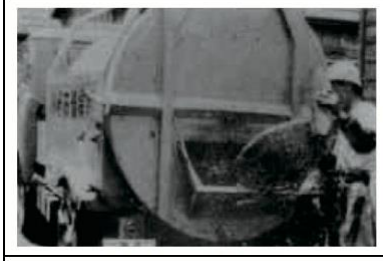
- “Emergency Declaration” on waste in 1990.

- Promotion of waste reduction and recycle after the emergency declaration.

Transition of Municipal solid waste collection tools

手車をひいている市役所の係の人

1940s



バックドラム車
（昭和32年～46年）

1950s

9

ロードパッカー車
（昭和35年～）

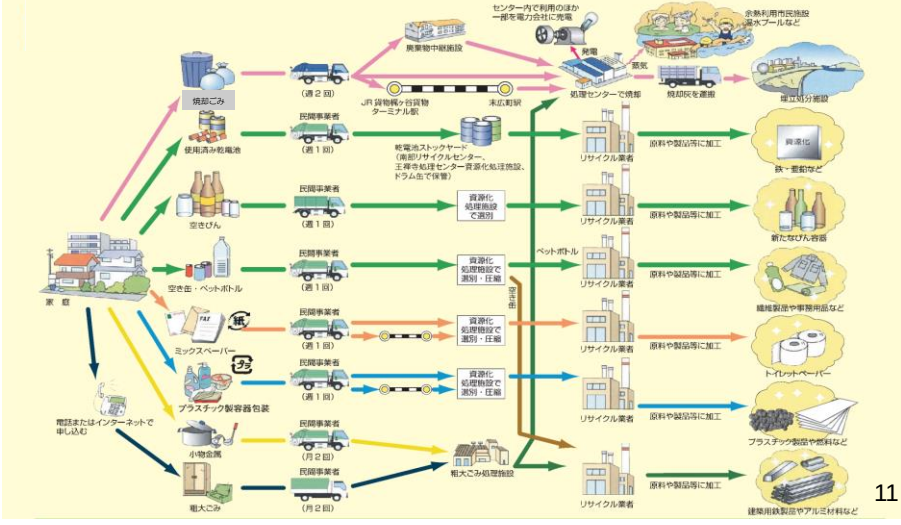
1960s

2017

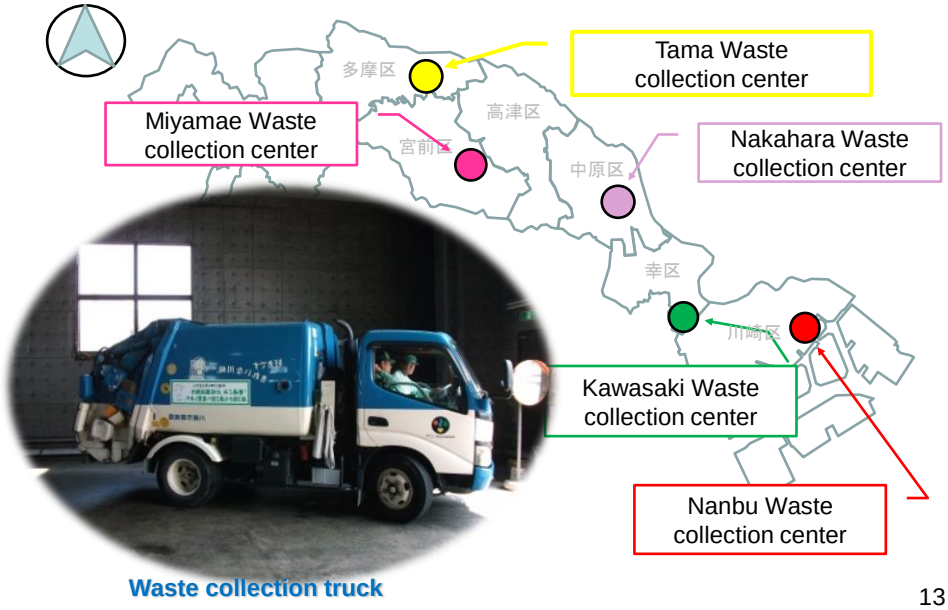
10

Solid Waste Management Flow in Kawasaki

- In Kawasaki, household wastes are categorized by 9 materials.
- Heat recovery at Incineration plant
- Final disposal of Incineration ash at seaside landfill site



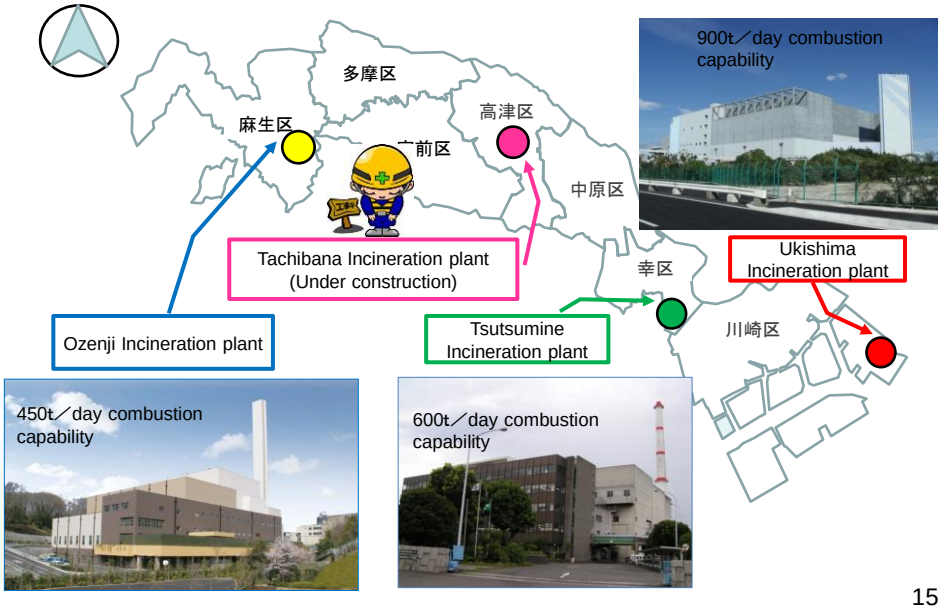
Municipal Solid Waste Management <Waste Collection>



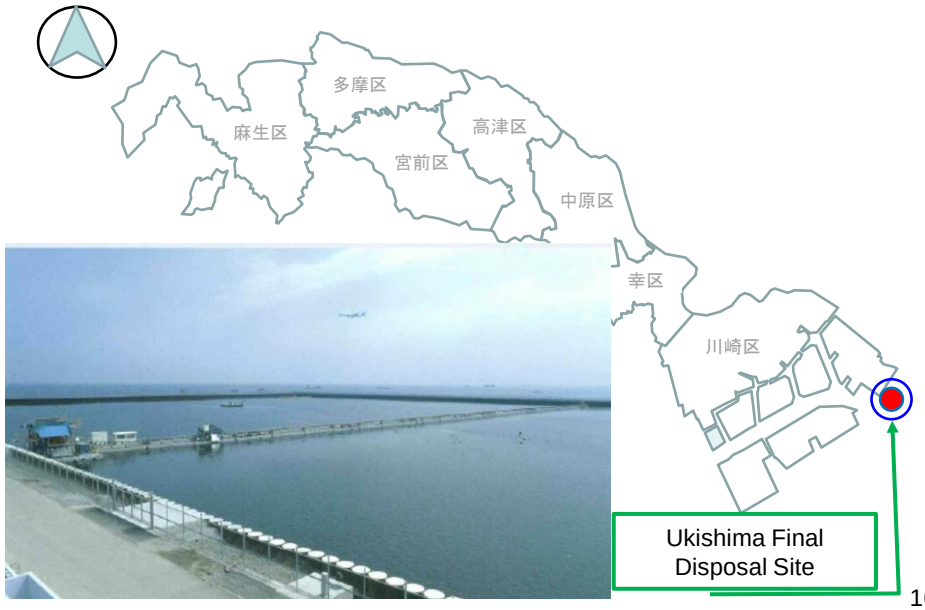
Waste collection truck

Municipal Solid Waste Management
<Waste Transportation by Train>

Municipal Solid Waste Management
<Waste Incineration Plant>



Municipal Solid Waste Management
<Final Disposal>



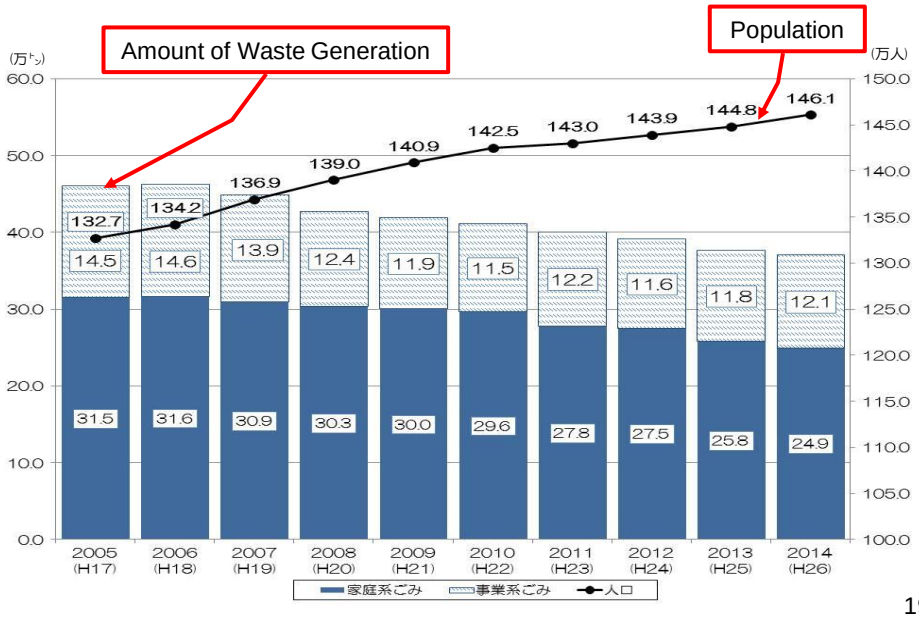
Ukishima Final Disposal Site for Incineration Ash

- **Ukishima Final Disposal Site No.1**
  Operation period 1978～2006
- **Ukishima Final Disposal Site No.2**
  2000 ～(Under operation)

After Incineration, Volume of Solid Waste would Reduce up to 1/50.

Solid Waste Management related Data

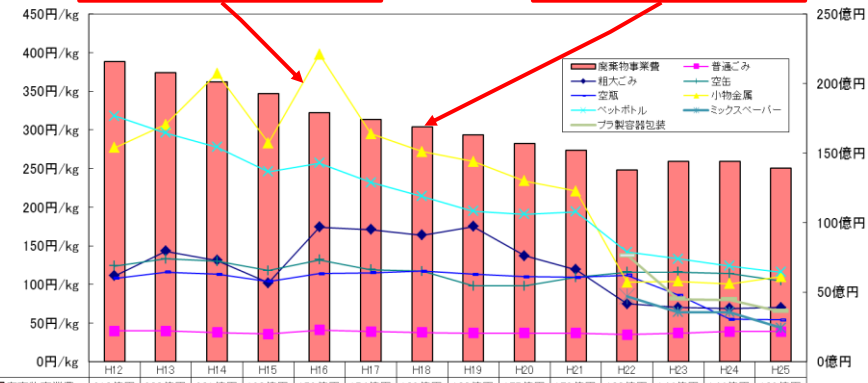
Trend of Solid Waste Generation in Kawasaki



Trend of Solid Waste Disposal Cost in Kawasaki

Disposal Cost per weight

Total Disposal Cost



	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25
廃棄物事業費	216億円	208億円	201億円	193億円	179億円	174億円	169億円	163億円	157億円	152億円	138億円	144億円	144億円	139億円
普通ごみ	40円/kg	40円/kg	38円/kg	36円/kg	41円/kg	39円/kg	38円/kg	37円/kg	37円/kg	37円/kg	35円/kg	37円/kg	39円/kg	39円/kg
粗大ごみ	111円/kg	143円/kg	131円/kg	102円/kg	174円/kg	171円/kg	164円/kg	175円/kg	137円/kg	119円/kg	75円/kg	70円/kg	69円/kg	70円/kg
空缶	124円/kg	133円/kg	130円/kg	118円/kg	132円/kg	119円/kg	117円/kg	98円/kg	98円/kg	109円/kg	116円/kg	116円/kg	114円/kg	105円/kg
空瓶	108円/kg	116円/kg	113円/kg	104円/kg	114円/kg	115円/kg	117円/kg	113円/kg	110円/kg	109円/kg	112円/kg	86円/kg	55円/kg	54円/kg
小物金属	277円/kg	307円/kg	373円/kg	283円/kg	398円/kg	295円/kg	272円/kg	259円/kg	234円/kg	221円/kg	103円/kg	104円/kg	101円/kg	110円/kg
ペットボトル	318円/kg	296円/kg	278円/kg	246円/kg	257円/kg	232円/kg	214円/kg	195円/kg	191円/kg	194円/kg	142円/kg	133円/kg	124円/kg	116円/kg
ミックスペーパー											85円/kg	64円/kg	64円/kg	44円/kg
プラ製容器包装											138円/kg	81円/kg	80円/kg	65円/kg

Attachment 2

2nd Workshop

Work Shop-2

Outline of Technical Study "Waste to Energy Plant Project for Yangon City in Myanmar"

18th January, 2018

JFE Engineering Corporation

Technical Study

1.Site Selection
2.Plant Capacity
3.Waste Analysis
4.Emission Standard
5.Plant Process Plan
6.Technical Issue

1. Site Selection (4 candidate sites)

- 4 candidate sites for WtE Plat in Yangon
  Hten Bin, Htawei Chaung , Thaketa , Kyi Su
- Site survey has been conducted in Dec. 2017 for all candidate site.

2. Plant Capacity

Waste Generated Amount

District	Waste Generated Amount [t/day]
West	408
North	703
East	527
South	419

※Source : PCCD

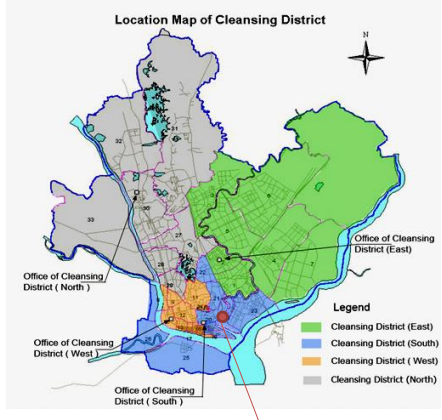
Considering Thaketa site location, the Plant will treat the waste from West and South districts.

408 t/day 419 t/day

827 t/day x 365days / 310days = 973 t/day

Waste Generated Amount Operating days

※Source : PCCD



Plant Capacity 1,000 t/d （500t/d x 2Line）

3. Waste Analysis

Estimated Characteristics of Waste in Yangon

Item		Unit	Min. LCV	Ave. LCV	Max. LCV
Lower Calorific Value (LCV)		kcal/kg	1,300	1,800	2,200
		kJ/kg	5,400	7,700	9,200
Composition	Combustible	wt.%	26	34	40
	Water	wt.%	60	55	53
	Ash	wt.%	14	11	7
	Total	wt.%	100	100	100

- Lower Calorific Value is estimated as above table based on the SSIP actual record and JFE's experience in other southeast Asia country.
- This value is used for plant design planning for the Fusibility Study.
- Actual waste analysis is necessary for detail design before starting the project.

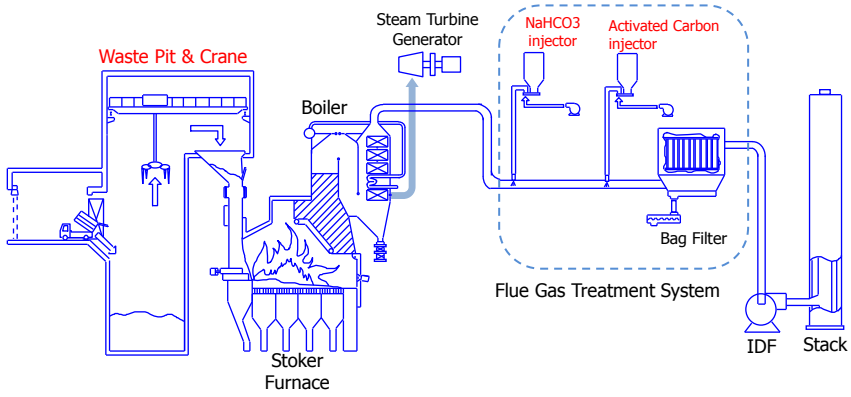
4. Emission Standard

Parameter	Unit	Guideline Vale	
		Myanmar ※1	Kawasaki
Cadmium	mg/m^3	0.05 – 0.1 (0.5-8 hour average)	0.56
Carbon monoxide	mg/m^3	50 – 150	-
Hydrochloric acid	mg/m^3	10	36
Hydrogen fluoride	mg/m^3	1	2.8
Mercury	mg/m^3	0.05 – 0.1 (0.5-8 hour average)	0.06
Nitrogen oxides	mg/m^3	200-400 (24 hour average)	120
Polychlorinated dibenzodioxin and dibenzofuran	ng TEQ $/m^3$	0.1	0.1
Sulfur dioxide	mg/m^3	50 (24 hour average)	48
Total metal	mg/m^3	0.5-1 (0.5-8 hour average)	11 (Lead)
Total suspended particulates	mg/m^3	10 (24 hour average)	22

※1 ; Souse : Myanmar Environmental Quality (Emission) Guidelines

- In this study, Plant Planning is based on this "Air Emission Level (from incinerators)" in Myanmar Environmental Quality (Emission) Guidelines.
- Flue Gas Treatment System will be installed in compliance with above standard.
- Guideline values in Myanmar are lower than in Kawasaki.

5. Plant Process Plan



Major Difference from SSIP

- Measure against Low Calorie Waste
  - ✓ Waste Pit and Crane will be installed to dry out waste in rainy season.
  - ✓ Actual effect of drying out will be confirmed by SSIP new Waste Yard in later.
- Flue Gas Treatment System,
  - ✓ Sodium Bicarbonate (NaHCO3) and Activated Carbon Injection are chosen considering "Air Emission Level".

6. Technical Issue

No.	Item	Issue	Future Action
1	Geological survey	Underground obstacles or unstable ground make civil cost increasing.	To conduct geological survey
2	Utility Condition	Without information of utility condition, detail design cannot be conducted.	To make Utility Map
3	Waste Analysis	Actual waste analysis is necessary for detail design. For example, appropriate calorific value setting prevent from consuming extra fuel by burner.	To conduct Waste Analysis constantly
4	Emission Standard	Generally, operation cost of Sodium Bicarbonate (NaHCO3) and Activated Carbon Injection system is higher than other system. To reducing operation cost, another kind of flue gas treatment system should be installed.	To set proper Emission Standard (Such as Own Emission Standard like SSIP or New Regulation in Yangon.)

Category of Waste

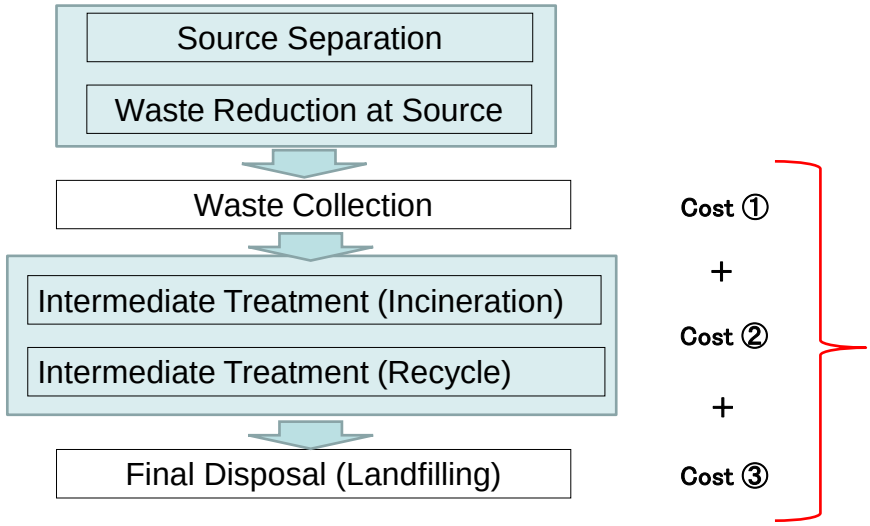
Municipal government responsibility

Household waste /Human waste → Municipality

Based on " Polluter Pay Principal "

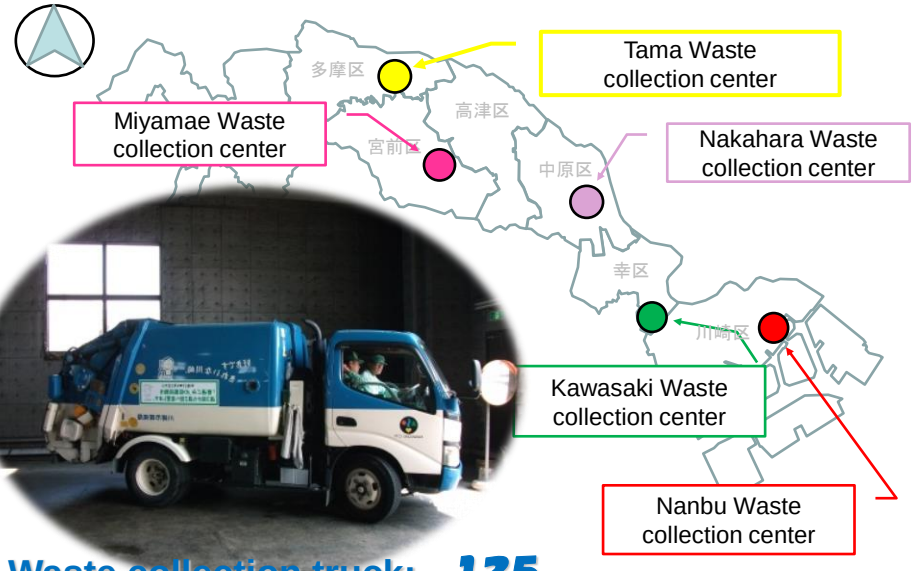
Industrial waste → Industrial waste management company

Basic flow of municipal solid waste management & a formula of the cost



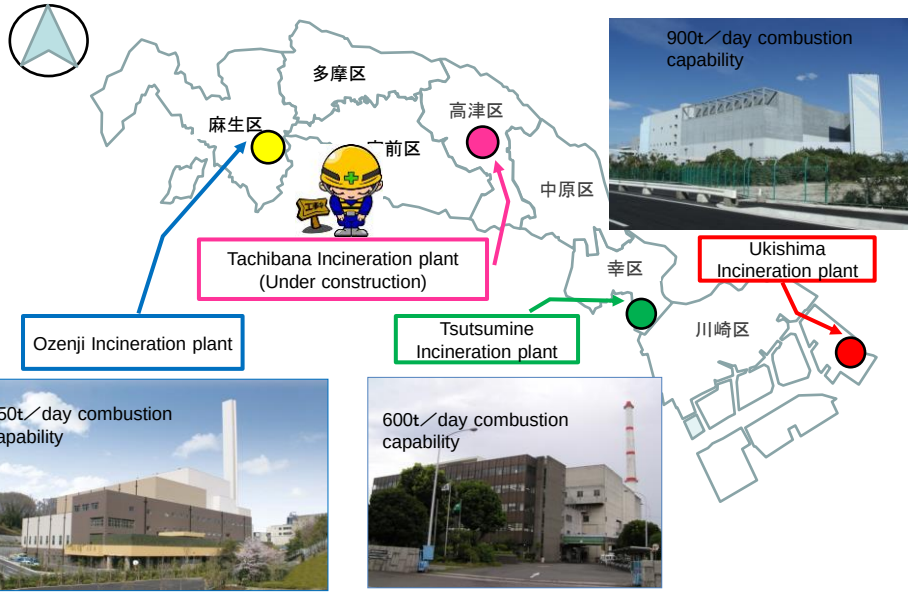
Waste Management Cost ① <Waste collection>

Waste Management Cost ①
<Waste Collection>

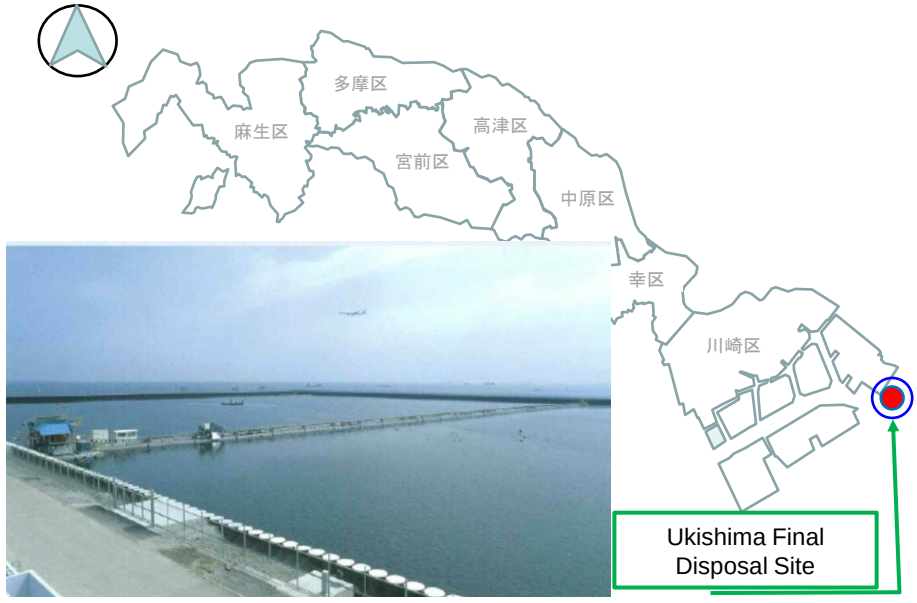


Waste collection truck: 135

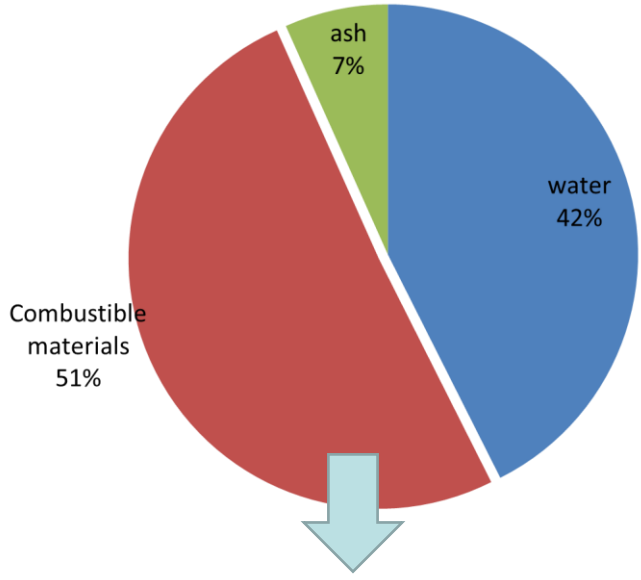
Waste Management Cost ②
<Intermediate treatment: Incineration & Recycle>



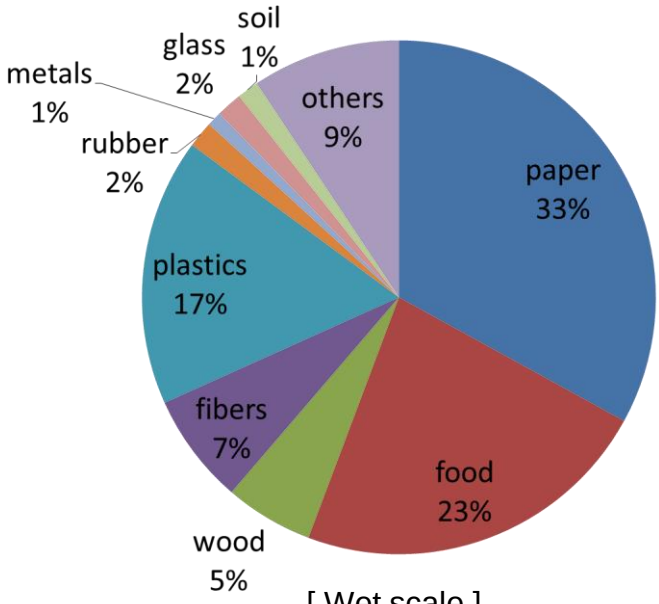
Waste Management Cost ③
<Final Disposal : Landfilling>



Waste composition in Kawasaki ①



Waste composition in Kawasaki ②



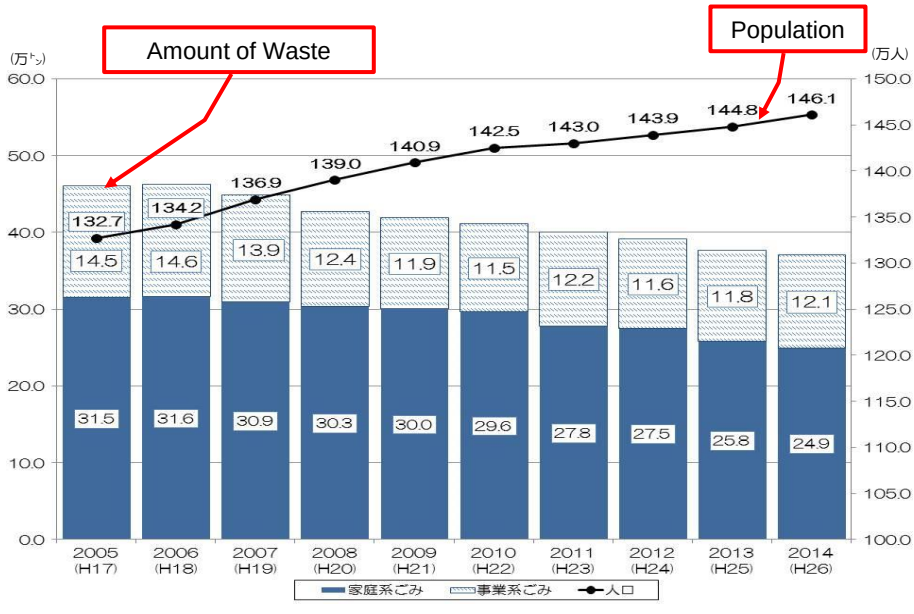
[Wet scale]

Calorific value

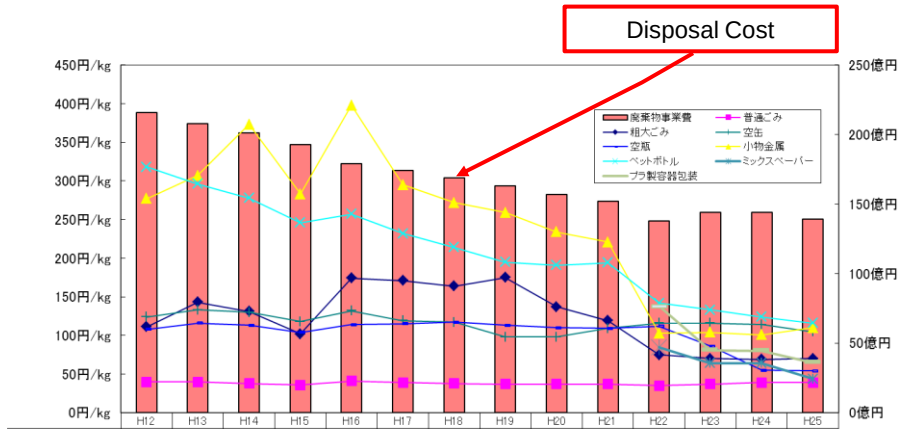
(High)
11,813 kJ/kg

(Low)
9,852 kJ/kg

Trend of Solid Waste Generation in Kawasaki



Trend of Solid Waste Disposal Cost in Kawasaki



	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25
廃棄物事業費	216億円	208億円	201億円	193億円	179億円	174億円	169億円	163億円	157億円	152億円	138億円	144億円	144億円	139億円
普通ごみ	40円/kg	40円/kg	38円/kg	36円/kg	41円/kg	39円/kg	38円/kg	37円/kg	37円/kg	37円/kg	35円/kg	37円/kg	39円/kg	39円/kg
粗大ごみ	111円/kg	143円/kg	131円/kg	102円/kg	174円/kg	171円/kg	164円/kg	175円/kg	137円/kg	119円/kg	75円/kg	70円/kg	69円/kg	70円/kg
空缶	124円/kg	133円/kg	130円/kg	118円/kg	132円/kg	119円/kg	117円/kg	98円/kg	98円/kg	109円/kg	116円/kg	116円/kg	114円/kg	105円/kg
空瓶	108円/kg	116円/kg	113円/kg	104円/kg	114円/kg	115円/kg	117円/kg	113円/kg	110円/kg	109円/kg	112円/kg	86円/kg	55円/kg	54円/kg
小物金属	277円/kg	307円/kg	373円/kg	283円/kg	398円/kg	295円/kg	272円/kg	259円/kg	234円/kg	221円/kg	103円/kg	104円/kg	101円/kg	110円/kg
ペットボトル	318円/kg	296円/kg	278円/kg	246円/kg	257円/kg	232円/kg	214円/kg	195円/kg	191円/kg	194円/kg	142円/kg	133円/kg	124円/kg	116円/kg
ミックスペーパー											85円/kg	64円/kg	64円/kg	44円/kg
プラ製容器包装											138円/kg	81円/kg	80円/kg	65円/kg

Waste Disposal Cost in Kawasaki (2015) ①

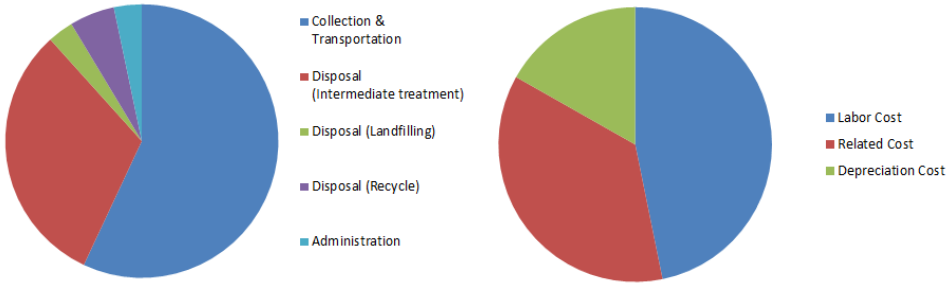
	Collection & Transportation	Disposal*	Management	Total Cost	Amount of Waste	Cost per ton
	(mil. MMK)	(mil. MMK)	(mil. MMK)	(mil. MMK)	(ton)	(mil. MMK)
Household waste	62,005	42,074	3,497	107,576	242,954	0.4
Bulky waste	3,563	5,293	921	9,777	9,366	1.0
Aluminum / steel Can	9,055	-308	361	9,108	7,046	1.3
Grass bottle	5,660	1,812	231	7,703	12,225	0.6
Small metal product	2,356	1,507	132	3,995	2,772	1.4
Pet bottle	6,086	797	254	7,137	5,042	1.4
Various used paper	5,060	435	199	5,693	13,618	0.4
Plastic container packaging	7,568	1,124	271	8,963	12,587	0.7
total	101,353	52,734	5,865	159,952	305,610	0.5

※Exchange Rate: 12MMK/JPY
※Disposal Cost is after including profit (ex. electric sales income, sales income from recyclable materials)

Waste Disposal Cost in Kawasaki (2015) ②

(mil. MMK)

	Collection & Transportation	Disposal			Administration	Sub Total
		(Intermediate treatment)	(Landfilling)	(Recycle)		
Labor Cost	62,072	15,634	491	0	5,034	83,231
Related Cost	34,744	18,169	2,686	8,279	831	64,710
Depreciation Cost	4,537	21,931	2,245	1,214	0	29,926
Cost Sub Total	101,353	55,734	5,422	9,493	5,865	177,867
					Profit	-17,915
※Exchange Rate: 12MMK/JPY					Cost Total	159,952



Component of waste management cost ①

	component
Collection & Transportation	
- Labor cost	salary for collection and transportation workers
- Related cost	maintenance fee lease fee for collection truck fuel fee utility cost communication fee
- Depreciation cost	facility construction cost ÷ period of use facility repair cost ÷ period of use purchase cost for collection truck ÷ period of use
Disposal (Intermediate treatment)	
- Labor cost	salary for incineration plant workers
- Related cost	consignment fee for facility operation maintenance fee interest on bonds for facility construction fuel fee utility cost communication fee chemical processing cost plant repair parts procurement cost
- Depreciation cost	facility construction cost ÷ period of use facility repair cost ÷ period of use

Component of waste management cost ②

	Component
Disposal (Landfilling)	
- Labor cost	salary for landfill site workers
- Related cost	consignment fee for landfill site operation maintenance fee interest on bonds for facility construction fuel fee utility cost communication fee chemical processing cost plant repair parts procurement cost supplies expense
- Depreciation cost	facility construction cost excluding subsidies × amount of landfilling per year ÷ maximum capacity of landfill site facility repair cost ÷ period of use
Disposal (Recycle)	
- Labor cost	outsourcing to private company
- Related cost	consignment fee for recycling facility (including labor cost) maintenance fee interest on bonds for facility construction fuel fee communication fee chemical processing cost plant repair parts procurement cost
- Depreciation cost	facility construction cost ÷ period of use facility repair cost ÷ period of use

Waste management cost per household in Kawasaki

■Cost Total: 159,952 million MMK

■Number of household in Kawasaki : 691,837 households

Cost per household in 2015 : 231,198 MMK/Year

Air emission standard in Kawasaki

parameter for air regulation	Yangon		Kawasaki		note
	guideline value	unit	guideline value	unit	
cadmium	0.05 - 0.1	mg/m3	0.5	mg/m3	
carbon monoxide	50 - 150	mg/m3	-		規定なし
Hydrochloric acid	10	mg/m3	20	ppm	塩化水素
Hydrogen fluoride	1	mg/m3	2.5	mg/m3	フッ素
Mercury	0.05 - 0.1	mg/m3	0.05	mg/m3	条例の規定なし（自主規制値）
Nitrogen oxides	200 - 400	mg/m3	5.2	m3/h	窒素酸化物（自主規制値）
Polychlorinated dibenzodioxin and dibenzofuran	0.1	ng TEQ/m3	0.1	ng TEQ/m3	ダイオキシン類
Sulfur dioxide	50	mg/m3	15	ppm	硫黄酸化物（自主規制値）
Total metals	0.5 - 1	mg/m3	10	mg/m3	鉛
Total suspended particulates	10	mg/m3	0.02	g/m3	ばいじん（自主規制値）
Ammonia			50	ppm	ヤンゴン側に規定なし
Cyan			10	ppm	ヤンゴン側に規定なし

Attachment 3

City-to-City collaboration Seminar

JCM City-to-City Collaboration in Yangon

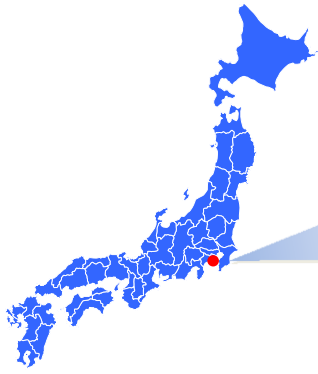
NIPPON KOEI

川崎市 KAWASAKI CITY

JFE

JCM seminar
January 30th, 2018

About Kawasaki-city:



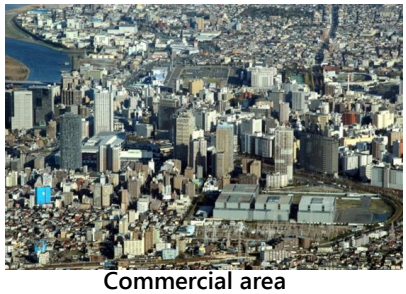
Population : **1,501,697 per.**
(As of Jun. 1, 2017)

Area : **144.35 km^2**

Various feature of the city

Kawasaki Port

Rich natural environment



Commercial area

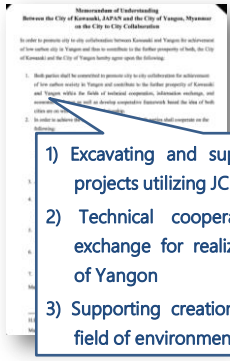
Industrial area

Experience of industrial pollution in Kawasaki

Overview of JCM City-to-city collaboration in Yangon

Outputs in 1st and 2nd year

Aug. 2015: *Start of city-to-city collaboration*
Oct. 2015: *1st Visit to Yangon*
Dec. 2015: *Discussion on Draft MOU at Yangon*
Jan. 2016: *Workshop on City-to-city collaboration at Yangon*
Mar. 2016: *Concluding MOU between Kawasaki and Yangon*
Mar. 2017: *Finalization of Draft Low-Carbon Action Plan*



1) Excavating and supporting of low-carbon projects utilizing JCM scheme
2) Technical cooperation and information exchange for realizing low-carbon society of Yangon
3) Supporting creation of new business in a field of environment

Overview of the 3rd Year

City-to-City Collaboration Activities

Apr. 2017: Start of phase-3
Aug. 2017: Workshop at Yangon to promote city-to-city collaboration, and discussion on low-carbon action plan (LCAP)

Explanation of LCAP, and discussion on further collaboration

FS Study for Project Formulation

Two FS study have been implemented under city-to-city collaboration Phase-3.

1. Replacement of pumps at a water treatment plant
2. Low carbonization of waste management

FS Study

Discussion with YCDC

JCM city-to-city collaboration project ② :

Feasibility study of waste to energy plant project for Yangon city

川崎市 KAWASAKI CITY

JFE

Feasibility study of waste to energy plant project for Yangon city

Yangon city, Republic of the Union of Myanmar

<Problems>

- Increasing waste generation along with the economic growth
  Yangon is facing the problem that the increasing of waste along with the economic growth, and environmental pollution caused by inappropriate waste treatment.
- Undeveloped waste treatment management
  It is necessary for Yangon city which has a plan to build large scale waste to energy plant to be acquired waste treatment management .

- Introduction of the appropriate WtE plant
- Capacity building for construction and operation of WtE plant

City to city Cooperation

Kawasaki City

Knowledge related to operation and maintenance of WtE plant

- Kawasaki City operates 3 waste treatment plants in the city, therefore Kawasaki city has sufficient knowledge of operation and maintenance of WtE plant.

Relationship with Yangon City

- FY2015 JCM project feasibility study for realization of low-carbon society in Asia "FY2015 JCM project feasibility study by City-to-City Collaboration in Yangon city" etc.
- Memorandum of Understanding : Between the City of Kawasaki, Japan and the City of Yangon, Myanmar on the City-to-City Collaboration

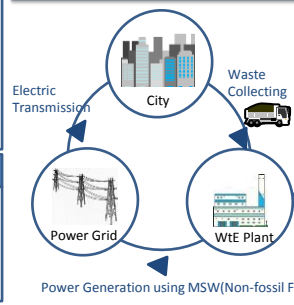
Details of research

① Social and Economic Situations
② Legal System
③ Plan for WTE Plant
④ Feasibility Study
⑤ Business Scheme

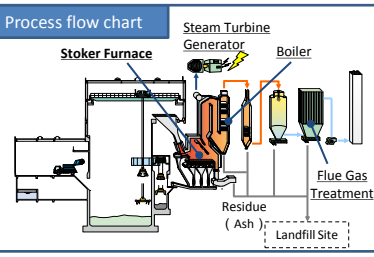
Technical specification

- Capacity: 248,000t/year
- GHG Reduction: 131,000t-CO2/year
- Power Generation: 52,000MW/year

Low-carbon and sustainable society



Process flow chart

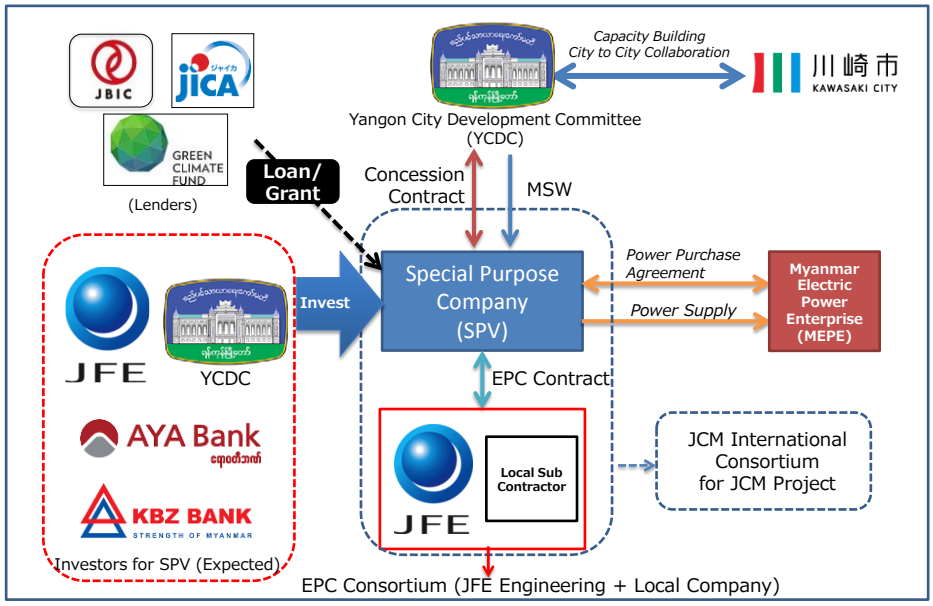


Advantage of WtE introduction

- Appropriate waste management
- Sanitary improvement, Life time extension of landfill site
- Improvement of demand for electricity

To realize WtE project with Kawasaki City's knowledge on waste management → In the future → To Expend the same business scheme to other cities

Project Scheme



Schedule (Plan & Action)

**WS: Work Shop*

No	Item	17/9	10	11	12	18/1	2	3
1	Study of the Legal System							
2	Planning of WtE Plant							
3	Selection of Off takers (Electricity・Steam)							
4	Project Finance Survey							
5	Project Scheme							
6	Feasible Study							
7	Capacity Building for Waste Management		Kick-off/WS*(1)			WS*(2)	Final Report /WS*(3)	
8	Finalization of Report							
9	Translation Work (JPN→ENG)							

【*Kick-off/WS (1)*】

【*Site Survey*】