Republic of the Philippines Davao City Environment and Natural Resources Office

## Collaboration Program with the Private Sector for Disseminating Japanese Technology for Waste-to-Energy system in Davao City

**Final Report** (Pre-Release Version)

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Japan International Cooperation Agency (JICA)

### NIPPON STEEL & SUMIKIN ENGINEERING CO.,LTD.

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JR(先)	
16-067	



### Location of Davao City

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## 1 Summary

#### 1.1 Summary

#### - Background of the Project

With the recent increase in waste generation boosted by expansion of urban socio-economic activities, it is one of the most urgent issues in Davao City to address the limited capacity of existing waste disposal landfill by reducing the volume of solid waste through further advanced technologies.

Similar serious waste management issues found in many other metropolitan cities make the Government of the Philippines start its full-fledged examination of the policy to promote introduction of waste-to-energy technologies.

- The technologies to be assessed for its introduction/application

Waste-to-energy technologies (Grated incinerator, etc.)

- Goal/Purpose of the Project
  - Identifying, in cooperation with Davao City, the current conditions and issues of solid waste management and assessing the viabilities of introducing waste-to-energy technologies to improve the City's waste management/treatment.
  - Reviewing the laws, regulations, and policies relevant to introduction of waste-to-energy technologies.
  - Evaluating feasibility of waste-to-energy application (in terms of financial/technological/environmental sustainability, social acceptance, and so forth).
  - - Integrated improvement of solid waste management system under the principle of 3Rs (Reduce, Reuse, Recycle) in cooperation with the Environment Bureau of Kitakyushu City.
- Scope of the Project Activities
  - Survey on current conditions of solid waste management in Davao City.
  - Review of the relevant laws/regulations and policies.
  - Formulation of the waste-to-energy facility construction and operation plan with its feasibility analysis.
  - Identification of the issues for project implementation.
- Achievement and Results
  - The project can clearly identify the current conditions and issues of solid waste

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management in Davao City based on the mutual trust with the City government, thereby building the basis for taking further steps to project implementation,

- Current prospect of project implementation
  - There are some hurdles in implementing the project under fully private investment initiative. Public sector assistance is required.
- Prospects and issues for project implementation
  - Although the interest and need of waste-to-technology is high, no prior experience in managing and operating WTE facilities is a big hurdle in the Philippines. A good example needs to be shown to make the Government of the Philippines confident enough to move forward to waste-to-energy technology. Public sector assistance from Japan, building consensus among all stakeholders (ranging from central/local governments to general public), and proper legal/regulatory scheme are all required to implement the first project of full-scale WTE facility. It is also of great importance to achieve a certain level of financial rate of return that is allowable for the investors and financial institutes.
- Plan of activities for Project Implementation
  - Continuing discussions with Davao City and local project partners and cooperation with Kitakyushu City, the Project will further elaborate the implementation plan of WTE facility development in consideration of the on-going activities of the Philippines Government on amendment and renewal the current legal/regulatory mechanism on WTE, G to G (The Philippines and Japan) dialogue and possible financial assistance from the Government of Japan.
- Possibility of utilizing ODA

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• Currently under consideration

#### **1.2** Outline of the Project

The outline of the Project is shown in the figure below.



The Project for Promotion of Waste-to-Energy Technology in Davao City, Republic of the Philippines Nippon Steel & Sumikin Engineering Co., Ltd. (The Philippines)



## 2 Background Information

### 2.1 Background Data and Information

#### 2.1.1 Profile of Davao City

Davao City is the biggest city and the center of socio-economy and culture in Mindanao Islands. Following Metro Manila and Metro Cebu, Davao is the center of the third largest metropolitan region (Mindanao Region) in the Philippines.

Davao City is a city in the southern part of Mindanao Island facing Davao Bay. Samal Island faces the eastern coast of the city, and the giant volcano Mount Apo is situated in the western part of the city. The surface area of Davao City is 2,443.61 km<sup>2</sup>, which makes it the largest city in the world. The city is composed of three districts and over 184 barangays (small villages). 50% of the area is afforested or tropical forest. 43% of the land is used for agriculture, which is the main industry of Davao City. Large-scale plantations that produce bananas, pineapples, coffee, and coconuts cover most of these agricultural areas.

Currently, only 10% of the city is used for housing, facilities, commerce, and industry. According to the land use plan of Davao City, 15% of the area is planned to be used for development, 67.19% for agricultural land, and 17.68% for forest conservation.

#### 2.1.2 Demography

According to the census conducted in 2010, the population of Davao City was 1.45 million. According to the estimation by Davao City, the population has reached 1.6 million in 2011. The average annual population growth between 2010 and 2015 is estimated to be 2.36%.

Year	Population
2010	1,449,296
2011*	1,489,145
2012*	1,524,375
2013*	1,560,439
2014*	1,597,356
2015*	1,635,147

\*Estimation by Davao City

(Source: Socio-Economic Indicator 2015, City Government of Davao)

Figure 2-1: Change in population (2010-2015)

#### 2.1.3 Gross regional domestic product (GRDP)

Gross regional domestic product (GRDP) of Davao City in 2013 was 258.5 billion PHP based on price level in year 2000. This is 6.8 % higher compared to the GRDP of the previous year. GDP per capita of 2013 was 54,359 PHP (approximately 1,200 to 1,300 USD) based on price level in year 2000.

Table 2-1: Change in GRDP of Davao City (2011 to 2013)

Item	Unit	2011	2012	2013
GRDP (based on price	1,000 PHP	225,431,679	242,070,406	258,485,862
level of year 2000)				
GRDP per capita	PHP	49,112	51,805	54,359
Growth rate	%	3.7	7.4	6.8

(Source: Philippine Statistics Authority)

According to the data of 2011, the service industry make up an important share in GRDP of Davao City. Agriculture, forestry, and fisheries make up 18.9%, manufacturing makes up 29.5%, and the service industry makes up 51.9% of GRDP of Davao City.

#### 2.1.4 Solid waste management in Davao City

#### a. Amount of municipal solid wastes

According to "10-Year Integrated Solid Waste Management Plan of Davao City 2007-2017" prepared by Davao City, the amount of generated and collected municipal solid waste is projected as shown in the table below.

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Year	Projected Population	Waste Collection (daily, kgs.)		
2011	1,489,145	833,921.20	387,022.83	
2012	1,524,375	853,650.00	396,178.97	
2013	1,560,439	873,845.84	405,551.85	
2014	1,597,356	894,519.36	415,146.43	
2015	1,635,147	915,682.32	424,968.16	
2016	1,673,832	937,345.92	435,022.24	
2017	1,713,431	959,521.36	445,313.86	
2018	1,753,968	982,222.08	455,849.27	
2019	1,795,464	1,005,459.84	466,633.91	
2020	1,837,941	1,029,246.96	477,673.51	
2021	1,881,424	1,053,597.44	488,974.57	

Table 2-2: Projected population and waste generated and collected in Davao City

According to the waste composition survey conducted by the Project Team at the final disposal site, the daily disposed municipal solid waste is estimated to be 500 - 600 ton/day. Thus, there is little gap between these figures and the projected figures shown in Table 2-2.

#### b. Collection and transport of municipal solid wastes

#### b.1. Collection system

In Davao City, there are two collection types, namely door-to-door collection and block/curbside collection, and the type of collection depends on the zone in the city. Under the door-to-door collection system, the collection vehicles of the municipality collect wastes from each household or facility. Under the block/curbside collection system, each household bring their wastes to designated collection points, and the vehicles collect wastes from those collection points.

Davao City is composed of 182 barangays (small villages) and 36,000 households with total of about 1.5 million residents. There are approximately 800 designated collection points in the city.

#### b.2. Sorted discharge and collection

According to Davao City, 3R (reduce, reuse, recycle) and sorted discharge is being promoted from before it was made an obligation by the Ecological Solid Waste Management Act (RA9003). Although Davao City used to collect municipal solid wastes 4 times per week, the city currently collects wastes only 2 times per week on average.

Currently, there are 48 recycling companies in Davao City that are registered or with permits.

According to Davao City, there are approximately 500 junkshops and recycling companies in the city as of 2014, including those that are informal. Davao City believes that the amount of wastes that are recycled by these junkshops and companies is approximately 60,000 tons/year.

#### c. Current treatment and disposal of municipal waste

Most of the municipal waste collected in Davao City is currently disposed at New Carmen Sanitary Landfill, which located in Tugbok District and approximately 15km distance from the center of Davao City. Its land area is 3.8 hectare.

The New Carmen Sanitary Landfill has been in operation since 2010 with the estimated possible landfilling operation of 8 to 10 years. As of 2015, 500 to 600 tons of waste has been disposed daily (recently nearly reaching 600 tons). Its remaining lifetime will be shortened for another few years due to the increased amount of waste disposal.

#### d. Current flow of municipal solid wastes

According to data from Davao City and our field survey, the flow of wastes from collection, recycle, treatment, to disposal is estimated to be as shown in the figure below.



Figure 2-2: Current flow of municipal solid wastes in Davao City (estimation)

#### 2.1.5 Solid waste management administration of Davao City

#### a. Organization

Wastes of Davao City are managed by the City Environment and Natural Resources Office

(hereinafter "CENRO"). CENRO is composed of 4 divisions, namely Administrative Division, Parks & Playground Division, Natural Resources Operations Division, and Environmental & Waste Management Division. Environmental & Waste Management Division is the division directly in charge of waste management.

On the other hand, political decisions regarding waste management are made by Davao City Solid Waste Management Board under the Mayor of Davao City. There are 17 members total, and the chairman is the Mayor, and the vice-chair is the City Administrator. Other members include representatives of Department of Environment and Natural Resources(hereinafter "DENR"), Department of Health (DOH), Department of Science and Technology (DOST), different departments of the city office such as the City Planning and Development Office (CPDO), League of Barangays (*Liga ng mga Barangay*), NGOs, and recycling companies. Under this Board, different committees, namely committees on policy, technical issues, and information education campaign (IEC), are established, which are composed of various experts for political decision-making on waste management.



Figure 2-3: Organigram of Davao City Solid Waste Management Board

#### b. Personnel of municipal solid waste management

There are about 1,300 personnel that are in charge of management of municipal solid wastes, mainly consisting of members of CENRO. The number of staff members in different divisions of CENRO is shown in the table below.

Services of CENRO	Permanent	Fixed-term
	employee	employee
Road cleaning	10	432
Waste collection	55	655
Integrated environmental and waste management	6	6
Others		100
TOTAL	71	1,193

Table 2-3: Personnel of municipal solid waste management in Davao City

## 2.1.6 Challenges concerning municipal solid waste management faced by Davao City

The challenges concerning municipal solid waste management faced by Davao City can be summarized as follows.

#### a. Limited landfill capacity to receive increasing amount of wastes

As of 2015, 500-600 tons of waste is landfilled daily in the existing final disposal site of Davao City. New Carmen Landfill Site has been operating from 2010 and was designed to be used for 8 to 10 years. However, due to the increase in population, economic development, and expansion of waste collection area, the amount of wastes to be disposed is exceeding the amount that was initially projected. As a result, the remaining lifetime of the landfill site is projected to be only a few years from 2016. On the other hand, selection of candidate sites for the new landfill site has not started. Therefore, there is the risk that collected wastes in Davao City will have nowhere to be landfilled in the near future.

#### b. Risk of health hazard and pollution from the final disposal site

At the New Carmen Landfill Site, the current daily disposed waste amount is exceeding the initial projection. Its landfill area is already 80 to 90% full, and there are wastes that have spilled over from the landfill area to the access road outside the landfill site. Further, although leachate treatment facility is installed, there is the risk that untreated leachate is contaminating the surrounding areas. As some of the roads inside the site are filled with wastes and thus inaccessible, waste collection vehicles cannot properly discharge the wastes in the landfill site. This could be one of the reasons why wastes are spilled over outside the landfill site.

The significant amount of landfilled organic wastes is generating methane gas due to anaerobic decomposition. Further, sanitary conditions continue to degrade due to bad odor and insects that are generated in the open-dumping areas.

## c. Lack of facilities to reduce the volume of wastes through intermediate treatment and recycling

As the current landfill site is reaching its landfill capacity, volume reduction of municipal solid wastes is an urgent issue. Although Davao City has been implementing various policies and activities to promote 3R, sorted discharge, recycling, and composting of organic wastes, these efforts are not large in scale. As a result, the amount of disposed municipal solid wastes continue to increase year by year.

Under this current condition, introduction of waste-to-energy technologies through measures such as waste thermal treatment (i.e. incineration) should be considered in order to drastically reduce the level of pollution and to reduce the amount of disposed wastes.

# 2.2 Proposed waste-to-energy technology and its characteristics

#### 2.2.1 Proposed waste-to-energy technology

Waste-to-energy technologies to be introduced in Davao City proposed by Nippon Steel & Sumikin Engineering Co, Ltd. are "incineration by grate stoker furnace" and "gasification". Both of these technologies are being applied worldwide including in Japan and have proven to be highly effective in pollution control and volume reduction of municipal solid wastes (over 80 to 90% of reduction rate).



Table 2-4: Outline of thermal treatment technologies for municipal solid wastes





The advantages of introducing Japanese waste-to-energy technologies are as follows.

1. Japan holds experience in incinerating low-calorie wastes without fuel and

operating and controlling energy-recovery facilities with precision

2. Japan possesses sophisticated pollution control technologies which enable installation of waste-to-energy facilities even in city centers and residential areas.

The first advantage is unique to Japan, as Japan has the history of incinerating low-calorie wastes with the objective of effectively reducing the volume of municipal solid wastes. On the other hand, technologies in Europe and the US incinerate high-calorie wastes with the objective of recovering heat and energy. As the wastes of Davao City are high in moisture content and low in calorific value, application of Japanese technologies and operation experience and know-how is considered to be more effective for volume reduction of wastes.

The second advantage is also unique to Japan. Japanese pollution control technologies have been developed over the years so that the facilities in operation would be able to respect the strict Japanese environmental and emission standards. As a result, waste incineration facilities are recognized today by Japanese citizens as useful waste-to-energy facilities, and such facilities are installed even in city centers. This is a phenomenon that cannot be observed in other countries.

#### 2.2.2 Contribution of the Project to the National Development Targets

To address the issue of worsened public sanitation in the cities due to increasing solid waste generation, the Government of the Philippines enforced, in 2001, Republic Act of 9003 (RA9003): Ecological Solid Waste Management Act that aims at reducing the final disposal amount of solid waste under the responsibility of local government through segregated collection and promotion of reuse and recycling. It also provided that all the final disposal facilities had to be operated in the so-called sanitary landfill method by February 2006. After a few years, however, the percentage of local governments that fully followed this sanitary landfill method did not even reach 10%. It revealed the weakness of local governments in solid waste management in many cases.

The level of awareness in Davao City is, in comparison with the other local governments, a lot higher especially in the relevant city offices and Davao branch of the Department of Education as represented by the fact that they frequently hold seminars on waste to raise awareness of general public. The City also had started operation of its sanitary landfill in 2011 with the total area of 3.8 hectare.

However, the landfill is planned to be utilized for 10 years while the available years will be further shortened due to increased amount of waste disposed. Introduction of intermediate treatment facilities such as incinerators is thus currently drawing strong attention for reducing the volume of waste.

In this context, the WTE technology proposed in this Project is expected to contribute to the

National Development priorities in the following respect:

- Volume reduction of municipal waste and extension of the life of the existing landfill;
- Improvement of environmental hygiene and pollution prevention/mitigation in the neighboring area of the existing landfill;
- Reduction of GHGs (reduction of methane emission from the landfill and CO<sub>2</sub> reduction through conversion of power generation source from fossil fuels to municipal waste; and
- Energy resource diversification by introducing WTE technologies

### 3 Project Summary

#### 3.1 Goal and Targets

#### 3.1.1 Goal

To implement the project under the PPP (Public-Private Partnership) with private sector investment finance of JICA through formulation of a detail business plan based on comprehensive identification of all the conditions for business development (including nature, socio-economy, relevant laws, regulations and policies, financial capacity, waste amount and characteristics, and so forth), project feasibility evaluation, and discussions/coordination with relevant stakeholders.

## 3.1.2 Achievement Targets (Contributions to development targets of the recipient country, region and city)

To make contribution to realization of the following development targets through implementation of the proposed WTE development project:

- ① Volume reduction of municipal waste and extension of the life of existing landfill;
- <sup>(2)</sup> Improvement of environmental hygiene and pollution prevention/mitigation in the neighboring area of the existing landfill;
- (3) Reduction of GHGs (reduction of methane emission from the landfill and CO<sub>2</sub> reduction through conversion of power generation source from fossil fuels to municipal waste; and
- ④ Energy resource diversification by introducing WTE technologies

Achievement Targets (Business development) The targets of the project in terms of the proposed business development are as shown below:

- (1) Identify current conditions of the following key factors in WTE facility business as a private investment project through detailed on-site surveys and discussions/negotiations with the relevant stakeholders:
  - ① Current conditions of solid waste management (including Waste Amount and Composition Survey)
  - 2 Review of relevant laws, regulations and policies (solid waste management, Investment rules and regulations, PPP, Public service concession contract, Power purchase contract, etc.)
  - ③ Institutional and financial mechanism and capacity of Davao City
  - ④ Identification and assessment of project risks
- (2) Implement site visits and trainings in Japan for the purpose of disseminating the exact understanding of WTE business and technologies among the relevant stakeholders of Davao City.

#### 3.1.3 Planned Activity Schedule

Activities	Month/Year	Working days	Location	Planned Activities	
Activity in Japan(1)	February 2015	10 days	Tokyo	Preparation of Work plan and Inception Report	
Activity in Davao(1)	March 2015	90 days	Davao	1st survey in Davao	
Site visits and	June 2015	15 days	Kitakyushu	Site visits and Training in	
training in Japan		10 00050	11100119 00110	Japan	
Activity in Japan (2)	June 2015	45 days	Tokyo	Preparation of Interim	
Tervity in Japan (2)	June 2015	45 days	Токуо	Report	
Activity in Davao	August 2015	45 days	Davao	2nd survey in Dayao	
(2)	August 2015	45 uays	Davao		
Activity in Japan (3)	October 2015	20 days	Tokyo	Preparation of DF/R	
Activity in Davao	November	5 dava	Davao	Explanation and discussions	
(3)	2015	Juays	Davao	on DF/R	
Activity in Iopon (4)	November	20 dava	Tokyo	Preparation and submission	
Activity in Japan (4)	2015	20 uays	токуо	of F/R	

Planned activity schedule of the Project is as shown in the table below.

#### 3.1.4 Project Members

The Project Activities are carried out by the following member companies with Davao City as

our counterpart.

Member Companies	Roles and Responsibilities
Nippon Steel and Sumikin	<ul> <li>Formulation of Project Development Plan</li> </ul>
Engineering (Project Proponent)	<ul> <li>Discussions and negotiations with the relevant stakeholders</li> </ul>
	of Davao City
	• Formulation and arrangement of the site visits and training
	program in Japan
Kitakyushu City and	<ul> <li>Guidance and supervision of waste amount and composition</li> </ul>
Kitakyushu City Environment	survey
Preservation Association	<ul> <li>Policy recommendations on solid waste management</li> </ul>
	<ul> <li>Formulation and implementation of site visits and training</li> </ul>
	program in Japan
EX Research Institute	• On-site detail survey (Identification of the current conditions
	of key factors in WTE development)
	<ul> <li>Reporting</li> </ul>

#### 3.1.5 Project Activities

Project Activities are as summarized in the table below.

	Task	Time schedule (Plan)						Activities	Targets		
		1 st	2nd	3 <sup>rd</sup>	$4^{th}$	$5^{\rm th}$	6 <sup>th</sup>	$7^{\rm th}$	8th		
		(JP)	(PH)	(PH)	(PH)	(JP)	(PH)	(PH)	(PH))		
1	Agreement on work plan									<ul> <li>Work plan</li> <li>Discussions with Davao City</li> </ul>	<ul> <li>Submission of IC/R</li> <li>Agreement with Davao City on IC/R</li> </ul>
2	Identification of facility design conditions									<ul><li>WACS</li><li>Legal Review</li></ul>	<ul> <li>Schematic facility design</li> </ul>
3	Identification of WTE business development conditions									<ul> <li>Local cost information</li> <li>City SWM budget</li> <li>FIT (feed-in-tariff ) mechanism</li> </ul>	<ul> <li>Formulation of WTE Project implementation plan</li> </ul>

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	Task		Time schedule (Plan)						Activities	Targets	
		1st	2nd	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8th		
		(JP)	(PH)	(PH)	(PH)	(JP)	(PH)	(PH)	(PH))		
4	Increasing understanding on WTE technology					•••		••••		<ul> <li>Training in Japan</li> <li>Project dissemination</li> </ul>	<ul> <li>Understanding on WTE technology by the relevant</li> </ul>
5	Official Recognition by Davao City on the proposed WTE Project development				•••			••••		<ul> <li>workshop</li> <li>WTE project development plan</li> <li>Explanation of the plan to Davao City</li> </ul>	<ul> <li>stakeholders</li> <li>Official reception of the project proposal by Davao City</li> </ul>
	plan										

### 4 Summary of Project Activities

Davao City, the metropolitan city in the Southern Region of the Philippines with the population of approximately 1.5 million, is facing an urgency in mitigating the increasing pressure on final disposal landfill of solid waste arising from rising amount of waste generation with expansion of metropolitan area and socio-economic activities.

The Project for Promotion of Waste-to-Energy Technology in Davao City consisted of numerous activities namely "field survey" to plan and assess the feasibility of the proposed waste-to-energy project, "training in Japan" to invite relevant partners in the Philippines to Japan, and "dissemination of the survey results" through activities such as organization of a workshop. The results of these activities are

#### 4.1 Field surveys

The field surveys were conducted based on the schedule shown below.

Dates	Members of field study	Outline of survey
1 <sup>st</sup> Field Survey	Nippon Steel & Sumikin	• 1 <sup>st</sup> Waste composition survey
(July 2015)	Engineering Co. Ltd (2	<ul> <li>Visits to IICA Philippines office</li> </ul>
()	members)	Iapanese embassy
	• Kitakyushu City (1 member)	<ul> <li>Explanation to National Solid Waste</li> </ul>
	Kitakyushu City Environmental	Management Commission
	Preservation Association (2	(NSWMC) and Dayao City and data
	members)	collection
	• EX Research Institute (1	•
	member)	• Data collection on construction cost
		through local constructors
2 <sup>nd</sup> Field Survey	Nippon Steel & Sumikin	<ul> <li>Field survey in Dayao City to</li> </ul>
(August 2015)	Engineering Co., Ltd (2	identify the current situation
(	members)	
	• Kitakyushu City (1 member)	
3 <sup>rd</sup> Field Survey	Nippon Steel & Sumikin	• 2 <sup>nd</sup> waste composition survey
(September 2015)	Engineering Co., Ltd (2	• Field survey and data collection
	members)	regarding current status of Davao
	Kitakyushu City Environmental	City
	Preservation Association (2	
	members)	
4 <sup>th</sup> Field Survey	Nippon Steel & Sumikin	Preparation of training in Japan
(October 2015)	Engineering Co., Ltd (2	Data collection regarding costs
	members)	<ul> <li>Proposal to Davao City and</li> </ul>
	• Kitakyushu City (2 members)	consultation
5 <sup>th</sup> Field Survey	Nippon Steel & Sumikin	Preparation of workshop
(January 2016)	Engineering Co., Ltd (1 member)	
	• Kitakyushu City (1 member)	
6 <sup>th</sup> Field Survey	Nippon Steel & Sumikin	Workshop
(February 2016)	Engineering Co., Ltd (2	
	members)	
	• Kitakyushu City (1 member)	
	• EX Research Institute (2	
	members)	
7 <sup>th</sup> Field Survey	Nippon Steel & Sumikin	• Reporting of survey results to Mayor
(March 2016)	Engineering Co., Ltd (2	of Davao City
	members)	Reporting to JICA Philippines and
	• Kitakyushu City (1 member)	Japanese embassy
		Reporting to NSWMC

Table 4-1: Schedule of field survey

Activities conducted in the field surveys are outlined below.

#### 4.1.1 Waste amount and composition survey

In order to effectively generate power by waste incineration, the wastes to be incinerated should have calorific value of between 1,800 and 2,000 kcal/kg. In order to identify the characteristics of wastes in Davao, the physical composition and calorific value of wastes that are brought into

the final disposal site were surveyed between July and September 2015.

The items that were analyzed are three contents and lower calorific value (Table 4-2). However, as University of Mindanao which was our partner in this survey did not possess a calorimeter, the lower calorific value was estimated to be 1,700 kcal/kg based on the Japanese method which is specified by Ministry of Health and Welfare Ministerial Notification No. 95, 1977

Item	Content
Three-content	Water-content, Combustible matter, ash
Calorific value	Lower calorific value
Physical	Paper, fabric, plastic, rubber/leather, tree/grass, kitchen
composition	waste, metal, glass, stone/porcelain, others

Table 4-2:	Items	ana	lyzed
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#### 4.1.2 Training Visit to Japan

Officials of Davao City were invited to Japan to participate in the training on waste-to-energy for five days from 30 November to 4 December 2015.

#### a. Participants of the site visit in Japan

Four members from Davao City, namely City Councilors who are the decision makers concerning waste management and energy and the Deputy Chief of Davao City Environment and Natural Resources Office, participated in the training in Japan.

Table 4-3: List of participants of	training in Japan
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Name	Post		
Ms. Myrna L' Dalodo Ortiz	Davao City Councilor, Chairperson, Committee on Environment		
Mr. Louie John Bonguyan	Davao City Councilor, Chairperson, Committee on Energy		
Ms. Marissa S Abella	Davao City Councilor, Vice-chairperson, Committee on Environment		
Ms. Dolores Remojo	Deputy Chief, City Environment and Natural Resources Office (CENRO)		

#### b. Outline of training in Japan

The schedule of the training is as shown below.

Month	D	ate	Time	Content of the training	Other information
11	29	Sun	AM	Trainees arrival	Fukuoka Airport
			PM		
	30	Mon	AM	Briefing	Kyushu International Center, JICA
			PM	Lecture of waste management in	Kitakyushu Asian Center for
				Courtesy meeting with Mayor Kitahashi	Low Carbon Society
12 1		Tue	AM	Site visit at Shinmoji waste-to-energy facility	Moji-ku, Kitakyushu-city
			PM	Site visit at Higari recycling center for waste cans and bottles	Kokurakita-ku, Kitakyushu-city
	2	Wed	AM	Site visit at Kogasaki waste-to-energy	Yawatanishi-ku,
				facility	Kitakyushu-city
			PM	Site visit at Kitakyushu plastic recycling	Kokurakita-ku,
				center	Kitakyushu-city
3 Thu A		AM	Site visit at waste collection site	Moji-ku, Kitakyushu-city	
			PM	Site visit to Eco-town (recycling complex)	Wakamatsu-ku,
					Kitakyushu-city
4 Fri		AM	Lecture on waste-to-energy	Kyushu Technical Center of Nippon Steel & Sumikin Engineering	
	PM Arrangement for results of the t		Arrangement for results of the program,	Kyushu International Center,	
	free discussion		free discussion	JICA	
	5	Sat	AM	Departure	Fukuoka Airport
PM		PM			

Table 4-4: Schedule of training in Japan

#### 4.1.3 Workshop in Davao City

A Workshop was organized on 11 February 2016 with the objective to disseminate the survey results to relevant partners and stakeholders.

The content of workshop is outlined below.

Name of workshop	Solid Waste Management and Waste-to-Energy: A Presentation of Feasibility Study on Proposed Waste to Energy Facility in Dayso City						
Date and time	13.00  to  18.00  11 February 2016	ste-to-Energy Facility in Davao City					
Venue	Marco Polo Hotel Davao						
Number of	Approximately 120 participants						
narticipants	Approximately 120 participants						
Program	Part 1: Opening (13:30 to 14:00)						
	Opening						
	Introduction of participants						
	Opening remerks	Hon Murna Dalada Ortiz					
	Opening remarks	City Councilor					
		Chairmanson, Committee on Environment					
	Walaama addraas	Hon Rodrigo R. Dutorto					
	welcome address	Davas City Mayor (read by on behalf)					
	Introduction of the proposed project	Mr. Kojski Tanjoka					
	introduction of the proposed project	General manager					
		Ninnon Steel & Sumikin Engineering Co					
		I td					
	Part 2: Results of survey (14:00 to	5 17:30)					
	1. Waste management of Davao	Engr. Elisa P. Madrazo					
	City	City Environment and Natural Resources					
		Office (CENRO)					
	2. Waste composition survey	Students of University of Mindanao					
	3. National policy on	Engr. Eligio T. Ildefonso, MPA, MEMD					
	waste-to-energy	Executive Director, NSWMC					
	4. Result of feasibility study	Mr. Noboru Kawai					
		Nippon Steel & Sumikin Engineering Co.,					
		Ltd.					
		Mr. Yasumitsu Kondo					
		Kitakyushu-city					
	5. Open forum						
	Part 3: Closing (17:30~18:00)						
	Message	Hon. Louie John Bonguyan					
		City Councilor					
		Chairperson, Committee on Energy					
		Mr. Takahiro Morita					
		Senior Representative					
		JICA Manila Office					
	Closing remarks	Ms. Tomoko Dodo					
		Director & Consult,					
		Consular Office Davao.					
		Embassy of Japan in the Philippines					

#### Table 4-5: Outline of workshop

## 5 Overall Evaluation of the Project

# 5.1 Project Achievement (Contribution to recipient country, region, and city

The Project was implemented for the purpose of identifying the key conditions of WTE business development in Davao City through a series of fact-finding surveys and review of the current solid waste management mechanism as well as discussions with various counterpart organizations in Davao City. As a result, the Project prepared a schematic design of WTE facility, cost estimation, and a project development plan with its feasibility analysis for its submission as a project proposal to Davao City. The project finally achieved the planned goal and targets with official reception of the above proposal by Davao City.

### 5.2 **Project Activity Targets Achievement**

## 5.2.1 Achievements, remaining issues and further actions to be taken (by project activity tasks)

The table below summarizes the achievements, remaining issues and required actions by project activity tasks.

	Task	Time schedule (Actual)							Level of	Remaining issues and	
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	$4^{th}$	5 <sup>th</sup>	$6^{\rm th}$	7 <sup>th</sup>	$8^{\rm th}$	Achievement	required actions
		(PH)	(PH)	(PH)	(PH)	(JP)	(PH)	(PH)	(PH)		
1	Agreement on work plan									Completed.	
2	Identification of facility design conditions	••••		••••						Completed. (Schematic facility design prepared.)	Detail facility design, quantity survey, and detailed cost estimation
3	Identification of WTE business development conditions	••••		••••	••••					Completed. (WTE project plan prepared.)	Further activities for plan implementation.
4	Increasing understanding on WTE technology					••••	••••	••••		Completed (Training program in Japan implemented.)	Reflection of the obtained knowledge to improvement of SWM (Preparation of WTE guidelines, etc.)
5	Official Recognition by Davao City on the proposed WTE Project development plan				••••					Completed. (Project proposal submitted and received.)	Continued discussions and negotiations with Davao City. Starting project preparation activities.

The project activities that have been conducted so far, including various surveys and project

promotions, produced the following achievements.

## a. Dissemination of understanding on waste-to-energy technologies among the relevant stakeholders in Davao city and the Philippines

Although waste incineration was recognized as prohibited by Clean Air Act (RA8749) in the Philippines, the Guidelines for Establishment and Operation of Waste-to-Energy Technologies for Municipal solid Wastes, which is currently in preparation by the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) and the National Solid Waste Management Commission (NSWMC), came out with new policy of promoting introduction of waste-to-energy technologies with proper incorporation of pollution control measures.

Under the situation above, our project activities, in collaboration with Kitakyushu City government made further efforts of promoting roles of Japanese waste-to-energy technologies in waste reduction and solution to the current serious solid waste management issues in the Philippines. A series of workshops and seminars on WTE and invitations of the relevant stakeholders of Davao City and Central Government such as DENR and NSWMC to the visits of WTE facilities in Japan produced a significant achievement in raising the correct understanding of WTE technology and building the consensus of introducing WTE technologies in the Philippines among them.

#### b. Confirming the necessity of WTE technology in providing solution to the solid waste management issue in Davao City and Clarification of the preconditions for WTE facility development

A series of surveys conducted under this project on the current state of solid waste management in Davao City revealed the following important findings for further promotion of WTE technology.

- The remaining capacity of the existing final disposal landfill is about to be exhausted in a few couples of year while acquisition of the land for new landfill becomes more and more difficult in Davao City. It is a critical issue to make a large scale reduction of waste, which is not able to be achieved immediately by the separated collection of recyclables and promotion of 3R and recycling in the limited scale under the increasing trend of waste generation. In this respect, it is crucial to introduce WTE technology in Davao City;
- The current amount and composition of municipal solid waste in Davao City basically meet the calorific value required for applying Japanese WTE technology.
   Furthermore, selective use of high calorific waste based on their segregated

collection from the generation sources will further increase the energy conversion rate (power generation efficiency) of WTE technology; and

Results of the survey on financial capacity of Davao City and interviews to the policy decision makers revealed that the capacity of the municipal government to cover the incremental cost of waste treatment with WTE technology is limited (Although no concrete figure was mentioned by any of the city government officials, it cannot afford to pay the tipping fee of far exceeding 1,000 peso per ton of waste treated considering the current financial capacity of the Davao City.) Income from selling the electricity is the key to secure the financially viable WTE facility development and operation in Davao City.

The above findings are the important preconditions for further elaborating the project development plan of WTE facility including project development schemes and financing measures. This project activities further clarified the issues to be addressed for implementation of our proposed WTE project.

#### 5.2.2 Current Issues /Actions to be taken for Project Implementation

This section compiles the current issues and strategies/actions to be taken for implementing the proposed WTE project.

Issues	Current conditions	Strategies/Actions
Issues Guidelines for Establishment and Operation of Waste-to-Energy Technologies for Municipal solid Wastes	<ul> <li>Current conditions</li> <li>Exchange of opinions on introduction of WTE technologies were carried out in the 1<sup>st</sup> Japan Philippines Environmental Policy Talk, which was held on October 27<sup>th</sup>, 2015.</li> <li>The guidelines is now under preparation.</li> </ul>	<ul> <li>Strategies/Actions</li> <li>Follow-up of the progress and contents of the guidelines as well as providing technical support and advice for proper selection of WTE technologies in accordance with the guidelines.</li> <li>The above support will further promote the high technology and operation standard of Japanese</li> </ul>
Feed-in-tariff for WTE based power generation	<ul> <li>It is confirmed that FIT price of biomass is to be applied for power generation from bio-waste (organic waste) while it is not sure whether the same price is to be applied to waste-to-energy based power generation including the utilization of non-bio (non-organic) waste.</li> </ul>	<ul> <li>WTE technology.</li> <li>The Philippines Government recognized that application of FIT for WTE based power generation will be examined when a concrete project proposal is officially submitted.</li> <li>The project will formulate the detailed project plan and make explanations to the relevant government authorities.</li> </ul>
Selection of Project location and securing the land	<ul> <li>There are still several candidate locations of the proposed project.</li> <li>No official process of site selection and land acquisition has started so far.</li> </ul>	<ul> <li>The project will start discussions with Davao City to determine the project location and reflect it to the project plan.</li> <li>Based on the determined project location, socio-environmental</li> </ul>

Table 5-1: Issues and strategies/actions required for project implementation

The Project for Promotion of Waste-to-Energy T	Technology in Davao	City, Republic of	f the Philippines
			Final Report

Issues	Current conditions	Strategies/Actions
		consideration required and other basic conditions for project plan formulation will be identified.
Basic preconditions for implementation of the proposed project (Term sheet of the proposed project)	<ul> <li>Preliminary project feasibility analysis was conducted for the WTE facility with the average daily waste treatment capacity of 450 tons and design power generation capacity of 7.3MW.</li> </ul>	<ul> <li>Considering the future increasing trend of waste generation and increasing the scale economy of WTE facility, the proposed waste treatment capacity of WTE facility is to be upgraded from 450 to 600 tons.</li> <li>Based on the determination of the project location, and the opinion of Davao City more detailed project development plan is to be formulated including project scheme, project income and cost estimations (initial investment), O&amp;M cost (including operation cost of SPC), risk allocation, financial plan, and so forth.</li> <li>The term sheet of the project is to be prepared for the purpose of negotiating with the relevant stakeholders on the specific conditions of the project.</li> </ul>
Project partners of the Philippines side	<ul> <li>Currently in discussions with some of the potential partners who have experiences in IPP project.</li> </ul>	• Start further discussions and negotiations after the review of the results of a full-fledged F/S.
Partnership with Kitakyushu City in promoting WTE technology	<ul> <li>Transfer of knowledge and experience of Kitakyushu City on Integrated solid waste management system to Davao City and other relevant government authorities through seminars/workshops and visits to the WTE facilities in Japan.</li> <li>Introduction of WTE facilities and public consensus building process in Japan for dissemination of correct information and understanding of WTE.</li> </ul>	<ul> <li>Providing support for disseminating sources separation of waste to increase power generation efficiency of WTE facility</li> <li>Providing support for public consensus building on WTE facility development.</li> <li>Providing support in operation and maintenance of WTE facility.</li> </ul>

## 6 Business plan

### 6.1 Outline of the proposed project

#### 6.1.1 Basic framework

The objective of the proposed project is to overcome the challenges that Davao City is currently facing with regard to waste management through establishment of a sustainable integrated waste

management system. This is to be achieved through decreasing the volume of the wastes to the extent possible at every step from waste generation to the final waste disposal. The principal components of the projects are (1) promotion of 3R and sorting at source and (2) efficient material and energy recovery from the sorted materials. These activities will minimize the amount of wastes to be disposed and contribute to environmentally sustainable development of Davao City.

The roles of different stakeholders in the proposed project is shown in the figure below.



Figure 6-1: Roles of stakeholders in the proposed project in Davao City

#### 6.1.2 Future waste flow

The future flow of municipal solid wastes in Davao City is projected as shown in the figure below.

The Project for Promotion of Waste-to-Energy Technology in Davao City, Republic of the Philippines Final Report



Figure 6-2: Projected future waste flow of Davao City

If the waste flow shown in the figure above is realized, the amount of wastes to be disposed in Davao City will reduce by 90% or more.

#### 6.1.3 Schedule of construction work

Design of the facilities will require approximately 1 year, and the construction work including civil works and construction of the incineration plant will require approximately 2.5 years. After construction is completed, half a year would be allocated for trial operation.

Year	1				2				3			
Quarter term	Ι	Π	Ш	IV	Ι	Π	Ш	IV	Ι	П	Ш	IV
Basic design												
Detailed design												
Civil works										1		
Construction of plant										1		
Trial operation												

Table 6-1: Schedule of construction work of the incineration plant

#### 6.1.4 Project scheme and project implementing body

The project scheme and implementation bodies for the waste incineration power generation project proposed by this Project would be as shown in the figure below. This project would be an important contribution to establishing the sustainable integrated waste management system in

#### Davao City



Figure 6-3: Project scheme of the waste-to-energy project

The proposed project scheme including information such as implementing bodies and financing methods is summarized in the figure below.

Item	Content
Project period	20 years
Capacity of the facilities	<ol> <li>Waste treatment facilities</li> <li>Treatment capacity: 600 tons/day</li> <li>Yearly days of operation: 320 days/year</li> <li>Waste reduction rate (by weight): Approximately 90 %</li> <li>Power generation facilities</li> <li>Power-generating capacity (to be sold): 9.73 MW</li> <li>Electricity to be annually sold: 74,688 MWh/year</li> </ol>
Initial investment	No descriptions in this section due to confidentiality.

Item	Content
Annual operation and maintenance (O/M) cost	No descriptions in this section due to confidentiality.
Financing method	<ul> <li>Finance by own capital: 30% of initial investment (to be shared between Japanese and Philippine companies)</li> <li>Finance by banks: 70% (to be financed by Japanese and Philippine banks)</li> <li>Interest rate: 7%</li> <li>Repayment period: 10 years</li> <li>Financial assistance from Japan: Assumed to be maximum 2 billion JPY</li> </ul>
Expected revenues	<ol> <li>Solid waste treatment fee (unit: 600 PHP/ton): 281 million JPY/year</li> <li>Sales from power sales (unit: 6.63 PHP/kwh which is the current sales price under the current FIT system for waste-to-energy facilities): Approximately 1,207 million JPY/year</li> </ol>
Others	<ol> <li>Depreciation period: 20 years</li> <li>Corporate tax: Exempted for 7 years after starting of operation, 10% after the eighth year (assuming Philippines Republic Act 9513 / Renewable Energy Laws 2008 is applied)</li> </ol>

#### 6.1.5 Project Risks and Countermeasures

This chapter discusses the risks that may arise in the process of implementing the proposed waste-to-energy project. The project proponents must properly address those risks to prevent them from arising in the project so that the potential negative impacts can be minimized.

#### a. Risks at the project preparation stage

The risks that could be expected at the stage before the actual construction, maintenance, and operation are expected as follows.

#### a.1. Risks involved in Environment Impact Assessment Procedure

The proposed project involves operation of the so-called "waste-to-energy facility" that is not just a power generation plant, but a waste treatment facility. As waste treatment facility in general is prone to generate concerns of people in the vicinity (not-in-my-backyard or NIMBY syndrome), it should be noted that building the consensus of local residents may require longer time and more compensation than expected. Particularly in the current situation that the project location is not yet identified, such possible risk should not be underestimated with no information of the conditions of the surrounding environment.

When compared to other municipalities in the Philippines, Davao City is relatively well aware of the necessity of waste amount reduction by intermediate treatment including application of incineration technology, however, a strong objection may arise from NGOs and resident organizations when the project itself is officially announced to start as repeatedly found in many other regions in the Philippines.

In the process of EIA, the project proponents, in collaboration with Davao city, should proactively transmit information that it will provide positive environmental and socio-economic effects to the surrounding environment and the residents in the neighborhood through environmentally intermediate treatment (waste amount reduction) of waste and energy utilization (power generation).

## a.2. Risks involved in land acquisition and obtaining business operation approval

Since the project location is not yet identified, the propose project has a significant risk of land acquisition. The project proponents must immediately start the discussion with Davao City to determine the project location so that the project preparation works such as applications for relevant business operation permits can be initiated.

#### a.3. Risks involved in financial arrangement

There are two risks in relation to financial arrangement of the project, i.e. equity investment in the project implementation body (Special Purpose Company: SPC) and project fund raising. The equity investment in the project will cover 20-30% of the initial investment of the Project while it will be shared by the Japanese consortium and the Philippines counterparts that will organize SPC. The percentage allocation of equity among them has to be clearly stated in the shareholders' agreement taking into account of the regulations and restrictions on foreign investment specified in the Philippines law. Especially where the project assumes a long-term project period with equity participation by Philippines partners, credit evaluation of local partners should be carefully undertaken. It is also necessary to consider what currency will be utilized for equity investment (local currency or foreign currency such as US dollar or Japanese Yen) to avoid/minimize the currency risk of the project.

As the project also expects loans from Japanese as well as Philippines banks, it is important to take measures so that the currency exchange risk and interest payment of the project are minimized by seeking for the possibility of loan by Japanese bank to be on a Philippine peso

basis and considering the selection of base currency for the project revenue.

## a.4. Contract Risks (Waste Management Service Contract and Power Purchase Agreement)

Long-term contract that can secure stable incomes from waste management contract service (tipping fee income) and power sales (electricity income) is the key to motivate the participation of private investment in the proposed project. As for the income from waste management contract service, it is essential that the guarantee for payment by the Davao City and/or the Philippines Government is clearly states in the contract related to the project. As for the income from power sales, in accordance with the Republic Act No.9513: An Act Promoting the Development, Utilization and Commercialization of Renewable Energy Resources and for Other Purposes of 2008, the Philippines has introduced so-called feed-in-tariff system since 2012. In this system, specific purchase prices are determined by the Energy Regulation Committee of the Philippines: ERC) for each power source. In 2014, revision of purchase have started, however, prices except for that of solar power have not been revised yet. The current feed-in-tariff in May 2016 is provided as shown in the table below.

Туре	Feed-in-tariff	Remarks			
	(PHP/kwh)				
Hydropower	5.90	Applied since 2012			
Biomass	6.63	Applied since 2012			
Wind	8.53	Applied since 2012			
Photovoltaics	8.69	Revised in 2014 and applied since 2015			

Table 6-3 : Feed-in-tariff for power generation from renewable energies in the Philippines

As to waste-to-energy facility, it is not yet confirmed which FIT will be applied although there are some examples in which the biomass FIT is applied to small-scale RDF generation projects as well as the methane capture and power generation project. In any case, discussions and negotiations with the relevant authorities on power purchase agreement need to be initiated at the earliest possible occasion, taking into account the time required for determining the detail agreement conditions.

#### b. Risks at the facility construction stage

#### b.1. Risks involved in completion of construction works

In implementing the construction works in developing countries, there are always the potential risks that they do not comply with the plan in terms of the time schedule, budget, and design specifications of the facility and equipment.

In the proposed project, Nippon Steel & Sumikin Engineering, the core member of the SPC, will be responsible for all the construction works based on an EPC (Engineering, Procurement, and Construction) contract; therefore, the risks involved in procurement of necessary materials and equipment in Japan and the Philippines can be avoided with its own well-prepared procurement plan.

However, especially the procurement of the materials and equipment abroad, there are still some risks such as the delay of arrival due to custom clearance and over-budget because of the import duties and value-added taxes levied at the Philippines border. Based on the close review of current relevant laws and regulations in the Philippines, the Project has to clarify all the potential risks of construction works and take necessary measures such as obtaining the available investment incentives and tax/duty exemption and reduction in collaboration with Davao City and the Philippines Government.

#### b.2. Risks involved in utility services

Ensuring utility services such as water supply, electricity, communication infrastructure, and so forth is one of the important factors to mitigate the risk that may arise in the construction stage.

To avoid this risk, the Project must have clearly defined utility services contract with the relevant authorities of Davao city as well as the Philippines Government while it will objectively assess the current conditions of utility services at the project location and surrounding area to take necessary measures against the services considered not sufficient for the project.

#### c. Risks at the project operation stage

## c.1. Risks involved in fuel (waste) procurement and the calorific value of waste

The propose WTE project includes risks of decline in project financial viability due to the change in its income and expense from the expected level e.g. the decrease in income arising from less amount of waste treated and/or electricity generated which cannot be attributed to the contractor, increase in expenses due to accidental malfunction of the machine and equipment, unexpected expense for maintenance of the facility, and so forth.

As to the project income, it is necessary to prepare relevant contracts such as waste management services and power purchase agreement by including some provisions to guarantee the minimum waste amount and the calorific value of waste, so that the minimum income to the project proponent will be guarantee.

Regarding the risk related to unexpected increase in expense, by making the project income / revenue structure viable in case contingency cost arise through keeping some financial reserve (Contingency cost-Physical contingency and Price contingency), a certain level of risk can be avoided. It is also useful to have some provision for compensation in related contracts by the order body in case unexpected additional expenses which are attributed to the order body arise.

As to force majeure such as natural disasters and environmental risks that can influence project viability seriously, the use of project insurance may be considered so that additional cost that may arises in such events are covered. However, in considering the use of insurance, it has to be noted that applying insurance to hedge any risk result in increase in the cost of SPC operation hence lower the project profitability. Therefore, careful consideration should be required according to the actual chance that such risk is likely to occur.

In addition, for PPP project, which is highly public in nature, and therefore considerably sensitive to the financial capacity of the local government, the guarantee/endorsement by the national government is essential in case of nonfulfillment of a contract by the order body occur.

#### c.2. Risks involved in operation of waste-to-energy facility

To mitigate the risk related to the operation of WTE facility, technical support by the experienced operators is needed to keep stable operation of the facility.

#### c.1. Currency exchange risk

In the proposed project, while most of the cost related to operation and maintenance of the project facility is to be settled by local currency of Philippines peso, the payment for EPC contract, waste management services, power purchase agreement, and bank loan may involve local as well as varying foreign currencies, hence pose a concern about exchange risk.

Proper management of the currency in the payment and settlement system is the key to minimization of the above risks in the Project. So-called "Exchange marry", in which a bank or company adjust the balance of different currencies based on their business payment and settlement schedule, and advance purchase of foreign currency are the examples of such measures.

Especially on the project incomes from tipping fees and power sales, the relevant contracts (waste management service contract and power purchase agreement) must have the provision on currency exchange rate such as periodical reflection of exchange rate to payment amount so that

the project income would not be sensitive to extreme fluctuation of currency exchange market.

#### a.1. Inflation risk

The proposed project is also facing the inflation risk during the period of construction as well as operation. All relevant contracts made by the project must have some clauses on how to address and reflect the inflation, including possible renegotiation of tipping fees and/or power sales price to be linked with the parameter to address the inflation (deflator), so that the potential inflation risk can be minimized.