FY2016 Project for Ministry of the Environment Japan

FY2016

Feasibility Study of Joint Crediting Mechanism

Project by City to City Collaboration

Waste to Energy Power Plant Project for Bali Province in Indonesia

Final Report

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JFE Engineering Corporation

Clean Authority of TOKYO

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Chapter 1 Investigation Overview

1.1 Background and Purpose of Investigation

In Asian countries with significant economic growth, increased population and improved standards of living cause an increase in waste generation and require appropriate waste processing. However in countries for which the waste processing system is undeveloped and immature, there is concern for the environmental pollution caused by inappropriate treatment of waste.

On the other hand, for Japan, who has improved advanced waste processing and recycling system technology, it is necessary to develop that technology for countries that are currently facing waste processing problems and achieve worldwide low-carbon society. At the 21st Conference of Parties to the United Nations Framework Convention on Climate Change (COP21) held in November 2015, all companies participated and the Paris Convention was adopted, becoming a fair and effective framework and announcement of forming early and steady global warming measures plan and taking measures for emission reductions and emphasizing the importance of city-to-city collaboration. Also, at the 22nd Conference of Parties to the United Nations Framework Convention on Climate Change (COP22) held in 2016, Japan gathered 16 countries who signed in a Joint Credit Mechanism (JCM) at the Fourth JCM Partner Country Assembly for the market mechanism that is an important pillar of the Paris Convention. There, representatives of the 16 countries and JCM's progress, including issuing JCM credit, were welcomed and JCM's further promotion confirmed.

Therefore, this investigation is to evaluate the feasibility of the JCM project based on achieving city-to-city collaboration for a low-carbon society, partnering with Clean Authority of TOKYO, who has that know-how, providing guidance of appropriate waste processing for municipal waste in SARBAGITA, Bali, Indonesia to achieve a resource circulation society.

At the local site, lifespan of the existing landfill site is getting tight and it is currently difficult to secure a new landfill site with Bali's geographic limitations. Therefore, this investigation evaluates the feasibility of this business under the premise that a power generation by waste plant would be introduced, facilitating appropriate waste treatment and improvement of the demand for electric power that Japan already has.

1.2 Business Feasibility

1.2.1 Current state of target regions

Bali is approximately 950 km from Jakarta, the capital of Indonesia, located on the East side of the island of Java. Denpasar is the capital of Bali located in southern Bali. It is located in the middle of the Lesser Sunda Islands. The area of Denpasar is 123.98 m^2 and as of 2005 the population was approximately 570,000, but this increased to approximately 800,000 in 2011 with a recorded population growth of at least 6% per year.

In Denpasar, municipal solid waste (hereafter MSW) is landfilled in the TPA Suwung landfill located in Denpasar with approximately 800 to 1,000 tons of MSW per day. The economy in Bali is growing greatly and with the accelerated increase in economic development and population, there is also an increase in the total municipal solid waste. The lifespan of use of this landfill site is coming to an end which is calculated at 5 years or less. Denpasar also has geographic restrictions so it would be difficult to secure a new landfill site. Bali is one of the leading tourist destinations in the world, centered around Denpasar, the capital of Bali and the economic development is outstanding compared to other states in Indonesia. The growth rate of total gross produce (hereafter GRDP) over the past five years for the state of Bali reached an average of 5.5% and the state is heavily dependent on the tourism industry, the main industry, accounting for approximately 50% ratio of this GRDP. Due to the strain on the final disposal site, in the event that environmental pollution occurs due to the waste disposal problem, the damage to the tourism industry on the island will also be great. It is easy to imagine the detrimental economic loss to the state of Bali if, for example, the tourism industry declined due to environmental pollution caused by the waste processing problem. Therefore, resolving the problem of waste processing in the state is an urgent, pressing issue and needs to be resolved quickly.

Therefore, as a policy to resolve the problem Denpasar is facing of a final disposal site, introducing a waste to energy plant is an effective resolution to the problem that will reduce volume of waste and the feasibility of this project is extremely high.

Figure1.1 Position of Bali

Figure1.2 Current situation of TPA Suwung landfill (As of August 2016)

Figure1.3 Current situation of TPA Suwung landfill (As of August 2016)

1.2.2 Enactment of the Indonesia Presidential Decree and Feed-in Tariff revision

Indonesia has the largest population in ASEAN and the fourth largest population in the world with 230 million and approximately 200 million tons of waste are disposed per day (of which approximately 100 million tons are MSW). The MSW in the country is being disposed on land in the final disposal sites mentioned above, but with the accelerated economic development and population increase, the final disposal sites of the metropolitan suburbs are currently being strained. Under this situation, the central government enacted the Waste Management and Public Cleansing Law in 2008 and decided to close the final disposal sites where open dumping is taking place will be closed within 5 years. However, closing of the final disposal sites are not going according to plan and considering the current state, the Presidential Decree (Ref: NOMOR18/TAHUN 2016/hereafter Presidential Decree No. 18) was announced in 2016 and there is now an obligation to dispose of waste by incinerating. Power generation by municipal waste is clearly defined as "generating power through heat treatment techniques such as gasification, incineration or pyrolysis by using municipal waste-based renewable energy" in Presidential Decree No. 18, Item 3, clarifying Indonesia's policies on MSW treatment. Also the feed-in tariff for waste to energy was revised in 2015 and purchase price for waste to energy was uniformly raised from IDR 1,450/kW (USD 11.5 cents) to USD 18.77 cents/kW. Development and revision of this type of legal system are considered to be great contribution to achieving projects and promotion of waste to energy plants in the country. Even in Denpasar, Bali, thanks to the Presidential Decree No. 18 mentioned above and feed-in tariff improvements, opportunities for a waste to energy plant project has improved and there are high expectations for realizing the waste to energy project by the Denpasar government officials. Also, while Navigat (hereafter NOEI: Navigat Organic Energy Indonesia), a local private corporation, was approved to run a methane fermentation power generation system at the Suwung landfill in the same city by Denpasar in the past, the project was aborted without running the equipment once. Based on past failures, the Denpasar government officials are focusing on "technical reliability" and "an elaborate business plan based on implementation of F/S" and recognize the importance of high quality infrastructure.

1.3 Investigation Contents

The investigation and implementation contents in this investigation are laid out below.

1) Understanding of the social/economic situation

Collect new, local information based on the Incubation and Overseas Promotion of Japanese Waste Management and Recycling Industry in 2014, Waste to Energy Project for SARBAGITA in Bali, Indonesia, Environmental Baseline Survey and reconsider the content. For collection of new, local information, get the cooperation of local companies and continue collecting information rapidly and effectively.

2) Legal system investigation

Collect new, local information based on the Incubation and Overseas Promotion of Japanese Waste Management and Recycling Industry in 2014, Waste to Energy Project for SARBAGITA in Bali, Indonesia, Environmental Baseline Survey and reconsider the content. The various standards, especially the flue gas emission standards required for plant planning, shall be determined after agreement with SARBAGITA Solid Waste Management Agency. Also, accept the advice of the Ministry of Environment and Forestry.

3) Planning of waste to energy plant

Examine the appropriate waste treatment method based on 1 and 2 above. Implement the schematic design of the plant for the considered waste treatment method. Schematic design creates appropriate process flow, material balance and layout using past waste to energy plant construction achievements. Also estimate the construction and operational costs and use it as the base for evaluation of feasibility.

4) Evaluation of feasibility

Evaluate profitability using the construction and operation costs estimated in 3 above. Also, quantitatively evaluate reduced effects for the burden on environment and perform a comprehensive evaluation and judgment of feasibility of a low carbon society.

5) Business plan drafting

Prepare business project in order to make the feasibility more concrete.

6) MRV Methodology plan creation

By introducing the waste incineration facility in this proposal, reduction of methane (CH4) and greenhouse effect gas emission in place of fossil fuel power from the landfill, and appropriate waste treatment are achieved. Effectively create an MRV methodology plan by utilizing an external consultant with a lot of experience in creating plans.

7) City-to-city collaboration

Introduce Japanese advanced technology and explain Tokyo's waste treatment management operation methods and international cooperation arrangement. Contribute to improvements of the waste processing management at the SARBAGITA Solid Waste Management Agency in the region being investigated and reinforce the partnership between cities.

1.4 Organization Chart for Investigation

An organization chart of this investigation is shown in Figure 1.4. The JFE Engineering Corporation as an operator works together with the Clean Authority of TOKYO as a municipality through city-to-city collaboration. Also, JFE Engineering's overseas subsidiary, PT. JFE Engineering Indonesia, as an operator, is getting a grasp of the local situation and investigating the legal system.

Furthermore, with the possibility of forming an SPC with the expectation of implementing the PPP project, dialogue has advanced with Japanese major trade companies and local Indonesian companies as developer candidates. Also there were meetings about the possibility of working with local Indonesian Engineering companies as EPC partners.

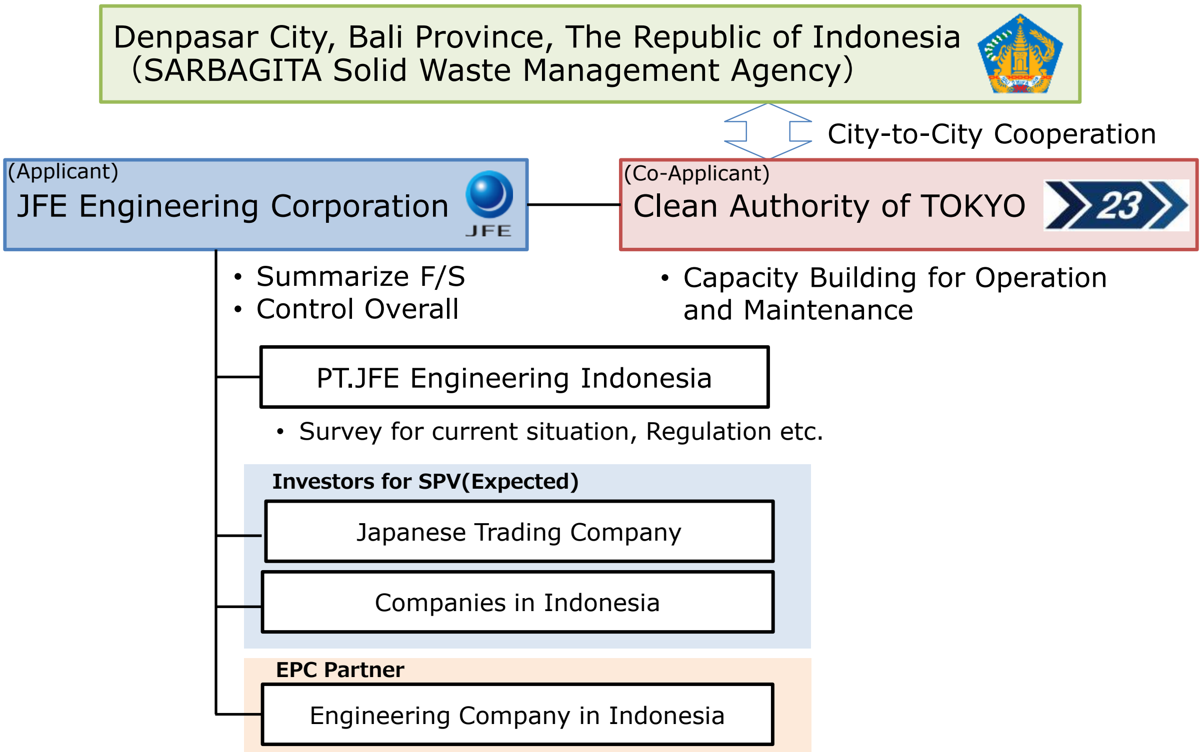
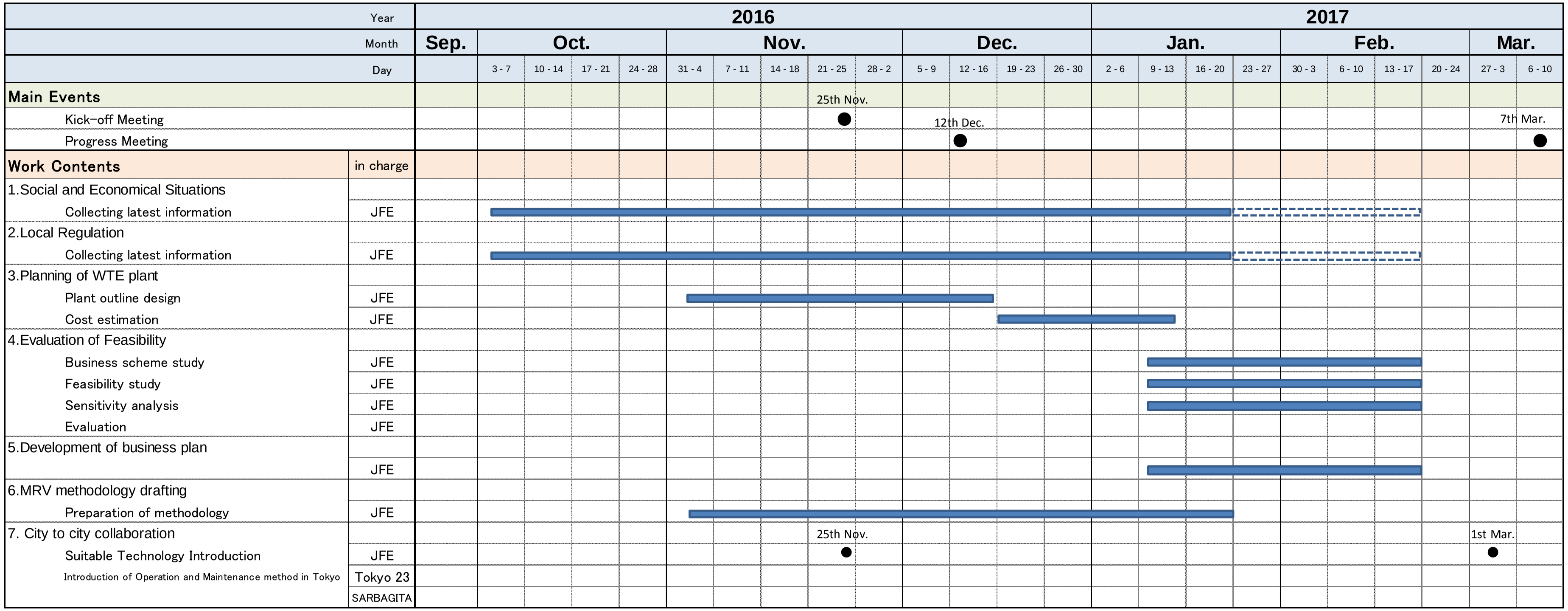


Figure 1.4 Organization chart for investigation and role

1.5 Investigation Schedule

The implementation schedule of this investigation is shown in Table 1.1.

Table 1.1 Implementation schedule



JFE: JFE Engineering
Tokyo23: Clean Authority of TOKYO
SARBAGITA: SARBAGITA Solid Management Agency

Chapter 2 Current Survey in the Target Region

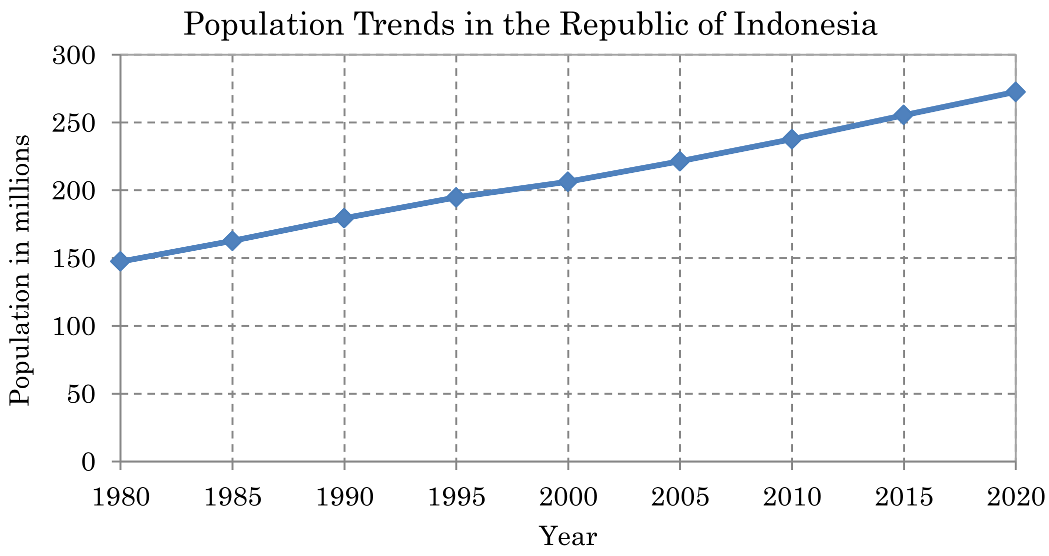
2.1 Social and economic situation

2.1.1 Overview of the Republic of Indonesia

Republic of Indonesia is located in the south-east part of Southeast Asia with 17,508 islands. It is bordered by Pápua Nèw Guínea, the Democratic Republic of Timor-Leste, Malaysia, the Republic of Singapore, the Republic of the Philippines and Australia. As of 2014, it has the population of 250 million and is the fourth most populous country on earth. As more than half of the population lives in the Java and Bali districts, the economic activities are concentrated in the areas.

From the 17 century and onwards, Indonesia was under the colonial rule of the Netherlands, etc. but it gained independence after the Second World War. It is a multi-ethnic country consisting of 300 Malay ethnic groups, and there have been religious and ethnic conflicts now and then.

Concerning the industry, other than agriculture, such as rice, coconut and tea, the country is rich in mineral resources of oil, natural gas, bauxite and tin. Regarding the economic growth rate, Indonesia had a negative growth due to the Asian currency crisis in 1998. However, after that, the state's economy has been steadily gaining speed, and now they are the leading country in the ASEAN, being the member of the VISTA bloc (Vietnam, Indonesia, South Africa, Turkey, and Argentina), a group of emerging markets following the BRICs, and the Headquarters of the VISTA is located in Jakarta, the capital of the country. The President Joko Widodo, who was elected in 2014, has been expressing his intention of focusing on the development of infrastructure since the inauguration.



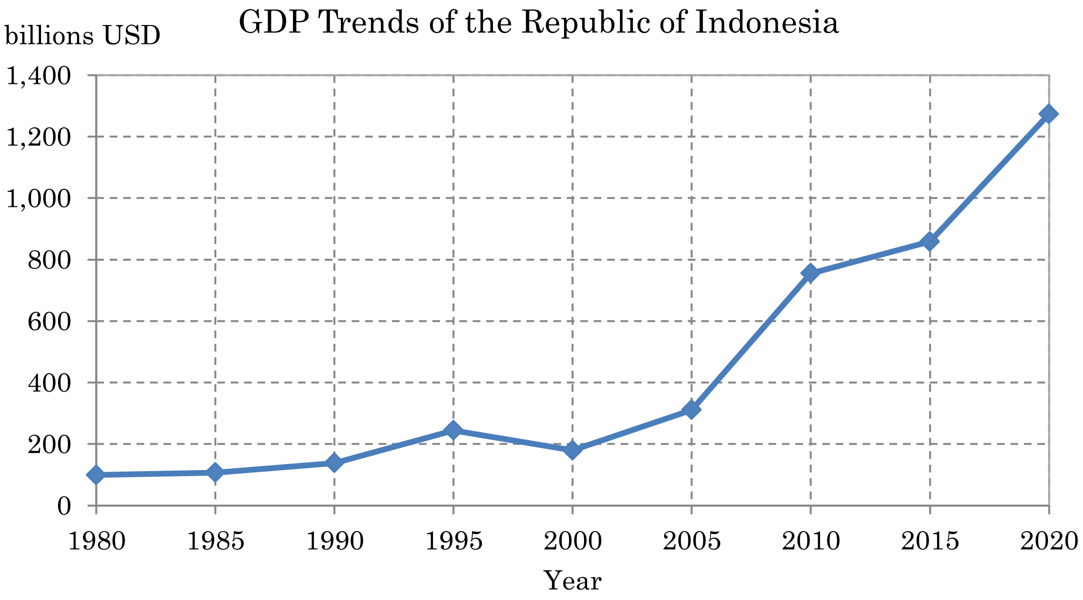
Source: IMF World Economic Outlook Database

Figure 2.1 Population trends of the Republic of Indonesia

2.1.2 Overview of Indonesian economy

Republic of Indonesia is the largest economic power in Southeast Asia, and its Gross Domestic Product (GDP) is about 87 trillion yen (in 2013). Indonesia was affected by the Asian currency crisis triggered by the devaluation of Thai baht in 1997, and was stagnated for a while, however, after that, the country recorded stable economic growth with an annual rate of about 6 percent. Compared to the other ASEAN nations, its economic growth has been remarkable.

Indonesian economy used to be supported by the resources industry such as oil exports for a long time. Especially in the 1970s and 1980s, oil exports accelerated the economic growth of the nation, and then, the nation became the net importer of oil in 2004. The Indonesian economy is now going through changes, shifting from the economy based on the exports of resources in the past to the one supported by its manufacturing industry and investments.

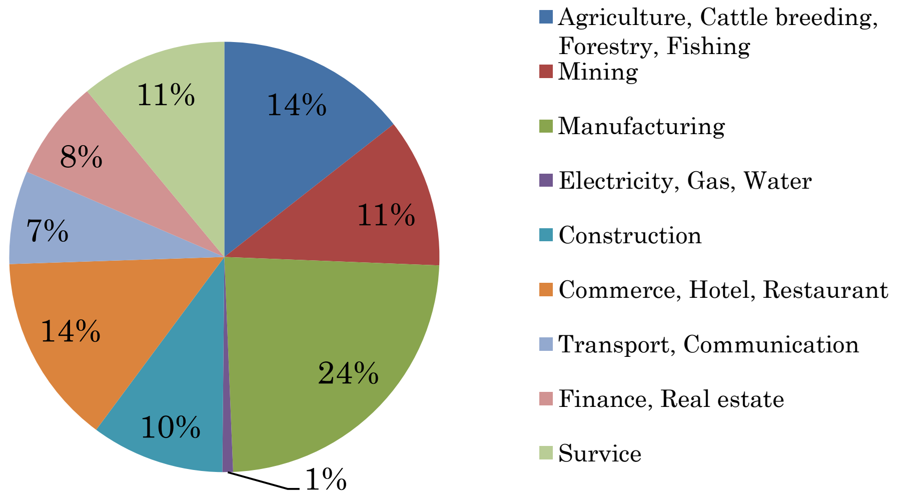


Reference: IMF World Economic Outlook Database

Figure 2.2 GDP trends of the Republic of Indonesia

Remarkable economic growth in the Republic of Indonesia can be evaluated as creating employment opportunities, increasing public expenditure in the areas of health, education and infrastructure, solving poverty as a result. However, according to the investigation of actual conditions by the Government of Indonesia, there are people who live below the poverty line of the nation, the monthly salary of Rp 275,779 ($21.20), and this group still accounts for 11.47 percent of the population, and the relative poverty rate is not low. This number is a decline from 23.4 percent in 1999, however, 27 million people are still in the poverty.

The Indonesia is a middle income country, achieving remarkable economic development and population growth, and its challenges are to ensure stable energy sources in the future. If the Indonesian economy continues to grow at the same level as now, the energy demand in the country will increase at a rate of around 8 percent every year, and in the period between 2010 and 2030, the electric power demand will be three times higher according to the estimate of the Ministry of Energy and Mineral Resources.



Source: Statistics Indonesia

Figure 2.3 Composition of Gross Domestic Product by Sector

2.1.3 Electric powers in the Republic of Indonesia

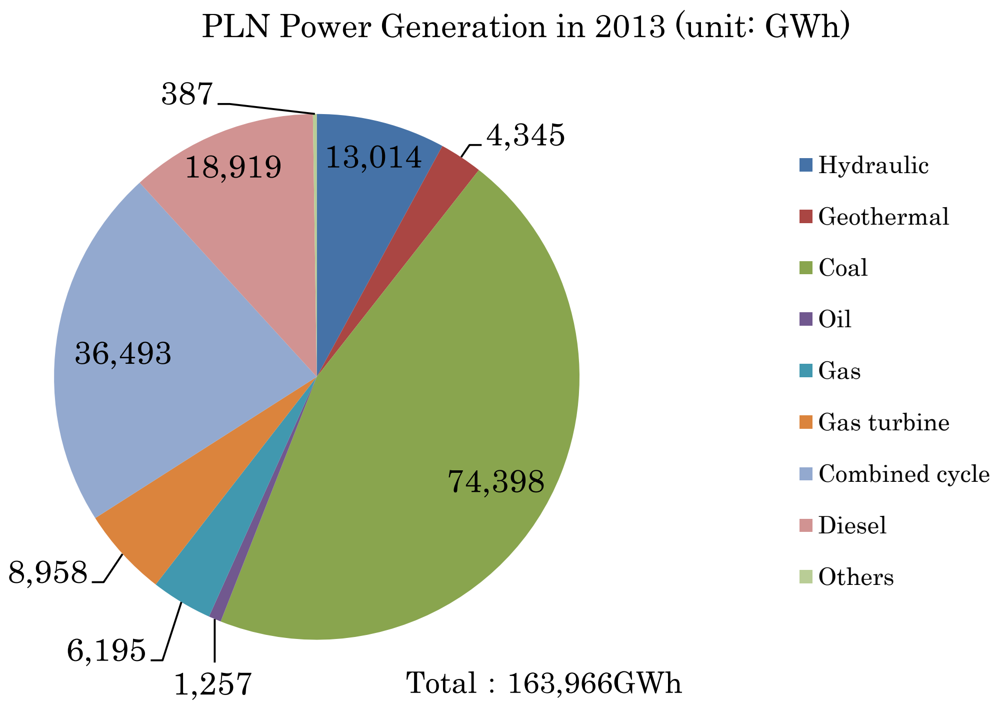
2.1.3.1 Energy resources

The Ministry of Energy and Mineral Resources in Indonesia confirmed that the nation has reserve of 120 billion tons of coal, the reserve of 3.6 billion barrels of oil, and the reserve of 101 trillion cubic feet of natural gas. These are confirmed reserves at present, suggesting that oil reserve-production ratio is 23 years, the reserve-production ratio of natural gas is 59 years, and the reserve-production ratio of coal is 146 years. Republic of Indonesia is rich in renewable energy resources in addition to fossil fuel. Thus, it is assumed that the scale of potential market in renewable energy market is extremely large. The amount of potential resources in renewable energy is as follows:

1) Hydroelectric power (75,000 MW)
2) Micro hydropower (1,013 MW)
3) Solar PV (4.8 kWh/m^2/day)
4) Biomass (32, 654 MW)
5) Wind power (3-6 m/s)
6) Geothermal (28,000 MW)

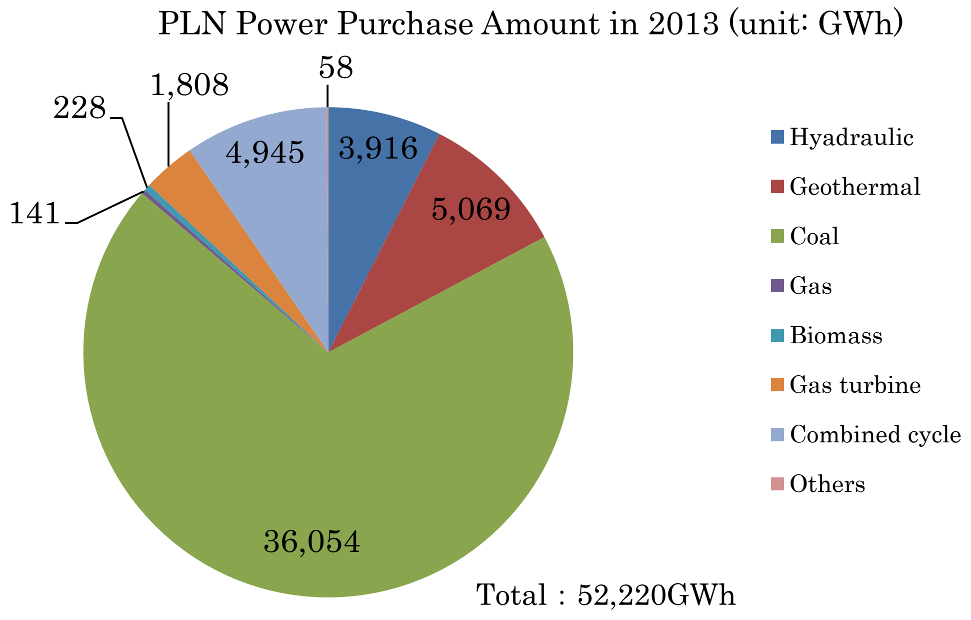
2.1.3.2 Energy balance

Regarding electric power supply and demand in the Republic of Indonesia in 2013, the amount of electric power generated by the state-operated electric power corporation, Perusahaan Listrik Negara Persoro (hereafter referred to as PLN) is shown in Figure 2.4. The amount of electricity that PLN purchased from IPP or private power generation is shown in Figure 2.5. On the electric power supply side, the electric power of 216,186 GWh in total was supplied in 2013. On the other hand, according to the amount of electricity sold by buyer shown in Figure 2.6, the electric power demand was 187,541 GWh. This suggests that electric power supply was higher than the demand in FY 2013.



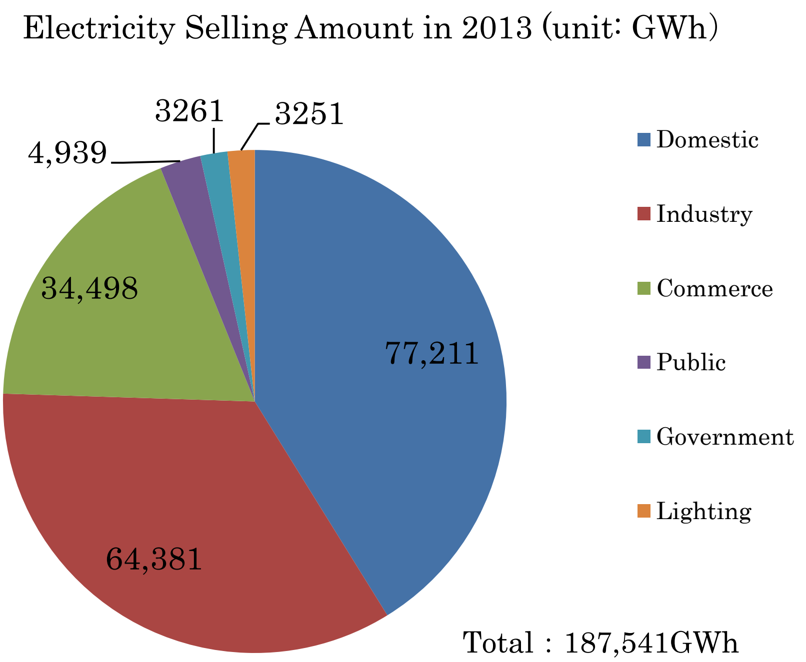
Source: Handbook of Energy & Economics Statistics of Indonesia 2014

Figure 2.4 Electric power generation by PLN (2013, unit GWh)



Source: Handbook of Energy & Economics Statistics of Indonesia 2014

Figure 2.5 The amount of electricity purchased by PLN from IPP and private power generation (2013, unit GWh)



Source: Handbook of Energy & Economics Statistics of Indonesia 2014

Figure 2.6 The amount of electricity selling by buyer (2013, unit GWh)

2.1.3.3 Energy supply and demand estimates

As of now, there is a balance between supply and demand, however, PLN estimates in the "Long Term Electricity Plan (2013-2022)" that the electric power demand is likely to grow at an annual average of 8.4 percent exceeding the estimated economic growth rate, and it is assumed that there is a need for new development of power sources in the future.

Table 2.1 Estimates of electricity selling in the Republic of Indonesia (unit % and TWh)

	Economic Growth Rate	Electricity Selling Amount
2013	5.8	189.0
2014	6.0	207.8
2015	6.9	226.8
2016	6.9	246.5
2017	6.9	266.0
2018	6.9	286.4
2019	6.9	308.0
2020	6.9	331.6
2021	6.9	357.7
2022	6.9	386.6

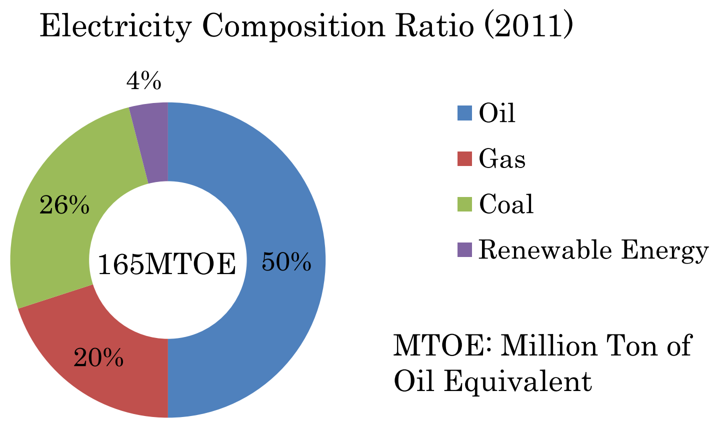
Source: Long Term Electricity Plan (2013-2022)

2.1.3.4 Renewable energy strategy

Energy strategy by the Government of Indonesia is provided in the National Energy Policy (KEN: Kebijakan Energi Nasional). In the Policy, the utilization of various energy sources, environmental sustainability and the maximum use of energy resources in Indonesia are stressed. The KEN was revised in 2014, and it set the targets of oil (25%), gas (22%), coal (30%), and renewable energy (23%) relative to the entire 380 Mtoe (million tons of oil equivalents) by 2025. As the background, concerning the energy by source in the Republic of Indonesia, as described in the energy by source (2011) in the below Figure 2.7, the fossil fuel power sources are extremely high, but the renewable energy is still low as 4 percent. Since the fossil fuel power sources cause high environmental impact, there is a pressing need to shift to the other power sources. Further, in recent years, with increasing protests from environment groups and local residents, it is getting extremely difficult to build new large coal thermal power plants, etc. One of the examples is a project of building a coal-fueled power generation plant in Padang. This was an equity co-investment project between a Japanese major trading company, IPP company and the PLN, and its construction was originally scheduled to start in 2012 and the commercial operation was to start in late 2016 in the initial plan. However, due to the combination of factors, such as citizens' lawsuits against land acquisition and the burden on the environment, etc., the project has been delayed significantly.

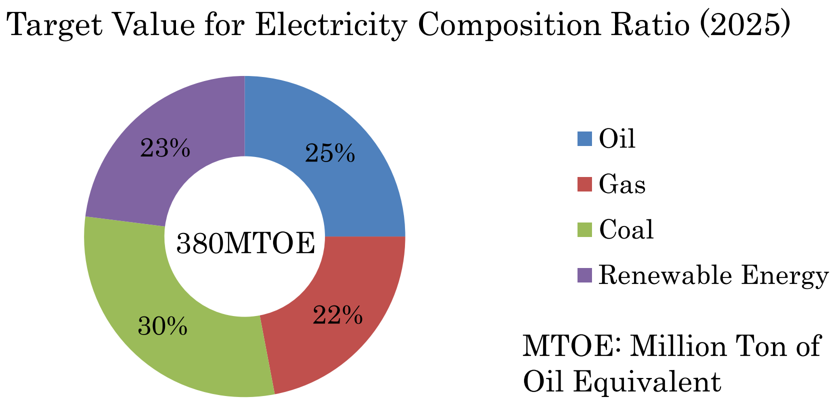
Figure 2.8 and Figure 2.9 show the current status and the future targets of the energy by source in the KEN. In comparison to the energy by source in 2011, the target ratio of renewable energy in 2025 is 23 percent (it was 4 percent in 2011). This suggests that the national energy strategic targets are to shift from conventional fossil fuel power sources by expanding the use of renewable energy.

Such targets in the KEN will be judgment criteria when the Government sets the energy policy. The Ministry of Energy and Mineral Resources and the PLN use these targets and are intended to spread renewal energy. With this, it is expected that this will be a driving force for spreading the waste-to-energy.



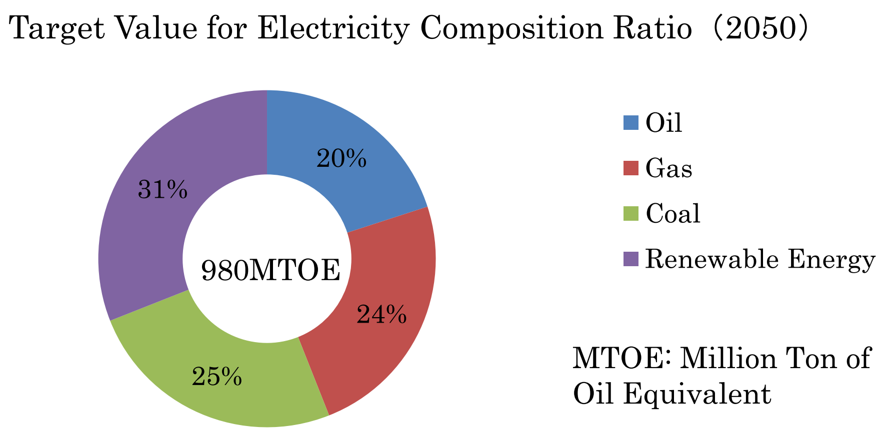
Source: ADB. Energy Sector White Paper. 2014

Figure 2.7 Electricity Composition Ratio (2011)



Source: ADB. Energy Sector White Paper. 2014

Figure 2.8 Target Value for Electricity Composition Ratio (2025)



Source: ADB. Energy Sector White Paper. 2014

Figure 2.9 Target Value for Electricity Composition Ratio (2050)

2.1.4 General aspects of Bali Province

Bali Province is situated between Java Island and Lombok Island. It is facing Bali Sea on the north side, the Indian Ocean on the south side, Selat Bali on the west side, and Selat Lombok on the east side. The Province includes the island of Bali, the largest island, with smaller islands of Nusa Penida, Nusa Ceningan, Nusa Lembongan, Serangan and Menjangan. The total area is 5,632.86 km^2. It consists of 8 Regencies (Jembrana Regency, Tabanan Regency, Badung Regency, Gianya Regency, Klungkung Regency, Bangli Regency, Karangasem Regency, and Buleleng Regency) and one City (Denpasar City). The capital of the Province is Denpasar City. As the lower administrative organization under Regencies and Cities, there are 55 Districts in total in all Bali Provinces. Bali Province has the population of about 3.89 million in total. The capital of Bali Province, Denpasar, has the population of about 835, 000[1]. It is on the increase from 789, 000 in 2010[2]. The population increase rate in the period between 2011 and 2013 in the entire Bali Province is 3.19 percent. Concerning the density of population, compared to 690 persons/km^2 in Bali Province, the concentration of population is rising in Denpasar city region: 4,170 persons /km^2 in Denpasar City, while 826 persons / km^2 in the neighboring Badung Regency.

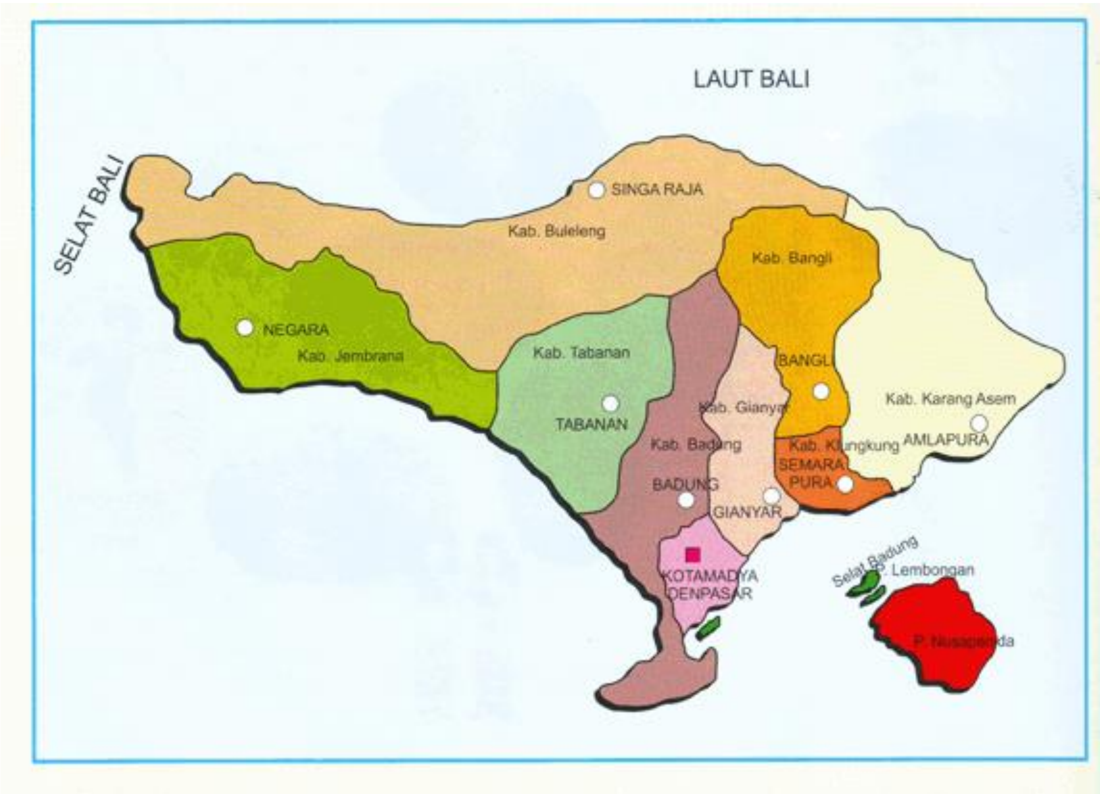


Figure 2.10 Map of Bali Province in the Republic of Indonesia

[1]Estimates by the 2012 census by Central Statistics Agency in Bali Province.
[2]The 2010 census by the Central Statistics Agency in Bali Province.

2.1.5 Overview of the Bali Province Economy

Gross Regional Domestic Product (GRDP) of Bali Province in FY 2012 was 33 trillion rupiah (about 280 billion yen) and its economic growth rate has been steady after the Asian currency crisis with the annual rate of 5.97-6.65％ in the period between 2008 and 2012. Also, by the industry, the tertiary industry accounts for 65 percent, followed by the primary industry of 19 percent and the secondary industry of 16 percent. GRDP per capita is about 825 dollars, which is 94 percent of the average in Indonesia.

Tourist industry is the most important industry in Bali Province, and in FY 2011, 7.65 million foreign travelers visited the place. The number of tourists does not get affected by the seasonal change, and the highest is in the dry season of July through September. Due to the development of tourism, there are many lodging facilities and restaurants in the Province. Of about 2.3 million workforce in Bali Province (2012), the majority of people work in the tertiary industry, which accounts for 52 percent. Then, it is followed by 26 percent in the primary industry and 22 percent in the secondary industry. The lowest wage is 967,500 rupiah (they differ depending on the regency), which is about 60 to 70 percent of the lowest wage in Jakarta City.

2.1.6 Electric power in Bali Province

Bali Province is classified as the Java and Bali in the PLN business region. Electric power demand from 2011 through 2021 in the Java and Bali is described in Table 2.2. It is expected that the demand is likely to increase to 259.4 TWh in 2021 from 120.8 TWh of 2011 with the annual average increase rate of 7.9 percent.

Table 2.2 Estimates for electric power demand and electrification rate in the Java and Bali

Content	2011	2012	2014	2016	2018	2020	2021
Energy Demand(TWh)	120.8	132.4	156.4	185.8	212.6	242.9	259.4
Growth Rate(%)	6.5	9.6	9.0	9.0	7.0	6.8	6.8
Electrification rate (%)	74.0	75.9	80.4	86.6	86.6	89.5	90.9

Source: Long Term Electricity Plan (2012-2021)

The plan of electric power supply by fuel type and fuel demand between 2012 and 2021 is shown in Table 2.3. In this period, the demand for coal will be more than double, and the demand for natural gas will be about 1.5 times higher. On the other hand, the demand for petroleum fuel will be reduced drastically. This is because that LNG will be the alternative to petroleum fuel.

Table 2.3 Composition of energy production by fuel in the Java and Bali

Fuel Type	2012	2014	2016	2018	2020	2021
Diesel	7,655	1,828	1,813	428	650	650
Marine Fuel	1,864	1,482	-	-	-	-
Gas	33,537	48,227	43,843	28,947	27,638	31,901
LNG	5,636	12,929	17,982	26,435	30,442	30,442
Coal	89,601	100,425	130,919	157,044	179,779	193,795
Hydraulic	5,273	5,273	5,807	7,891	8,425	9,162
Geothermal	7,953	8,401	11,651	21,948	30,371	30,371
Total	151,519	178,652	212,102	242,781	277,393	286,408

Source: Long Term Electricity Plan (2012-2021)

2.2 Natural environment

2.2.1 Weather in Bali Province

The Bali has a tropical marine climate. There are two seasons; dry season and rainy season divided by the transition period. The dry season is between the months of April and October, and the rainy season is between the months of November and March.

2.2.1.1 Temperature in Bali Province

The annual average temperature of the entire Bali Province in 2012 was 26.8 degC and it recorded 27.3 degC in Denpasar City. The highest temperature in the entire Bali Province was 27.5 degC in Buleleng Regency, and the minimum temperature was 19.7 degC in Tabanan Regency.

2.2.1.2 The amount of precipitation and humidity in Bali Province

Annual precipitation in 2012 was 1,767 mm. The maximum precipitation recorded throughout the year was 528.5 mm in March. In recent years, due to the effect of global warming such as the rise in the atmospheric temperature and the rise in the sea surface temperature, the precipitation pattern is changing in Bali Province, and the dry season and the rainy season come in a different cycle.

The average humidity of four observation points in Bali Province was 80.5 percent. The maximum humidity was 96 percent at the Karangasem observation point, and the minimum humidity was recorded as 27 percent at the Sangra Depasar observation point.

2.2.1.3 The percentage of sunshine in Bali Province

In 2012, the average percentage of sunshine in Bali Island was 69 percent. The lowest percentage of sunshine was recorded as 18 percent at the Karangasem observation station in January while the highest percentage of sunshine was recorded as 95 percent in October at the Sangra Denpasar observation point.

2.2.2 Topography and geology of Bali Province

2.2.2.1 Topography of Bali Province

In Bali Island, there are a range of mountains in the central part from east to west, with volcanic groups in between the mountains. The highest mountain in Bali is the Agung Mountain at an altitude of 3,142 meters. Additionally, there is a range of mountains includingthe Merbuk Mountain (1,356 meters) in Jembrana Regency, the Patas Mountain (1,414 meters) in Buleleng Regency and the Seraya Mountain (1,058 meters) in Karangasem Regency. Bali is geologically divided by these ranges of mountains into the northern part with narrow low lands with gentle gradient and the vast western area with steep gradient. In Bali Province, there are Bratan Lake, Buyan Lake, Tamblingan Lake and Batur Lake. Unlike the northern part, in the southern part of Bali, rivers are running through the low land, such as 62,500-meter Ayungtkad River.

2.2.2.2 Geological features in Bali Province

Concerning the geological features in Bali Island, it consists of mainly *Regusol* and *Latasol* (red soil), with slight mixture of the *Mediteran* and *Andasol layers*. There is *Latasol* stratum that is most subject to erosion across Kalopaks, Petemon, Langikit, and Punpatan in the western part, distributed across the Punu Mountain, the Pintu Mountain, the Juet Mountain, and the Surya Mountain, and it accounts for 44.9 percent in the Bali Island. There is a *Regusol* stratum that is easily subject to erosion from the eastern part of Amlapura to Tulik, from the Singaraja coast to Suririt, Bubunan, Kukulkan (near Tamblingan lake, Buyan Lake, and Bratan Lake), Batukal forest, Kusamba village in the south coast, Sanur, Benoa and a part of Kuta. This stratum accounts for 39.93 percent in Bali. *The Andasol* stratum can be found in a part of forest near the mountains of Baturiti, Chandikunin, Vanitatis, Gobleg, Pupuan, and Batucal. There is *Mediteran* stratum, which is slightly resistant to erosion across the hills of Jajiransapunida and the neighboring islands, Kutahill, and Prepattoago. Additionally, there is alluvium, which is highly resistant to erosion, across Negara, Sumberklampok, Manggis and Angada.

2.3 Current status of the waste treatment in the target region

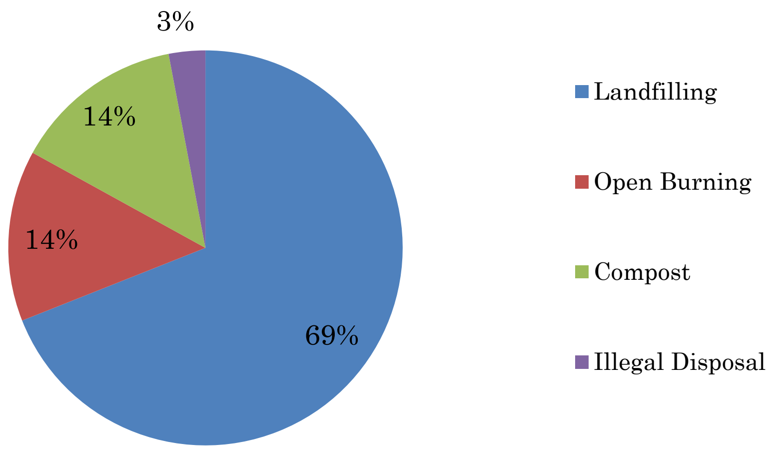
2.3.1 Flow of waste, the amount of production, collection and disposal

Regarding the amount of waste produced in the Republic of Indonesia, it is estimated to be about 80.3 million tons with about 2-3 liters a day per person, 440 million liters a day on the entire land, and 154 billion liters a year.

As to the details of waste, the percentage of organic waste related to food is higher in bigger cities. In major cities, such as in Jakarta, Makassar, Surabaya and Bandung, the organic waste accounts for 60 percent or more of the total waste. There are a lot of paper wastes as well, and it accounts for 10 percent or more of the total in most cities. On the other hand, there are a lot of plastic and rubber waste as well, which accounts for nearly 10 percent. Meanwhile, the percentage of non-organic waste varies depending on the city, at about 10 percent to 30 percent.

It is expected that the amount of household waste will increase accompanied by population growth. Providing that the annual population growth rate is 0.9 percent, it is assumed that the total population will grow to be 262 million in 2020, and the amount of waste generated per person will also go up. The amount of waste produced per person a day in 1991 was 0.7 kg, however, the amount was increased to 0.8 kg in 1995. It is assumed that the amount of waste generated will be increased to 0.91 kg in 2020.

According to the waste disposal methods in the Republic of Indonesia, about 70 percent of the total waste is disposed at Final Disposal Sites by Open Dumping land-filling. The Controlled Landfill has been applied to some Final Disposal Sites such as Jakarta and Bali Province, etc. However, due to the disposal of unhygienic and inappropriate waste, environmental problems are being revealed every year, associated with the rise in the amount of waste generated driven by growing number of people. The burning of a field and illegal dumping are also increasing, causing environmental problems in marine pollution and soil contamination.



Source: Indonesia Domestic Solid Waste Statistics, MoE, 2008

Figure 2.11 Waste disposal method in the Republic of Indonesia

Regarding the amount of municipal solid waste in SARBAGITA wide area, the amount of waste received at the Suwung Landfill (TPA: Tempat Pembuangan Akhir meaning Final Disposal Site in Indonesian language) in 2012 was recorded as about 800 tons a day, and it was about 300 tons a day in Denpasar City only. As there is no measuring instrument to measure the waste received, such as a track scale, at Suwung Landfill, the exact amount generated is not known. However, in conducting this feasibility study, we asked the Denpasar City Environment Bureau to provide data on the amount of waste received at the Suwung Landfill, and we confirmed the data. According to the record of the Denpasar City Sanitation Bureau, it is assumed that the amount of waste produced in Denpasar City in 2013 was 2,700 m^3 a day, and the amount of waste carried in by one local resident was 3.5 – 4 litter a day.

Figure 2.12 shows the amount of waste generated as well as the flow of waste disposal in Denpasar City based on the interview with the Denpasar City Sanitation Bureau for the implementation of the feasibility study.

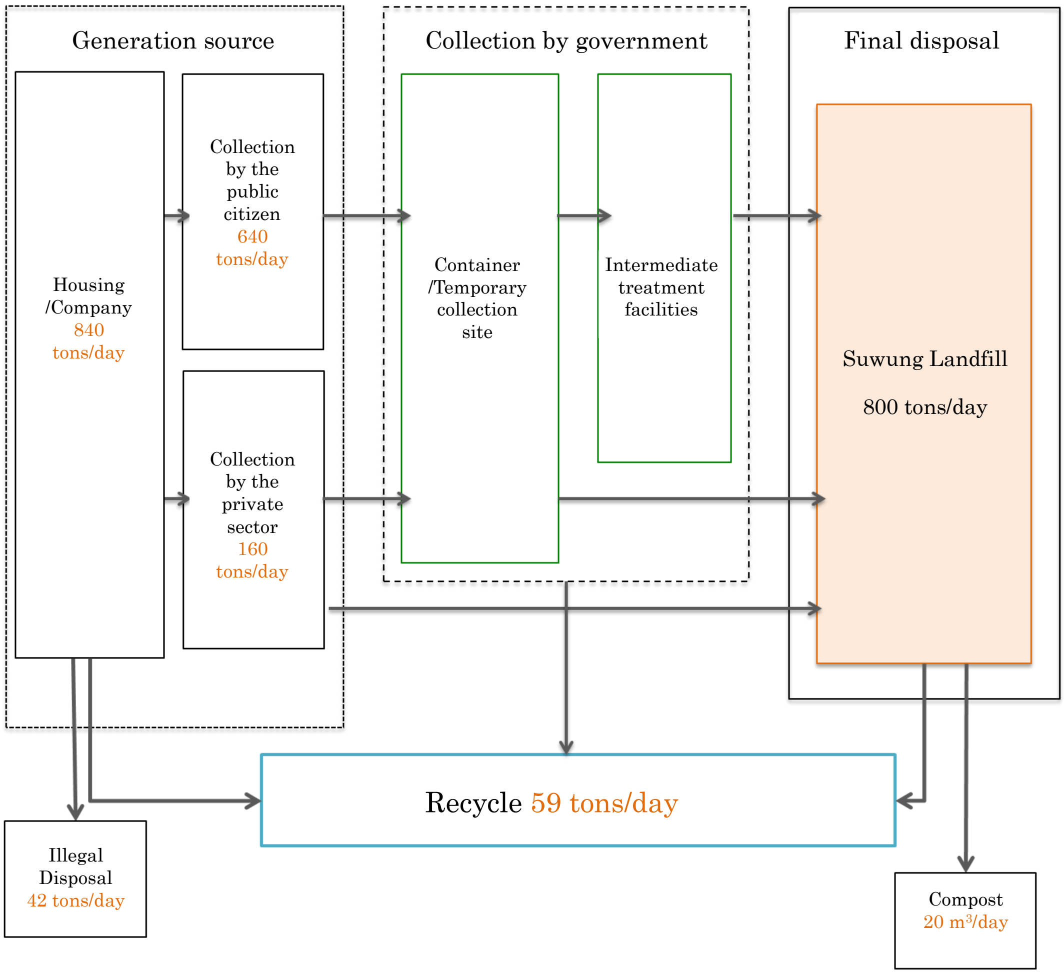


Figure 2.12 Flow of waste in Denpasar

Denpasar City Sanitation Bureau said that it was difficult to accurately assess the total amount of waste produced in Denpasar City because of rampant illegal dumping and the picking of the valuables at the place where waste was generated. Therefore, in this survey, using the data of receiving amount of waste provided by the Denpasar City Sanitation Bureau and the numerical values given through the interviews with the head of Denpasar City Environment Bureau and with other concerned parties, we calculated backwards from the ratio relative to the amount generated in each process that is assumed as the amount received at Suwung Landfill in 2012. With this, the total amount generated was estimated as 840 tons a day. Of the amount produced, it is assumed that 5 percent is illegally dumped. And the remaining 95 percent is brought to the Temporary Disposal Site (TPS: Tempat Pembuangan Sampah- meaning the waste disposal area in Indonesian language), or directly brought to the Suwung Landfill. Of the waste carried out, 80 percent is carried into TPS by residents or the collectors hired by the community in rear-cars or tricycle truck, etc. The remaining 20 percent is collected by private dealers to be received by TPS, and some of which are directly transported to Final Disposal Sites. At TPS, the waste pickers pick the valuables.

The waste received at the TPS will be transported to Waste Transfer Facility in the 35 vehicles of 6 m^3 owned by the Sanitation Bureau. The number of trips is four times a day. Waste transshipped at the Waste Transfer Facility will be delivered to the Suwung Landfill. Suwung Landfill is operated under the management of the SARBAGITA Solid Waste Management Agency, and in the site area of 32 ha, there are Open Dumping areas in five zones, and Sanitary Landfill in one zone (the Controlled Landfill Zone). The use of zones at Suwung Landfill is summarized in the below Figure 2.13. At present, Open Dumping Sites in Block II through Block V have been closed, and only Block I and the Controlled Landfill Zone (used only in the rainy season) are currently used.

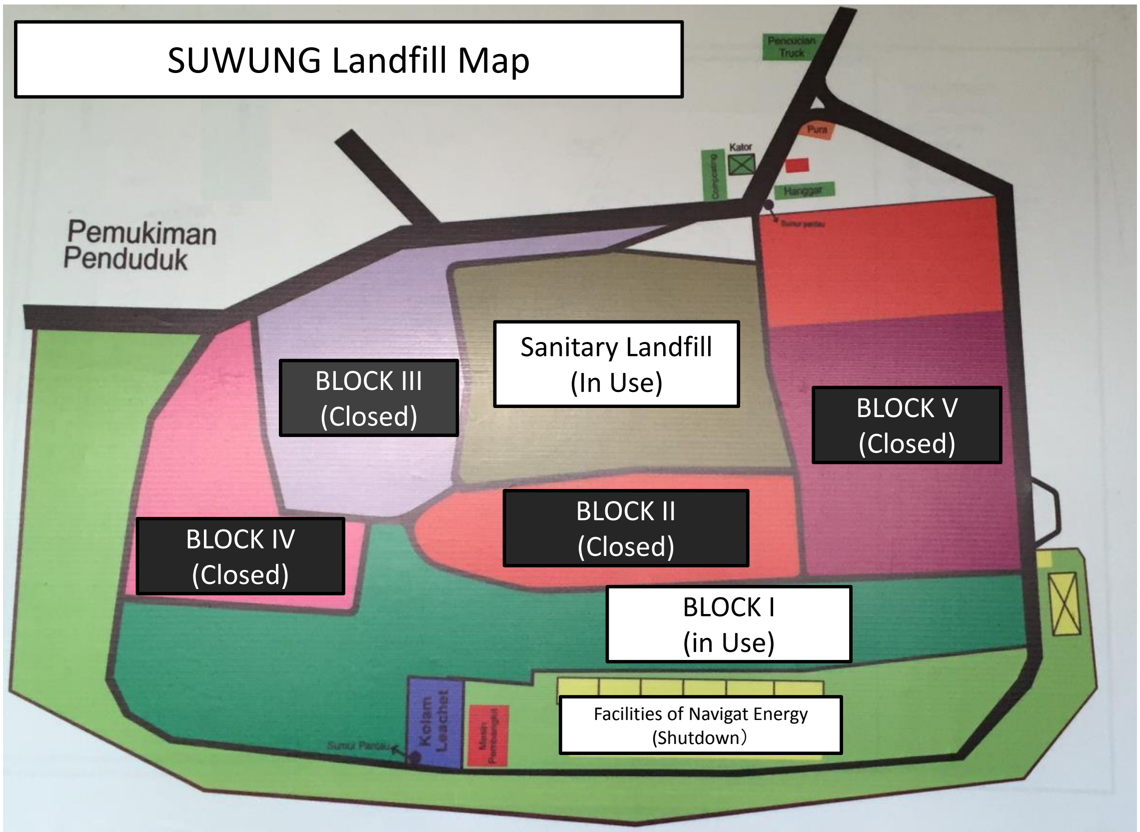


Figure 2.13 Overview on the zones of Suwung Landfill (as shown on site)

Figure 2.14 shows the Block I as of July 2016. As the waste accumulated is likely to collapse in rainy season, it is operated with the Sanitary Landfill (Figure 2.15) by keeping balance between Open Dumping and Sanitary Landfill. According to the Denpasar City Sanitation Bureau staff who manages the Suwung Landfill, the number of receiving waste trucks is about 500 units a day. About 800 to 1,000 tons of waste is carried in from SARBAGITA district. The remaining lifetime of the Final Disposal Site was reported to be about 3 to 5 years.

Figure 2.14 Block 1 being used for land reclamation (July 2016)

Figure 2.15 Sanitary Landfill

Denpasar City signed a contract with NAVIGAT(hereinafter referred to as NOEI: Navigat Organic Energy Indonesia) on the construction of methane fermentation facilities, and a part of the facilities was built by the NOEI. However, since it was concession agreement (contract) without treatment cost, it was difficult to ensure economic profitability, and the facilities were never used, and the contract was terminated in May 2016. At present, there are pretreatment facilities for separation (Figure 2.16), concrete tanks (Figure 2.17) and the gas engine building (Figure 2.18) within the Landfill Site.

Figure 2.16 NOEI facilities (they are assumed to be the pretreatment facilities for separation)

Figure 2.17 NOEI facilities (concrete tanks that look like methane fermentation tanks)

As in Figure 2.18, as of July 2016, there was the gas engine building built by NOEI company, and the accumulation of waste was not observed in the surrounding area. However, when we visited the area in November 2016, the accumulation of waste had collapsed, crushing the gas engine building. The accumulation of waste of about 1 to 2 meters high was observed even near the pre-treatment facilities.

Figure 2.18 July 2016 (the gas engine building on the right side of the photo)

Figure 2.19 November 2016 (the roof of gas engine building can be seen at the center of the photo)

Additionally, there is a City-operated Compost Center in the disposal site, where they compost organic waste that has been separated from the waste received. However, they say that the production is small, and it is about 20 m^3 a day. The compost produced is not sold, and is used for greening of the City, such as fertilizer for street plants, etc. for free.

Figure 2.20 Compost Center

2.3.2 Types and composition of wastes

According to the interview with the Denpasar City Sanitation Bureau, the amount of waste collected a year in Denpasar City in 2013 was 904,835 m^3, and the amount of waste collected a day is estimated as 2,479 m^3. Based on the investigation of the amount of waste and its characteristics in the local area, the bulk specific gravity of waste in Denpasar City was 205.6 kg/m^3. Based on these results, the unit requirement in Denpasar City with the population of 708,454 was about 0.719 kg per person a day. The unit requirement and the amount generated by the composition of waste are shown in Table 2.4.

Table 2.4 Unit requirement and the amount generated by the composition of waste

Contents	Composition (%)	Unit Requirement (g/person/day)	Generation (tons/day)
Organic	37.1	266.7	189.0
Pruning	17.7	127.3	90.2
Plastic	12.3	88.4	62.7
Paper	7.6	54.6	38.7
Diaper	6.7	48.2	34.1
Others	4	28.8	20.4
Fruit Peel	2.8	20.1	14.3
Rigid Plastic	2.4	17.3	12.2
Fiber	2.4	17.3	12.2
Magazine	1.7	12.2	8.7
Glass	1.6	11.5	8.2
Wood	1	7.2	5.1
Cardboard	0.8	5.8	4.1
Rubber, Leather	0.5	3.6	2.5
Iron	0.4	2.9	2.0
Drink carton	0.4	2.9	2.0
Newspaper	0.4	2.9	2.0
Styrofoam	0.2	1.4	1.0
Hazardous waste	0.1	0.7	0.5

2.3.3 Current status of collection and transportation, treatment and disposal and recycling

We will report the current status of waste management in Denpasar City, the main area of SARBAGITA district. In Denpasar City, there are rules that waste should be taken out between

17:00 and 19:00 every day. Local residents are required to take waste to containers near home or to the Temporary Disposal Site (TPS). The delivery from these places to Final Disposal Site (TPA) is under the control of the administration. Waste is carried out in either the individual collection by each household, or in the joint collection based on the group of 25 local residents. Then, the waste will be transported from the TPS to the TPA using the trucks of the Denpasar City Sanitation Bureau. There are seven TPSs / DEPOs (Waste Transfer Facilities) in Denpasar City, where transshipment is also carried out from TPS to the collection truck. At this stage, the valuables are separated in some areas. Waste will be carried into Final Disposal Site via TPS or Waste Transfer Facility.

Next, we will describe how waste is carried into Final Disposal Site: The delivery from SARBAGITA District to the Suwung Landfill is described in Table 2.5

Table 2.5 Delivery to the Suwung Landfill

No.	Origin of transporation to Suwung Landfill	Average derivery amount in 2012 (tons/day)												
		Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
1	Badung	81.11	71.92	63.28	66.49	57.41	55.96	58.40	62.50	71.31	54.65	57.60	59.30	63.33
2	Denpasar	366.55	353.92	307.31	302.22	255.31	271.98	261.80	288.70	235.83	281.57	275.66	258.30	288.26
3	Tabanan	11.00	10.63	9.82	11.30	10.21	6.68	12.48	9.20	6.30	9.90	6.63	6.21	9.20
4	Gianyar	–	–	–	–	–	–	–	–	–	–	–	–	
5	Collection Company	265.59	386.92	432.91	337.44	277.32	329.06	351.20	394.20	388.84	386.05	388.20	325.40	355.26
6	Unknown	72.43	82.34	81.33	71.75	60.03	66.37	68.39	75.46	70.23	73.22	72.81	64.92	71.61
	Total	796.68	905.73	894.65	789.20	660.28	730.05	752.27	830.06	772.51	805.39	800.90	714.13	787.65

Mainly, waste is brought in by Denpasar City, Badung Regency and business operators, and at present, the amount to be brought in from Gianyar and Tabanan Regences is small. However, they are considering delivering the waste of Gianyar Regency and Tabanan Regencies currently received at the other disposal sites to the Suwung Landfill in future.

2.4 Waste related legal system, policies and plans

2.4.1 Waste related legal system

As mentioned earlier, in the Republic of Indonesia, with rapid economic growth and increasing population, problems are being found in various places, such as the increase in the amount of waste as well as the diversification of the quality. In response to this situation, the Government of Indonesia, mainly the Ministry of Environment and Forestry and the Ministry of Public Works and Housing, are developing the policy and strategy for the optimum waste reduction and waste management methods based on the three R's (reduce, reuse, recycle) as well as working on the preparation of related legal systems, with the aim of changing the direction of waste management from “collecting and disposing” to “reducing and disposing.”

In the Republic of Indonesia, the core of waste management is the Act regarding Solid Waste Management. The Chapter 18 of the Act stipulates that government regulations and ministerial ordinances shall be set forth within one year from the enforcement of this Act, and the municipal ordinances shall be set forth within three years, and the details related to waste management shall be described as well. With this, the local governments responsible for waste management are required to develop the appropriate ordinances, stipulating the specific methods for reducing the amount of waste, separation, reuse and recycle for citizens.

The outlines of laws are shown below:

(1) The Act regarding Solid Waste Management (No.18 /2008)

The Act regarding Solid Waste Management is the new comprehensive legal restrictions set for municipal waste. Based on the Act, wastes are now classified into three types: household waste, household-like waste and specified waste. The household waste is a waste to be produced by general household. The household-like waste is a type of waste similar to “household waste” which is produced from commercial sectors, industrial sectors and public facilities. The specified waste is a waste that includes hazardous materials and waste during disasters. The Act stipulates that waste management should be carried out by the waste reduction and the proper treatment, and everyone must implement the waste reduction and the proper treatment in a way that suits the environment. The waste reduction is defined as waste minimization, reuse, and recycling, while the proper treatment is defined as separation, collection, transportation, intermediate treatment and final disposal.

The Act also requires the managers of the residential area, commercial area, industrial area, public facilities and social facilities to install the waste separation facilities. Additionally, the Acts provides the introduction of a licensing system in waste disposal business, requiring manufacturers to dispose of their products and packages as their responsibilities.

According to the Act, the Final Disposal Sites where open damping is conducted must be closed down within five years. However, as of February 2017, the shutdown of Final Disposal Sites where open damping is carried out is not competed, and there is no outlook for abolition.

(2) The Government Regulation regarding Management of House-hold Waste and Household-like Waste (No.81/2012)

This Government Regulation provides the details on the management of household waste and household-like waste based on the Act No.18/2008. The Regulation provides the development of waste management policy and strategy as well as the development of waste management master plan by local governments. Additionally, it stipulates the development and implementation of the waste reduction plan in the manufacturing processes and sales activities, the production of containers and packaging to minimize the amount of waste produced, the implementation of recycling program and the recommendation of reuse as the responsibility of the manufacturer. The Environmental Bureaus in Provinces are required to discuss with producers on the recommended use of decomposable containers and packaging under the cooperation of the Ministry of Industry.

The Regulations also provide the details on the separate collection of waste, the transportation and the final disposal, and the local governments' information on waste reduction for local residents, and public participation.

(3) The Act regarding Environmental Protection and Management (No.32/2009)

The Act provides environmental protection and environmental management, including provisions about greenhouse gas emissions reduction, the climate change adaptation and mitigation measures, and enhancing response skills to cope with the growing number of disasters due to climate change. In addition, in the Ministerial Ordinance No. 19/2012 developed according to the Act, the "Climate Change Village" Program (Program Kampung Iklim) is described. Under this Program, pilot project business are carried out for the collection of greenhouse gas emissions data from regions as well as for capacity development in order to achieve the greenhouse gas emissions reduction targets in the Republic of Indonesia.

(4) The Ordinance of the Ministry of Environmental (No.1/2009)

The Ordinance provides the items related to "ADIPURA Program" which is the environmentally advanced city competitive system. The "ADIPURA Program" was started in 1986 as the environmentally advanced city competitive system under the Environmental Management Act (NO. 4/1982), and cities with the population of more than 20,000 are participating in the Program. There are four items to be assessed in the cities under the system: Management aspect, Physical aspect, Public health aspect, and Open Green Space Amenity aspect. For waste related, waste management organizations in Management aspect as well as the preparation of waste management facilities in Physical aspect are also assessment targets.

(5) The Ordinance of the Ministry of Environment(No.13/2012)

The Ordinance provides the implementation of the three R's (reduce, reuse, recycle) through "Waste Bank." The "Waste Bank" is a community-based waste reduction program. Under this Program, with the support of the Ministry of Environment and Forestry, "Waste Bank" facilities are set up at the levels of RT (i.e. neighborhood unit) and RW (i.e. neighborhood block association consisting of several neighborhood units) in each district. Local residents voluntarily bring recyclable waste from each household to these places, which will be separated, measured, and sold to recycling operators.

In the entire land of the Republic of Indonesia, there are "Waste Bank" related facilities at 1,195 locations as of December 2012.

Figure 2.21 Waste Bank in Denpasar City

(6) The Ordinance of the Ministry of Public Works and Housing (No. 21/2006)

This Ordinance provides the national policy and strategy in the development of waste management system. The outline is as follows:

1) Targets

- Waste reduction for sustainable waste management.
- Expanding waste management service and improving the quality.
- Enhancing the roles of citizens and private sectors.
- Improving organizational structure and operation structure.
- Enhancing the financing.
- Enhancing the development and enforcement of laws.

2) Numerical targets for 2010

- Reducing the amount of waste by 20%.
- Providing the service to the 60% of population.

3) Policy and strategy

Table 2.6 Policy and strategy

Policy	Strategy
1. Waste Reduction at generation source	・Enhancement of the public awareness for 3R ・Development and implementation of incentive and disincentive for 3R ・Buildup of collaboration between sectors, especially industry and commerce
2. Enhancement of positive joining by the public and private sector as partners of waste management	・Enhancement of understanding for waste management through the primary education ・Spread of guideline and guidance for waste management ・Improvement of the training to community related to waste management, especially to women ・Promoting of community level of waste management ・Development of preferential treatment for private sectors
3. Expanding of service and improvement of quality for waste management	・Effective utilization of equipment ・Planning and expanding of service based on fairness ・Upgrading and expanding of equipment for the target of service expansion ・Landfill site care ・Conversion of landfill site to control dumping or sanitary landfill ・Enhancement of widespread final disposal based on urban area ・Study of proper technologies in consideration of environment
4. Development of organization and legal regulation	・Conversion to self-reliant agency or corporation for waste management ・Performance improvement of waste management agency ・Separation of regulation agency and implementation agency ・Enhancement of the collaboration between stakeholders such as government agency, develop, NGO, university and so on ・Human resource development of central government and local government related to waste management ・Enhancement of widespread waste management based in urban area
5. Securement of source of money	・Sharing the recognition of the priority of waste management by the decision makers of central and local government ・Enhancement of the awareness for feasibility of waste management

(7) The Ordinance of the Ministry of Public Works and Housing (No.3/2013)

This Ordinance provides the development of facilities for managing household waste and household-like waste. With this Ordinance, municipalities are required to establish the Temporary Disposal Site capable of performing the three Rs - reduce, reuse, recycle- (hereinafter referred to as

TPST-the 3R) as the facilities for collecting waste from the local community in residential areas, commercial areas, industrial areas, special areas, public facilities and other facilities.

At the TPST-3R, the separation collection of household waste, composting organic waste, recycling containers and packages, and the separate collection of hazardous waste (batteries and fluorescent) are carried out. The Ordinance states that the community based waste reduction activity, such as “Waste Bank,” can be also integrated into the TPST-3R activity.

(8) The strategy based on the three Rs by the Ministry of Environment

The draft strategy based on the three Rs by the Ministry of Environment is being developed mainly by the Institut Teknologi Bandung, with the assistance of the UNCRD and the IGES. The overview is as follows: The strategy based on the three Rs was to be announced officially as the Ordinance of the Ministry of Environment after its completion, however, as of now, it is not known when the strategies will be developed or enforced.

(1) Fundamental concepts

- Participation of manufacturers and the awareness of civilians are the keys.
- Municipal waste and industrial waste are resources.
- Those that produce waste shall be responsible.
- Changing the direction and the sense of values in the society from the End of Pipe to the approach based on the three Rs.
- Recycling is an economic activity.
- The activity based on the three Rs needs to be improved by monitoring and assessment on a continuous basis.

(2) Strategy

- Establishment of a new organization as advisory panel.
- Development of laws and policies.
- Development of technologies and information system.
- Enhancing the roles of stakeholders (the Central Government, the Government of Province, the Government of Regency and City, waste pickers, corporations, communities, and research institutes) and the alliance.
- Finance measures (based on the principle that the central and local governments are responsible for the three Rs of municipal waste, and those who carry out the waste are responsible for the implementation of the three Rs in the industrial sector).

- Promotion of international cooperation

As the action plan, for each period, 2009-2011, 2012-2013, and 2014-2017, the specific details to be implemented as well as the organizations for the implementation for the above strategy are described, and the targets are described in Table 2.1-7:

Table 2.7 Policy and strategy

Target year	2011	2013	2017
Urban waste related	・Enhancement of awareness of concerned parties ・Preparation of regulation and facility ・Accumulation of 3R know-how ・Formulation of 3R clearing house* ・Preparation of local regulation	・Recycle of 75% of plastic ・Effective utilization of 30% of un-recycled plastic waste ・Composting of 35% of urban waste ・Recycle of 30% of iron, glass and paper ・30% reduction of final disposal amount	・Recycle of 85% of plastic ・Effective utilization of 60% of un-recycled plastic waste ・Composting of 55% of urban waste ・Recycle of 45% of iron, glass and paper ・45% reduction of final disposal amount
Industrial waste related	・Development of nation's politics related to industrial waste 3R	・Recycle of 15 million tons of hazardous waste	・Recycle of 27 million tons of hazardous waste

*Clearing house is a service that enables the interactive use of data in various formats via multiple information systems.

(9) Environment Impact Assessment System - Analisis Mengenai Dampak Lingkungan Hidup (AMDAL)

The Environment Impact Assessment System/Analisis Mengenai Dampak Lingkungan Hidup (AMDAL) is based on the provision in the Article 15 of the Act regarding the Environmental Management in 1997 "business that may have significant impacts on the environment must implement environmental impact assessment" (the introduction is based on the Article 16 of the former Act regarding Environmental Management in 1982). In the "Government Regulation regarding Environmental Impact Assessment (No.15/1993)," the system was drastically revised by simplifying the initial screening process and enhancing the power of the Environmental Impact Management Agency/BAPEDAL) for the assessment of projects involved with several government agencies. After this, the Regulation was revised in 1999. (Government Regulation No. 27/1999). The

Government Regulation provides a list of target projects, AMDAL Assessment Committee procedure guidelines, the establishment of AMDAL Assessment Committee and Regional Committee, technical assessment guidelines and the procedure of public participation. Further, the type and scale of target projects or activities are stipulated in “the Ministerial Decree by the Ministry of Environment (No. 17/2011) regarding the type and scale of the projects or activities that require the implementation of environmental impact assessment.” At the stage of developing the method documents, business operators are required to discuss with residents, disclose the residents’ proposals, opinions and comments, disclose the details of the study by Assessment Committee to government agencies, and disclose information. On the other hand, residents have the right to obtain information and submit proposals, opinions, and comments.

(10) Presidential Decree (No.18/2016)

The Presidential Decree is intended to promote the construction of the municipal waste-to-energy facility in seven designated cities (Special Provincial District of Capital of Jakarta, Bandung City, Tangerang City, Semarang City, Surabaja City, Surakarta City and Makassar City) and the overview is as follows:

- To improve the quality of environment through the municipal waste-to-energy, and enhance the roles of new energy and renewal energy in the state-owned electricity supply, under the responsibilities of the local governments of 7 cities in the nation, the construction of the municipal waste-to-energy facility (the facility where municipal waste will be converted to electric power energy by gasification, incineration or thermal treatment technology by thermal fusion.) will be promoted from 2016 through 2018.
- Heads of seven cities may appoint a local government owned company or a private enterprise for building the municipal waste-to-energy facility.
- In the process of appointing a local government-owned company or a private enterprise, the seven cities shall ensure the implementation of the following:
  ① The use of municipal waste of at least 1,000 tons a day
  ② The use of location of the municipal waste-to-energy facility in the land allocation plan of Provinces and City.
  ③ Feasibility study from the perspectives of laws and regulations, organizations, financing, socio-culture, technologies, etc.

  Further, consultants can be hired for conducting the feasibility study.
- A local government-owned company or a private enterprise appointed, etc. (hereinafter referred to as “Companies Appointed, etc.”) shall need to satisfy the license for electric power business procurement. Companies Appointed, etc. will be granted with the license for construction

direction investment. The heads of relevant ministries and agencies, the relevant groups and the relevant local governments will support the license procedure for Companies Appointed, etc. and its simplification.

- The Minister of Energy and Mineral Resources will appoint the state-controlled electric power company, Perusahaan Listrik Negara - (PLN) as the one to buy electricity from Companies Appointed, etc..
- The sources of funds required for building the municipal waste-to-energy facility will be the national budget, the budget of local government and the other legal fund sources.
- The central government may provide subsidies to local governments for waste management cost. The provision of cost is regulated by the provisions to be stipulated after the coordination between the Minister of Home Affairs coordinating, the Minister of Finance and the related Ministers.
- Procedures for the procurement of land necessary for building the municipal waste-to-energy facility by the central government, local governments and Companies Appointed, etc. will be based on the regulations concerning the procurement of land for constructing public facilities.
- In building the municipal waste-to-energy facility, domestic products shall be used with priority.
- The heads of the relevant ministries and agencies, the relevant groups, and the relevant local governments will cooperate with each other through the control and supervision to promote the construction of the municipal waste-to-energy facility.
- The Team of Coordination will be established to support the construction of the municipal waste-to-energy facility. The Team of Coordination will play the role of coordination, supervision and support necessary for enhancing the smooth construction of the municipal waste-to-energy facility. The Team of Coordination consists of relevant ministries and agencies, with the Coordinating Minister for Maritime Affairs as Chairperson and the Coordinating Minister for Economic Affairs as Vice Chairperson. The details of the Team of Coordination will be stipulated by the Coordinating Minister for Maritime Affairs.
- The Team of Coordination will report to the President on the status of coordination regarding the construction of the municipal waste-to-energy facility every six months as well as when necessary.

Figure 2.22 Seven cities designated by the Presidential Decree No. 18/2016 and their waste volume

Concerning the above Presidential Decree No. 18/2016, according to the local newspaper dated 16 January 2017, due to the approach of environmental non-governmental organizations, the Supreme Court declared that the Decree is invalid. According to the Ministry of Environment and Forestry, there is still a need to further investigate the judgment and deal with the findings. However, there is no change in the direction of promoting waste-to-energy, and we obtained information that the Ministry of Environment and Forestry is now working on the revised Presidential Decree. Accordingly, it is assumed that the trend of enhancing waste processing by thermal treatment is likely to continue.

2.4.2 Other relevant legal systems

2.4.2.1 Spread of renewable energy

The details of laws and regulations related to renewable energy in the Republic of Indonesia are shown in Table 2.8. In the national energy policy delivered in 2014, the Republic of Indonesia set the goal of increasing the renewable energy ratio to 23% by 2025 in the energy by source, and to this end, the nation is working on various laws and regulations including the FIT.

Table 2.8 Laws and regulations related to renewable energy

Year	Policy
2006	National energy policy (KEN)
2009	New electricity law
	・New renewable energy
	・Constitution of secretariat of energy saving
2012	Ordinance of the Ministry of Energy and Mineral Resources No.4/2012
	・Establishment of waste to energy power tariff (1,050IDR/kWh)
2013	Ordinance of the Ministry of Energy and Mineral Resources No.19/2013
	・Amendment of waste to energy power tariff (1,798IDR/kWh)
2014	New national energy policy (KEN)
2015	Ordinance of the Ministry of Energy and Mineral Resources No.44/2015 号
	・Amendment of waste to energy power tariff (18.77UScent/kWh)

Further, Table 2.9 shows FIT price to be used for waste-to-energy stipulated in the Ordinance of the Ministry of Energy and Mineral Resources No. 44/2015.

Table 2.9 FIT price for the methane gas power generation technology

No.	Category	FIT Price (centUSD/kWh)
		Capacity <20MW
1	High pressure	16.55
2	Middle pressure	
3	Low pressure	20.16

Table 2.10 FIT price for the thermal treatment power generation technology

No.	Category	FIT Price (centUSD/kWh)		
		Capacity <20MW	20MW<Capacity<50MW	Capacity >50MW
1	High pressure	18.77	15.95	13.14
2	Middle pressure		-	-
3	Low pressure	22.43	-	-

The main issues and problems of the above current FIT systems in the Indonesia can be summarized as the two following points:

1) Regulations regarding the period of selling of electricity to a power company:
The Regulations do not provide the PPA (Power Purchase Agreement) period in the PPA (Power Purchase Agreement) with PLN, and according to the interview in the local area, the PPA (Power Purchase Agreement) period can change depending on the individual agreement with PLN. Normally, in nations such as Japan, Kingdom of Thailand, Singapore, where IPP business in waste-to-energy has been established, the waste-to-energy business period is usually around 20 to 25 years. For IPP business units, unless the period of selling of electricity to a power company is not secured at FIT price, it is difficult to decide business cash flow. Accordingly, it is not possible to establish IPP business.

2) Inadequacies in the central government's finance support for FIT
At present, there is no subsidiary system by the central government for the FIT system in the Republic of Indonesia, and the differential premium with other power sources is the responsibility of PLN. Accordingly, there is no incentive for PLN to purchase renewal energy at FIT price. When compared to cheaper power sources such as a coal-fueled power generation, the production cost of renewable energy is expensive. When compared to other fossil fuels power sources, the purchase price is comparatively high. This can deteriorate the PLN's financial situation. Under such circumstances, they are rejecting the purchase of electricity at FIT price. In addition, since there are no punitive provisions for PLN rejecting the purchase, it has been difficult to negotiate with PLN on purchase in many renewable energy projects as well as the waste-to-energy projects. To overcome this current status and develop renewable energy according to the national energy strategy as mentioned above, the incentive for PLN by the central government, such as financial assistance, is indispensable. With this, the development of the laws and regulations for finance assistance is expected.

As described in the Chapter 6, to establish waste-to-energy business in the Republic of Indonesia, if a private enterprise conducts the waste-to-energy business in PFI/BOT scheme on behalf of the local government as investors, more specific FIT system should be developed. In addition, it is necessary to ensure the fulfillment of a contract signed in the PPA. With this, it is assumed that there would be a case where the application of IIGF that corresponds to sovereign guarantee in the Republic of Indonesia to be detailed later in the section 2.4.2.3 may be necessary in forming Project Finance.

2.4.2.2 Outline of the Public Private Partnership (PPP) laws in the Republic of Indonesia

PPP system in the Republic of Indonesia is prepared mainly based on the Presidential Decree No. 67/2005. Content of the PPP Presidential Decree have been revised three times since the enforcement. (the Presidential Decree No. 13/2010, Presidential Decree No.56/2011 and Presidential Decree No.66/2013). Through these revisions, the government support framework was clarified, and with the Presidential Decree No. 38/2015 promulgated in March 2015 (hereinafter referred to as the "New PPP Presidential Decree"), the content of PPP system was drastically changed. Overview of PPP system in the Republic of Indonesia reflecting the changes are summarized in Table 2.11.

Table 2.11 Overview of PPP system

Category	Outline	Remarks
Sector	Transportation(airport, port, train etc.), road, irrigation, water and sewerage, waste water and waste material, information and communication, electricity and oil and gas related facilities, education facilities, social facilities such as hospital and public housing	
Selection of PPP business	・Solicited and unsolicited ・Verification and determination through the public hearing	・There are few unsolicited businesses.
Selection of developer	Selection of developer based on bidding process for both solicited and unsolicited. However, in the case of the followings, developer can be appointed directly. ① In case that the developer has already carried out the develop and management of the infrastructure ② In case that only the developer can introduce the new technology ③ In case that the developer has	

Category	Outline	Remarks
	acquired the all or most of land space at site.	
Implementation of the business	Concession agreement with contract owner of public side or providing business license by contract owner of public side	Financial closing shall be completed within 6 months from contract. However, extension of a deadline is to be provided to the owner as needed and the limitation of the number of extension of a deadline is not regulated clearly.
Contract owner of public side	・Central or local government, state-owned company (In case of contract owner of public side) ・Interregional business; Central government ・Specified stat-owned company by the sectors	
Main government support	・IIGF (government guarantee) ・VGF (government support for CAPEX) ・Appropriation of land based on the law ・Tax preference	

The followings are the main laws and regulations for PPP system in the Republic of Indonesia:

- The Presidential Decree No. 78/2010 on Infrastructure Guarantee in Public Private Partnership Provided Through Infrastructure Guarantee Fund (hereinafter referred to as "IIGF") as well as the Finance Minister Decree No. 260/2010 on the Implementing Guideline for Infrastructure Guarantees in Public Private Partnership;(the content of systems can be found in the section 2.4.2.3).

- The Finance Minister Decree No. 223/2012 for Viability Gap Funding (VGF) framework for PPP projects (see the section 2.4.2.4 for the details of the system).

- Law No.2/2012 concerning land acquisition for PPP projects and the related enforcement regulations.

  By the development of this Law stipulating the framework of the expropriation of land by the government organizations, it is expected that the issue of acquiring land for projects, which is the major bottleneck in infrastructure business in the Republic of Indonesia, will be mitigated.

- Presidential Decree Number 75 of 2014 concerning the Acceleration of Infrastructure Priorities Development (hereinafter referred to as the Presidential Decree for Enhancing Priorities").

  The Decree provides the checking of the land expropriation right of the government agencies who control the priorities stipulated in this Presidential Decree.

In addition, the Republic of Indonesia has established the following organizations with the purpose of promoting infrastructure business.

・IIGF(Indonesia Infrastructure Guarantee Fund)

The IIGF is an independent state owned enterprise 100% owned by the Government of Indonesia. It was established in 2009 to provide guarantees for PPP projects.

・PT SMI(Sarana Multi Infrastruktur)

The PT SMI is an independent state owned enterprise 100% owned by the Government of Indonesia. It was established in 2009 to finance infrastructure projects.

The main services of SMI are as follows:

① Investments and loans for infrastructure projects (including the mezzanine).

② Advisory service consulting (Advice on finance, transaction advisory).

・PT IIF(Indonesia Infrastructure Finance)

The IIF, a financial institution, was established with the principal shareholders including the SMI, the IFC (International Finance Corporation), the ADB (Asian Development Bank) and the DEG (Deutsche Investitions-und Entwicklungsgesellschaft GmbH). The institution intends to provide a long term fund in the Indonesia rupiah mainly for infrastructure projects in the Republic of Indonesia (airport, ports, railroads, highways, irrigation, water supply and drainage, communications, electric power, oil and gas, etc,.).

The IIF provides the following main services:

① Provision of funds and guarantees, such as the long-term loans for infrastructure projects.

② Advisory service

・KPPIP(Komite Percepatan Penyediaan Infrastruktur Prioritas)

The KPPIP is the Committee of Infrastructure Priorities Development Acceleration. The members include the key cabinet members and the Director of the Ministry of National Development Planning. The establishment of the Committee is based on the Presidential Decree for Enhancing Priorities.

The series of steps from the establishment of PPP project to the completion are as follows:

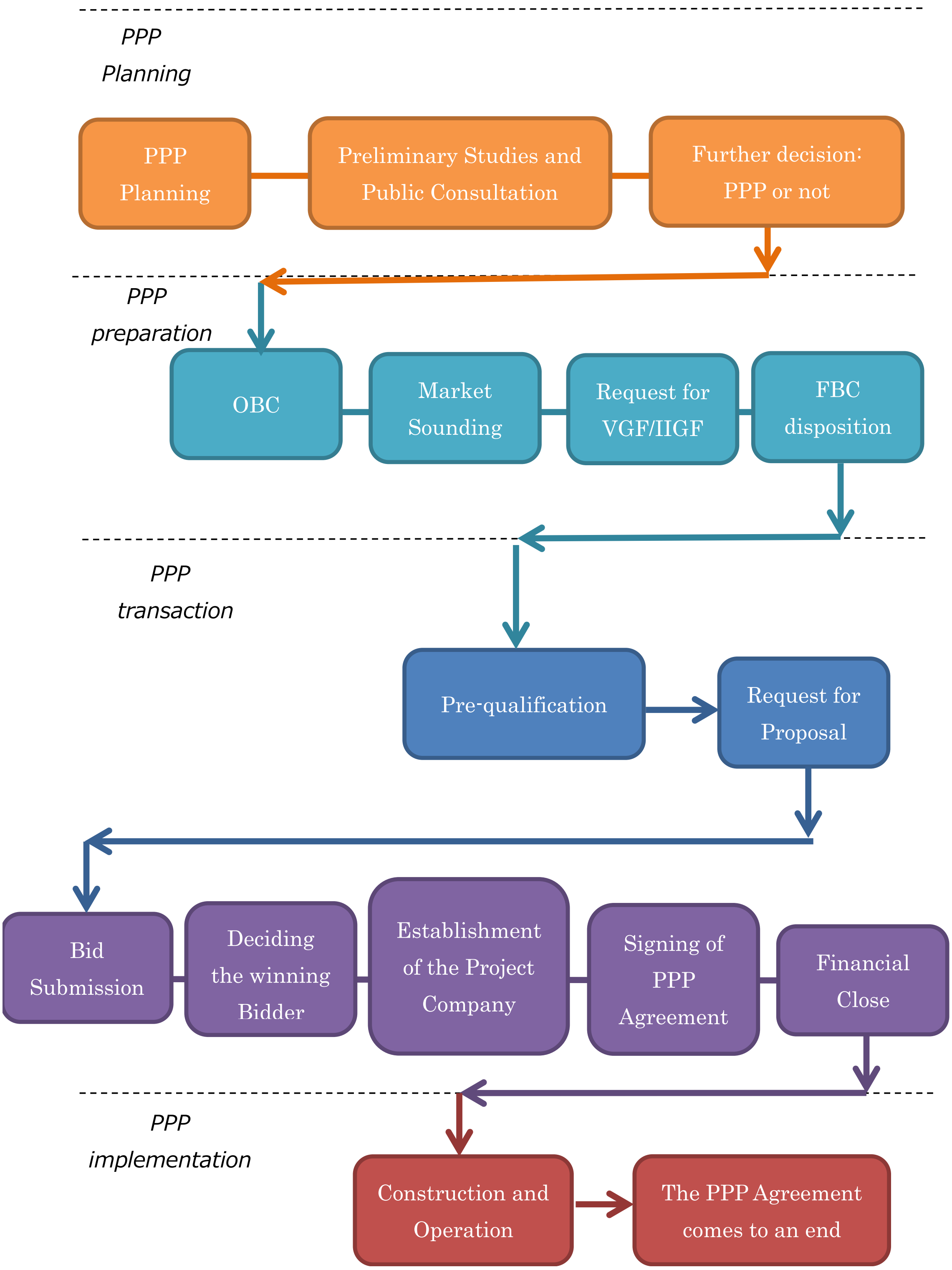


Figure 2.23 Flow of PPP scheme

2.4.2.3 IIGF

The Indonesia Infrastructure Guarantee Fund (IIGF), the state owned enterprise 100% owned by the Government of Indonesia, guarantees the fulfillment of a contract by Government Contracting Agency in PPP projects, reducing the risks of Private Developer.

- Agreement scheme in the IIGF guarantees

In PPP projects for which the IIGF Guarantee Agreement is concluded, three parties of Private Developer, Government Contracting Agency, and IIGF will enter into three agreements. (①PPP Agreement, ②Guarantee Agreement and ③Recourse Agreement)

① PPP Agreement: Private Developer and Government Contracting Agency enter into PPP Agreement that provides the claims and obligations regarding the PPP project.

② Guarantee Agreement: IIGF and private operators enter into Guaranty Agreement on PPP Agreement. This Guarantee Agreement ensures the fulfillment of the PPP Agreement by Government Contracting Agency.

③ Recourse Agreement: IIGF and Government Contracting Agency enter into Recourse Agreement. IIGF will pay Private Developer on behalf of Government Contracting Agency based on the written payment request from Private Developer if certain requirements are met, however, based on this Recourse Agreement, Government Contracting Agency will make payment to IIGF.

If Government Contracting Agency does not agree to the IIGF's claim for reimbursement, in the end, it is expected that the Ministry of Finance will assist the Government Contracting Agency's payment to IIGF through the government budget system. There is a possibility that the budget or subsidies for Government Contracting Agency may be cut off by the Ministry of Finance, and we can say that this agreement scheme works as a strong restraining influence on Government Contracting Agency for the fulfillment of the contract.

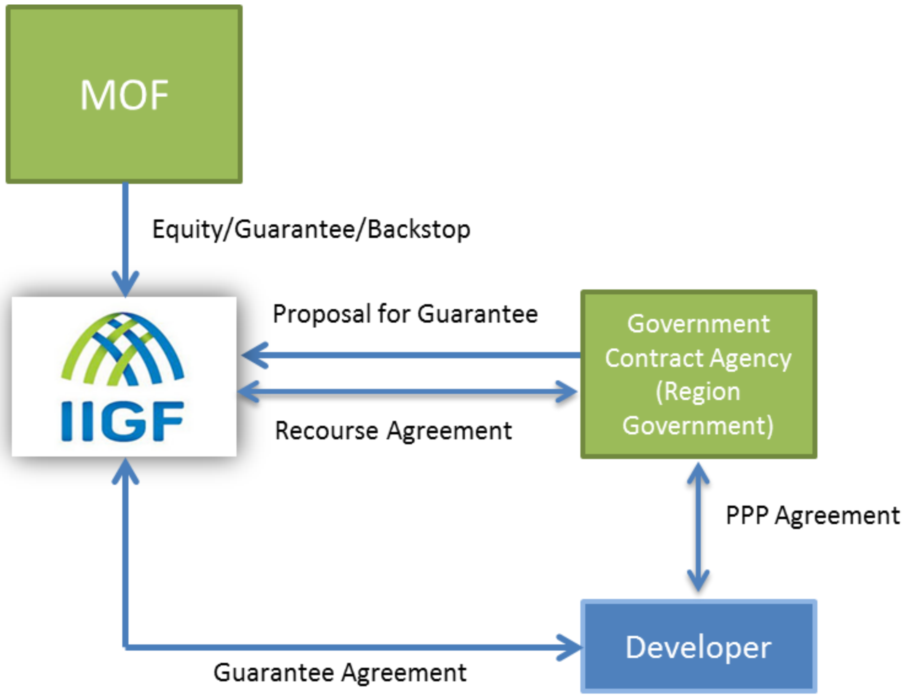


Figure 2.24 Functions of IIGF

- Sectors to be guaranteed by the IIGF

In order for IIGF to provide guarantees for projects based on the Presidential Decree concerning PPP, it is a condition to select Private Developer by competitive tender bid. Unsolicited PPP projects procured based on the Presidential Decree concerning PPP can be granted with guarantees. However, projects by state-owned companies and projects based on negotiated contract are not covered by IIGF's guarantees. As the corresponding sectors, 19 sectors are designated in the New PPP Presidential Decree: (transportation, roads, irrigation, water supply, sewerage, wastewater treatment, waste, communication and information, electricity, oil/gas/renewable energy, energy saving, public urban facilities, education facilities, sports and arts facilities, special zone, tourism, health, prisons and public housing).

- Risks of the guarantee by IIGF

The followings are the main risks for the IIGF guarantee :

- Site Risk: excessive cost burden due to a delay in land acquisition and the transfer of local residents.
- Network Risk: The loss in cases where the surrounding network that needs to be developed for satisfactory functioning of infrastructure could not be conducted according to the government schedule.

- Political Risk: Changes in laws and regulations that may directly damage projects. Loss due to political elements that cannot be controlled by private sectors, such as a delay in permits and license rights.
- Off-taker Payment Risk: Loss in cases where the off-taker fails to agree to mandatory payment in PPP project plan.

2.4.2.4 VGF(Viability Gap Funding)

VGF is a financial support for PPP projects to be provided by the Ministry of Finance, and it assists a part of construction cost (up to 49%). VGF is intended to improve the profitability of projects and supports the establishment of a economically beneficial project with low profitability. VGF is a program to be operated by the Ministry of Finance, and it is operated according to the Finance Minister Decree. Accordingly, the VGF is not applied to all PPP projects, and projects need to be in compliance with criteria described in the Finance Minister Decree. The specific operation policy based on the Finance Minister Decree regarding VGF (No. 223/2012) are as follows:

Requirements related to the amount of VGF (the Article 5 in the Finance Minister Decree regarding VGF):

- The amount of VGF is determined by the ratio of VGF in construction cost. VGF should be a level at which it is not a large percentage of the total construction cost in the corresponding project.
- VGF will be provided in cash within the above amount range.
- Construction Cost includes construction cost, equipment cost, installation expense, interest cost during construction, and the other construction related expenses.
- However, it does not cover the expenses required for land acquisition or the expenses related to tax incentives.

Requirements for projects to which VGF is applicable. (the Article 8 in the Finance Minister Decree regarding VGF):

- A project that is economically viable but financially not viable.
- A project with a scale of more than one billion yen.
- A project that went through a bidding process stipulated in the Presidential Decree concerning PPP (the Presidential Decree concerning PPP stipulates that the negotiated contract and the project proposed by private group are not covered by the government finance support. Accordingly, it is assumed that the negotiated contract and the project proposed by private group will not be covered by VGF).
- A project in which the ownership will be transferred from Private Developer to Government

Contracting Agency when the project period described in PPP Agreement is terminated.

- A project in which the following aspects are presented through the Pre FS:
  ① A project in which the optimum risk sharing between Private Developer and Government/Government Contracting Agency was presented.
  ② A project in which its economic viability was proved as a result of considering technologies, environment and society and the study from legal perspective.
  ③ A project in which its financial viability was proved for the first time with the provision of VGF.

- VGF Approval Flow

The following approvals at three stages are required for the application of VGF by the Ministry of Finance:

1: Preliminary approval for the provision of VGF (prior to P/Q).

- Screening on whether VFG will be applied to the relevant project or not before the issuance of P/Q.

2. Approval related to the amount of VGF (after P/Q).

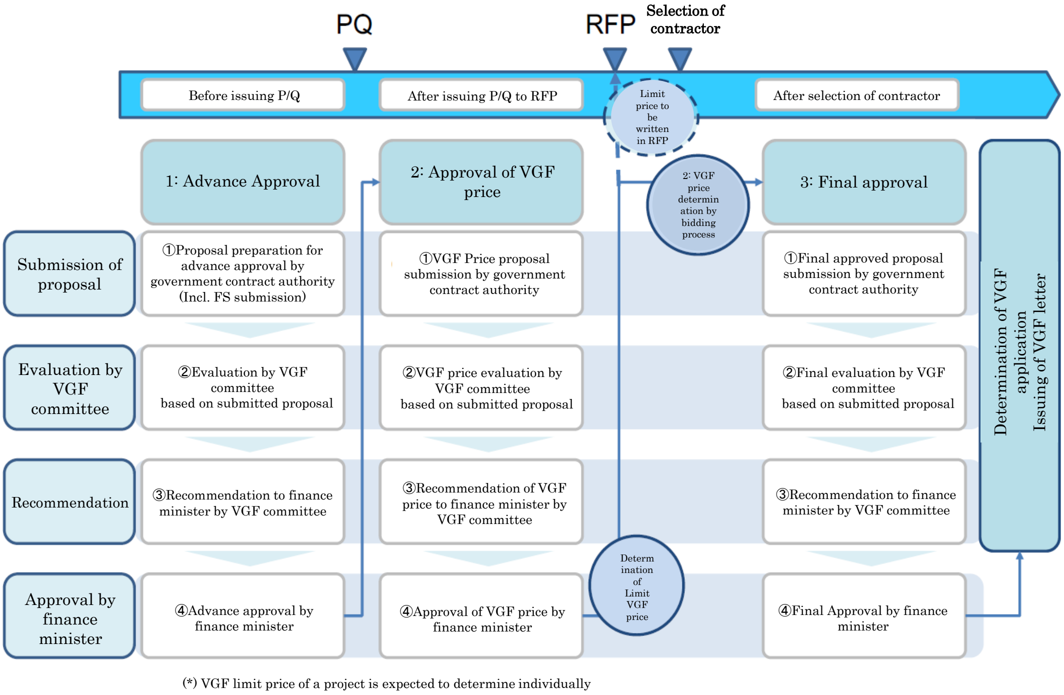
- After the issuance of the P/Q, the maximum amount of VGF for the relevant project will be examined. Depending on the project, the maximum amount based on the examination result will be described in RFP.

3. Final approval (after the selection of Private Developer)

- Final approval after the selection of Private Developer by bidding. The amount presented by the successful bidder will be the amount to be approved.

In all three approvals stages in the above, the following four processes are to be taken:

① Submission of proposals by Government Contract Agency.
② Examination by VGF Committee.
③ Recommendation by VGF Committee based on the result of examination.
④ Approval by the Minister of Finance.



Source: “Republic of Indonesia PPP Handbook” by the JICA

Figure 2.25 VGF application flow

- Selection of Private Developer in projects to which VGF is applicable.

In the bidding for a project to which VGF can be applied, the amount of VGF approved by VGV Committee at the second approval stage will be the maximum amount, and depending on the project, the maximum amount will be described in RFP. The amount of VFG will be the only parameter for the evaluation of price during bidding.

2.5 Meeting with local stakeholders

2.5.1 JCM feasibility study kickoff meeting based on the city-to-city collaboration

We had a meeting with the local government on 25th November (Friday) in 2016 for the implementation of the feasibility study. In the meeting, we explained the scheme assumed, the risk allocation (risk sharing) if a private business unit receives a contract for waste-to-energy business in PFI/BOT method, the introduction of failures of the waste-to-energy projects in countries in the world, and the superiority of stoker furnace. Additionally, our partner for this feasibility study, the Clean Authority of TOKYO, explained the safety of stoker furnace, the selection methods of operators, and the importance of Tipping Fee. Table 2.12 describes the outline of kickoff meeting.

Table 2.12 Kick-off meeting outline

1. Date	25th November, 2016 9:30-12:00
2. Location	Meeting room in Denpasar city government office
3. Attendee (Denpasar city)	Denpasar city, deputy mayor, Mr. IG. N. Jaya Negara Denpasar city, director of cleansing department, Mr. I Ketut Wisada SARBAGITA solid waste management agency, Director, Mr. I. Made Sudarma
4. Attendee (Japan)	Clean Authority of Tokyo JFE Engineering Corporation PT. JFE Engineering Indonesia
5. Agenda	1. Explanation of meeting purpose 2. Greeting message by deputy mayor 3. Presentation about expected business scheme, risk allocation 4. Presentation about worldwide example of failure, technology comparison 5. Presentation about contractors selection method, importance of tipping fee 6. Q&A 7. Closing 8. Photographing

2.5.2 Project Scheme assumed

As to the Project Scheme assumed for this project, based on the fact that Denpasar City wishes to outsource waste processing project in BOT scheme, if a project is conducted in BOT scheme, it would be indispensable to make the project as BOT based on the laws related to the PPP in the Republic of Indonesia from the below perspectives. Based on this, we explained to Denpasar City on the advantage of making it as BOT according to the PPP laws.

① The adaptation of IIGF that corresponds to sovereign guarantee by the Republic of

Indonesia is an indispensable precondition for forming Project Finance.
(The details are described in the Chapter 6.)

② If Viability Gap Fund (VGF), the financial support by the Indonesian Central Government, can be applied, it would be possible to receive a subsidy for equipment expense up to 49% and as a result, the disposal expense to be covered by Denpasar City can be reduced.

The scheme of this project was understood by the City because it is financially difficult for Denpasar City to generate disposal expense, and that they have a strong interest in using the financial support by the central government as much as possible.

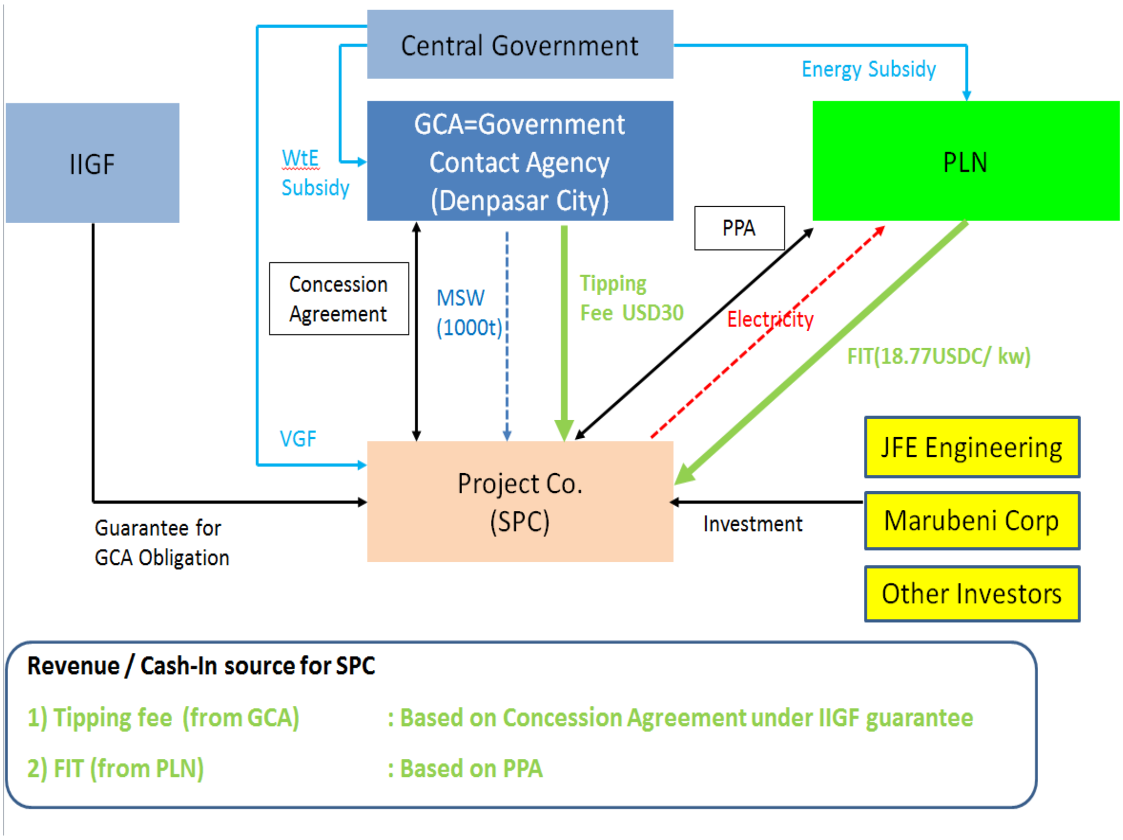


Figure 2.26 Business scheme

2. 5.3 Risk sharing in BOT projects

As described in Chapter 6, we explained that if it is a BOT scheme based project plan, in which a private operator receives a contract of waste-to-energy business, unless the risk is properly shared between the developer and the project owner who is Denpasar City, it would be difficult to achieve business because of "a failure to arrange finance," "a failure to establish business (bidding)" and "bankruptcy of business." Sharing risks in waste-to-energy business in Denpasar City is closely related to the formation of finance. Therefore, it is necessary to discuss the matter between the concerned parties in the future.

Table 2.13 Risk allocation

	Risk contents	GCA	SPC	CG	Note
Preparation and Construction Phase	Land Preparation	✔			
	Site Clearance	✔			
	Opposition of the local residents	✔			
	Engineering, Procurement, Construction of WtE Plant		✔		
	Completion and Performance of WtE Plant		✔		
	Cost Over run		✔		
Operation Phase	Operation & Maintenance		✔		
	Supply of Waste (Volume and quality)	✔		Guarantee	Central government shall guarantee SPC's revenue in case GCA breach the concession agreement
	Feed in Tariff (unit price, Period)	✔		Guarantee	Same as above (by IIGF)
	Tipping Fee	✔		Guarantee	Same as above (by IIGF)

	Risk contents	GCA	SPC	CG	Sample of Measures
Operation Phase	Ash disposal	✔			
	Accident and trouble of facility due to prohibited waste	✔			
	Environmental emission risk		✔		
	Cost Over run		✔		
	Accident and physical damage of facility and equipment		✔		
Ove roll Phase	Change in law	✔			SPC shall not be responsible for the change in law related to the operation of WtE
	Force Majeure (e.g. Disaster, War, Riot, Act of god...)	✔			
	Financial support from Japanese bank for international cooperation (JICA, JBIC)		✔		

GCA: Government Contract Agency= Denpasar City
SPC : Special purpose company for WtE operation
CG : Central government

2.5.4 Introduction of the failures in waste-to-energy projects and the explanation of proper technologies

We talked about the failure cases of incineration power generation project, which used unfit technologies in the world, mainly in Southeast Asian Nations. As result of interviewing the Denpasar City Government, at present, about 50 investment companies are approaching Denpasar City, and some of which are proposing a technology with no track record. With this, we explained the loss of economic and human resources resulting from the application of inappropriate technologies that emphasize the disposal cost that appears to be cheap on the surface. We also told them that it would be most desirable to adopt a mechanical stoker type incinerator for the intermediate treatment of municipal solid waste.

Denpasar City and SARBAGITA Sanitation Union are aware of the risk of adopting inappropriate technologies, and they seemed to be quite interested in applying the stoker furnace which is a technology with proven results for the Waste to Energy project in Denpasar City.

2.5.5 Importance of the selection methods of operators and the disposal cost in the Tokyo's 23 wards

The international business division of the Clean Authority of TOKYO, who is the partner of this feasibility study, explained the following:

① The management and operation method of the waste-to-energy facility.
② Safety of waste processing.
③ Process of selecting waste operators
④ Importance of tipping fee.

Denpasar City and the SARBAGITA Sanitation Union showed a strong interest in the presentation by the Clean Authority of TOKYO, who is the Tokyo's wide area union similarly to the SARBAGITA Sanitation Union and actually operates and maintains the waste-to-energy facilities. It is assumed that the capacity building through municipalities as this one is highly effective for exporting Japan's high quality infrastructure and we believe it is necessary to continue this initiative in the future.

Figure 2.27 Kickoff meeting

2.5.6 Summary of this Chapter

This Chapter described the situations related to economy, energy and the generation of waste in the target region, as well as our views on the development of legal framework for the establishment of PPP projects in the Republic of Indonesia, laws and regulations for the regeneration projects, and laws and regulations for waste management. Laws concerning waste-to-energy business have not been developed in most of the countries in the ASEAN, and it is still a difficult challenge for Japanese private sectors. Meanwhile, although there is still a need to develop the detailed rules in laws and regulations in the Republic of Indonesia, they are in the process of developing legal framework necessary for waste-to-energy projects, including PPP related laws and FIT related laws. With this, the environment of business investment is gradually improving. In establishing and achieving waste-to-energy business projects in the Indonesia, we believe we can push forward the establishment of the projects by launching various support programs through dialogue between the governments of Japan and Indonesia; the support for creating systems for the development of necessary laws and regulations, the support for creating the waste-to-energy technology selection guidelines, and the support for establishing waste-to-energy business model.

Chapter 3 Characteristics of Waste Incineration Method

3.1 Types of incineration methods

3.1.1 Considerations for incinerator method

Incinerator methods for municipal solid waste are shown in Figure 3.1. In Japan, incineration plants with mainly stoker furnaces and fluidized bed furnaces as mainstream have been common for a long time. Starting in around 2000, ash melting furnaces (for incineration ash) auxiliary to incineration plants became common for the purpose of waste volume reduction and at the same time, gasifying and melting furnaces gained popularity as a technology for melting ash and noncombustible matter, etc. Since the volume reduction rate of waste is high, municipalities with limited landfill space tend to introduce these melting facilities.

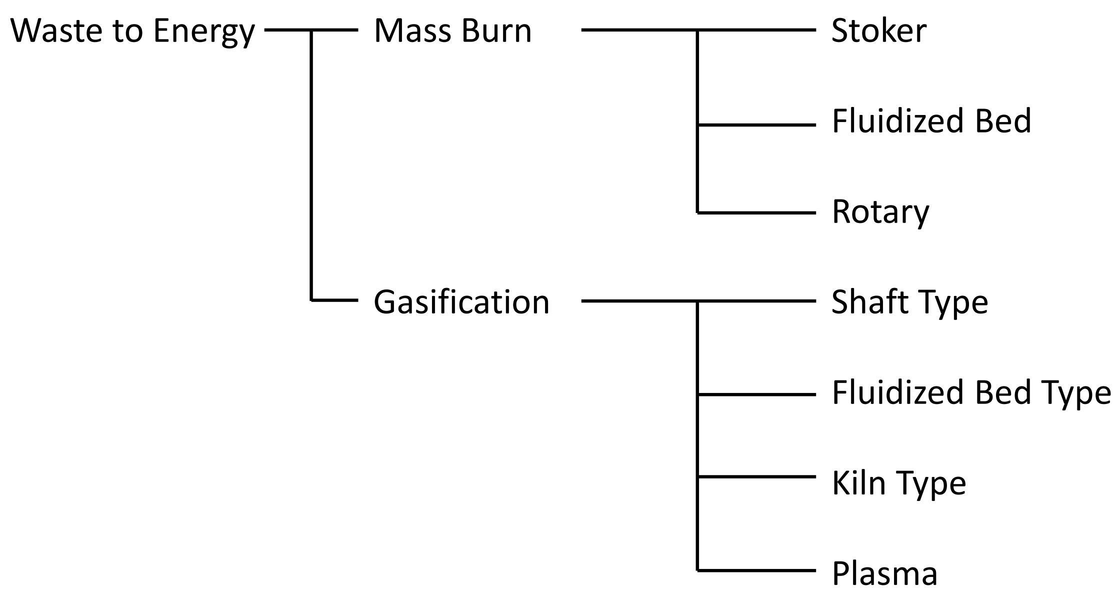


Figure 3.1 Incinerator method

The number of incineration plants and the technology ratio introduced, including overseas, are shown in Figure 3.2 and Figure 3.3. We know that half of the incineration plants in the world are constructed in Japan. Also, the stoker furnace makes up 74% of the incineration method introduction ratio and it is clear that the stoker furnace is the mainstream even throughout the world.

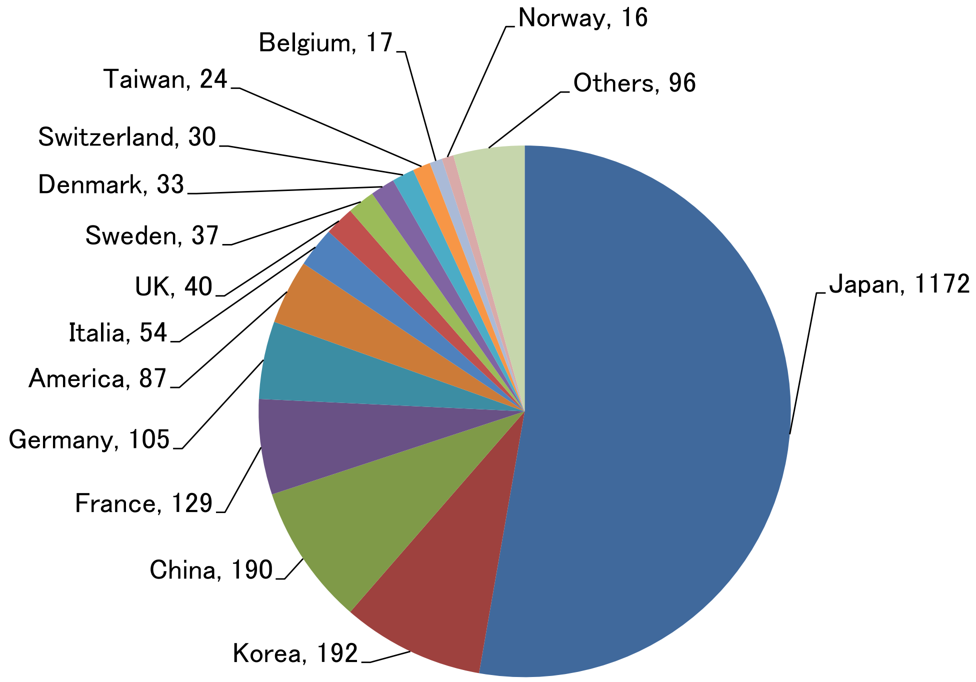


Figure 3.2 Number of waste incinerators introduced throughout the world[1]

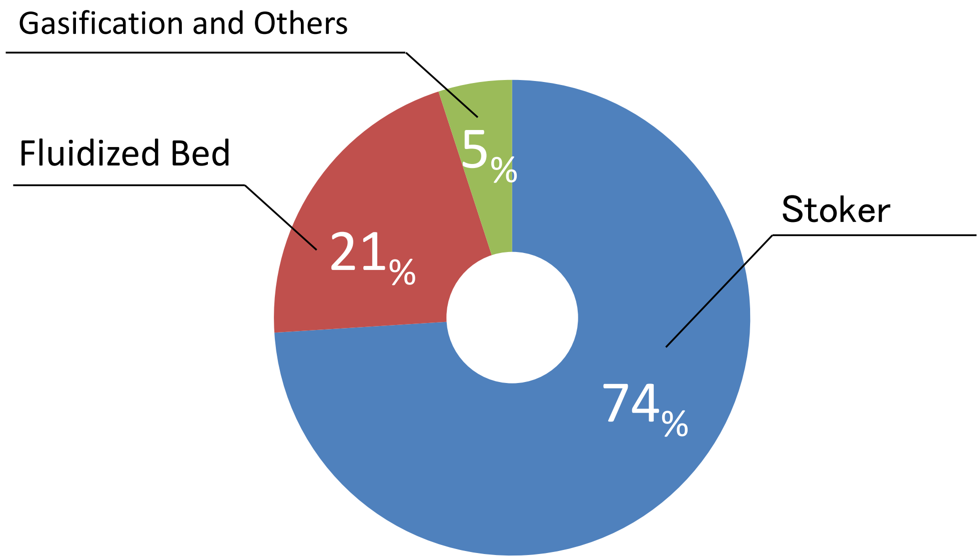


Figure 3.3 Ratio of incineration methods introduced throughout the world[1]

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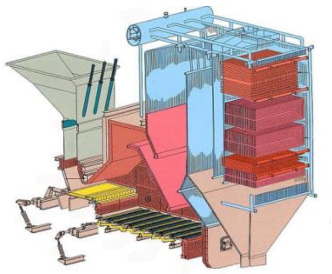
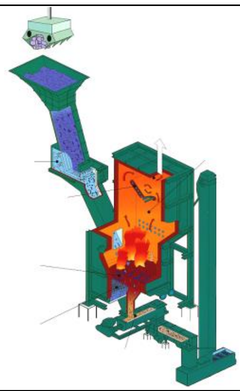
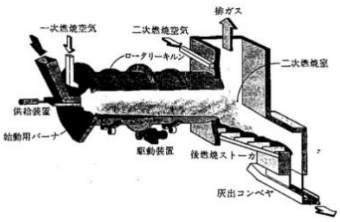
[1] Mark Döing and others, 2015. *Waste to Energy 2015/2016*, 8th edition, Germany: ecoprog GmbH

3.1.2 Overview of incinerator type

An overview of incinerator method types is summarized in Table 3.1.

Table 3.1 Overview of Incinerator types

Type	Stoker	Fluidized Bed	Rotary (kiln Stoker)
Figure			 [2]
Outline	Waste is combusted on the moving grate with air injected from the lower part of the furnace. After combusting the waste in drying, combustion and post-combustion zone, ash is discharged from the furnace. Ash and incombustible waste are mostly discharged from the end of the grate. A part of ash is flying in the flue gas and collected in bag filter as fly ash.	Waste is charged to the hopper by waste crane and crushed finely by waste feeder. Fine waste charged into furnace is rapidly combusted in fluid hot sand with high-pressurized combustion air. Metal and incombustible wastes are discharged from the bottom of the furnace with fluid sand, and ash is flying in the flue gas and collected in bag filter. Fluid sand discharged to outside is recovered to return to the furnace after separating from incombustible waste.	Stoker (grate) is installed in back of cylindrical kiln. Waste is thermally decomposed in the kiln with a small volume of air and combustible gas is generated. The waste contains carbon is charged to the stoker to burn in sufficient air. Incineration ash is discharged by ash conveyor set at the bottom of the furnace. Combustible gas is completely combusted in the stoker furnace and the secondary combustion chamber. A part of ash is flying in the flue gas and collected in bag filter as fly ash.

[2] M Shigaki, 2000, *Etoki Haikibutsu no nensho gijyutsu kaitei 3 han*、ohmsha

Next, a comparison chart by incinerator type is shown.

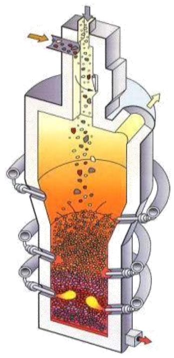
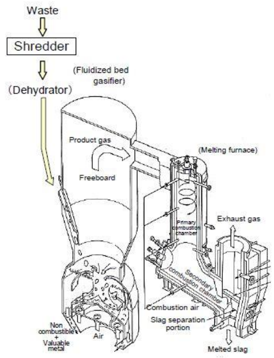
Table 3.2 Comparison between Incinerator types

Type	Stoker	Fluidized Bed	Rotary (kiln Stoker)
Waste Type	- There are many records for combustion of municipal solid waste and industrial waste.	- It is suitable for sludge incineration - The size of waste should be less than 50 mm.	- Bulky waste and high calorific value waste such as waste plastic and oil sludge can be treated.
Final Production	- Bottom ash - Fly ash	- Incombustible waste (including metal) - Fly ash	- Bottom ash - Fly ash
Advantage	- Various types of waste are acceptable. - Large capacity of a furnace is widespread. - The most conventional and proven technology.	- It is suitable for sludge incineration. - Start-up and shut-down operations can be carried out easily in a short time. - There are many records	- Various types of waste are acceptable using the function of kiln and stoker.
Disadvantage	- High calorific value waste (3,000kcal/kg or more) is not preferable.	- Pretreatment (waste crushing) is required for stable combustion. - There are no records of large scaled furnace. - The operational control is difficult to meet waste fluctuation due to rapid combustion. - Auxiliary fuel is necessary for low calorific value waste.	- There are no records of large scaled furnace.

3.1.3 Overview of gasifying and melting furnace types

An overview of three types of gasifying and melting furnace method, shaft type, fluidized bed type and plasma type is summarized in Table 3.3.

Table 3.3 Overview of gasifying and melting furnace types

Type	Shaft Type	Fluidized Bed type	Plasma Type
Figure			 [3]
Outline	The waste charged from the top of the furnace with coke is dried and gasified in the furnace. Ash content of waste is melted in high temperature atmosphere caused by the reaction between fixed carbon in coke and waste and supplied oxygen. The slag and metal converted from ash is discharged from slag outlet. Slag is utilized for various ways such as asphalt aggregate etc. In addition, metal is recycled for counterweight and copper recovery. The feature is that the various types of waste such as sludge and medical waste can be treated.	Fluidized bed furnace as a gasifying facility and ash melting furnace are separately installed. Metal and incombustible wastes are discharged from the bottom of the furnace with fluid sand, and fly ash is sent to the melting furnace. Fly ash is melted under high temperature by combustion of pyrolysis gas.	Plasma torches are installed on the side of cylindrical furnace. The heat generated by plasma can melt the ash content of waste, however the high electrical consumption is disadvantage for this technology. The temperature in the furnace achieves to 3,000 degC or more, thus the synthesis gas does not include tar. Synthesis gas can be utilized as fuel gas. However, this technology is not commercialized in the world.

[3] Alter NRG Web Page

Next, a comparison chart by incinerator type is shown.

Table 3.4 Comparison between types of gasifying and melting furnaces

Type	Shaft Type	Fluidized Bed type	Plasma Type
Waste Type	Municipal solid waste, Industrial waste, Medical waste, Sewage sludge, RDF, Waste plastic etc.	- It is suitable for sludge incineration - The size of waste should be less than 50 mm.	Municipal solid waste, Industrial waste, Medical waste, Sewage sludge, RDF, Waste plastic etc.
Final Production	- Slag and metal - Fly ash	- Incombustible waste (including metal) - Slag and metal	- Slag and metal - Non-ferrous metal - Chemicals etc.
Advantage	- Various types of waste are acceptable. - High volume reduction ratio can be achieved. - There are sufficient records of construction and more than 10 years operation.	- It is suitable for sludge incineration. - Start-up and shut-down operations can be carried out easily in a short time.	- Various types of waste are acceptable. - High volume reduction ratio can be achieved. - If synthesis gas can be available, the power generation efficiency is higher to introduce it to gas engine.
Disadvantage	- Carbon dioxide (CO_2) is emitted from coke.	- Pretreatment (waste crushing) is required for stable combustion. - There are no records of large scaled furnace. - Auxiliary fuel is necessary for low calorific value waste. - High volume reduction ratio is smaller than the one of shaft type because the incombustible waste discharged from the fluidized bed furnace is not melted.	- There are no commercial records in the world. Continuous operation is difficult guessingly

3.2 Comparison of types of incineration

This section compares stoker furnaces and fluidized bed furnaces, which are incinerators with shaft type and plasma type which are gasifying and melting furnaces, in consideration for which technology is most suitable for Denpasar.

3.2.1 Construction and operation costs

Table 3.5 shows the relative comparison of the construction and operation costs of the various incineration methods. As the gasifying and melting furnace is pathognomonic, construction costs are limited by the production company. Along with that, construction costs tend to be high compared to stoker furnaces and fluidized bed furnaces. Furthermore, the temperature zone in the furnace gets hot and the furnace unit is expensive in furnace of plasma type and when synthesis gas is used then a refining process is required, so plasma type is more expensive than other technologies and is actually the most expensive incineration method in the table.

However, regarding operation costs, combustion is intermittent and it is difficult to control with the fluidized bed furnace and in the event the waste calorie count is low, it often requires auxiliary combustion for stable combustion. Therefore, there tends to be more fuel used compared to the stoker furnace. Also, the gasifying and melting furnace has a higher operation cost compared to the stoker furnace from the use of coke as the waste melting heat source in the shaft type. Furthermore, operation fees are extremely expensive in the plasma type, due to the high amount of electricity used with plasma and the high amount of water utilities used in gas refinement.

From the above, when the four combustion types in the table were determined from the perspective of construction and operation costs, the stoker furnace is the most economically superior furnace.

Table 3.5 Construction and operation costs

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Shaft Type	Plasma Type
CAPEX	+	+	++	+++
OPEX	+	++	++	+++
Evaluation	A	B	C	D

Cost： +(not expensive)→ +++(expensive)

Grading evaluation index: + (low) → +++ (high)

3.2.2 Stability

Evaluation of the stability of various incineration methods are shown in Table 3.6. As mentioned before, stoker furnace is the most common technology in the world and can be said to run stably. Also, the main furnace units have advanced to large-scale and even in Japan are constructed with a furnace capacity of 500 t/d per furnace. Even the shaft model, which is a gasifying and melting furnace, has a history of results in

Japan and can be said to run stably. However, combustion is intermittent and it is difficult to control with the fluidized bed furnace and in the event the waste calorie count is low, it is inferior to the stoker furnace in terms of stability as it requires auxiliary combustion for stable combustion. Also, continuous running with plasma type is extremely difficult, although there are virtually no plants that use it for commercial operation and so the cause is not clear. Therefore the evaluation determined the stability to be extremely low.

Table 3.6 Stability

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Stoker	Fluidized Bed
Stability	- The most Conventional - Large capacity(400-500t/d) is already proven	- The operational control is difficult to meet waste fluctuation due to rapid combustion. - Auxiliary fuel is necessary to meet waste fluctuation.	- Proven technology in Japan	- Not commercialized due to instability of operation
Evaluation	A	C	A	D

Evaluation index: A:Excellent, B:Good, C:Acceptable, D:Not Acceptable

3.2.3 Residue volume

Table 3.7 includes the evaluation of the amount of residue discharged from the various incineration methods. The amount of residue is the amount of end product from the incinerator and in stoker furnaces, bottom ash and fly ash are discharged as residue while in fluidized bed furnaces, noncombustible matter including metals and fly ash are discharged as residue. With the gasifying and melting furnace, the produced slag and metal can be reused so the residue volume is lower compared to the incinerator. Also, with the plasma type, nonferrous metals and chemicals can be collected in the process of refinement of synthesis gas and technically the amount of residue can be made to be extremely low.

Also, while the amount of residue in gasifying and melting furnace is low compared to the incinerator, user of slag and metal, etc., must be secured. Japan has Japanese Industrial Standards regarding use of slag and there is an appropriate legal system for such use, but overseas there is often no legal system of waste molten slag. From the above, it is crucial with the gasifying and melting furnace to consider even the destination of the end products.

Table 3.7 Amount of residue

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Stoker	Fluidized Bed
Final Production	- Bottom ash - Fly ash	- Incombustible waste (including metal) Fly ash	- Slag and metal - Fly ash	- Slag and metal - Non-ferrous metal - Chemicals etc.
Evaluation	B	B	A	A

Evaluation index: A:Excellent, B:Good, C:Acceptable, D:Not Acceptable

3.2.4 Environmental load

Evaluation of the environmental load of various incineration methods are shown in Table 3.8. Here, other technologies are compared with the stoker furnace as the standard. As mentioned before, combustion in fluidized bed furnaces is intermittent and it is difficult to control and in the event waste calorie volume is low, auxiliary fuel may be necessary and since fossil fuels such as kerosene are used for this, carbon dioxide (CO2) discharge is higher than stoker furnaces and the environmental load is also higher. Also, as the shaft type uses coke as a heat source for melting waste, the amount of CO2 discharge is higher than stoker furnaces and an environment load is also increased. Even in plasma type, as plasma is used for melting waste and the decomposition of tar in pyrolysis gas, it consumes more energy than the stoker furnace. Therefore CO2 emission increases and so does the environment load.

From the above, we can conclude that the stoker furnace incineration technology has the lowest environmental load.

Table 3.8 Environmental load

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Stoker	Fluidized Bed
Environmental Load	-	- Auxiliary fuel is necessary for low calorific value waste.	- CO2 is emitted from coke.	- Large amount of self-electric consumption is necessary due to plasma torch
Evaluation	A	B	C	C

Evaluation index: A:Excellent, B:Good, C:Acceptable, D:Not Acceptable

3.2.5 Results of implementation

Table 3.9 shows evaluation from the results of introducing the various incineration methods. It is clear from Figure 3.3 in section 3.1.1 Ratio of incineration methods introduced throughout the world, that the stoker furnace is the most common technology no matter where you look in the world. Therefore, according to the introduction results, the stoker furnace has the most superior technology.

Table 3.9 Worldwide introduction results

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Stoker	Fluidized Bed
Evaluation	A	B	C	D

Evaluation index: A:Excellent, B:Good, C:Acceptable, D:Not Acceptable

3.2.6 Summary of incineration methods

Table 3.10 summarizes the items evaluated from section 3.2.1 to 3.2.5 in the previous paragraph. In conclusion, evaluating overall, the stoker furnace is the most superior technology and the technology that should be introduced in Bali is the stoker furnace. Shaft types, which are gasifying and melting furnaces, use a superior technology that has shown results in Japan and it is a technology that should be introduced in places where there is little land available and limited landfill space like in Japan, or under conditions in which there is a demand for incineration other than general waste.

Based on the above, feasibility of the introduction of stoker furnace technology in Denpasar, Bali will be studied.

Table 3.10 Summary of comparison of various incineration methods

	Mass Burn		Gasification	
	Stoker	Fluidized Bed	Stoker	Fluidized Bed
Expenditure	A	B	C	D
Stability	A	C	A	D
Residue Ratio	B	B	A	A
Environmental Load	A	B	C	C
Records	A	B	C	D

Evaluation index: A:Excellent, B:Good, C:Acceptable, D:Not Acceptable

3.3 Technological superiority

3.3.1 Superiority of Japanese technology

Electric power generation from waste incineration in Japan started with the first machine in 1965 and in about 50 year history from then to now, over 300 units have been introduced with well-established technology that achieves overall electric power generation of 7.21 billion kWh/year. There has been a prominent rise in manufacturers in China, South Korea and India in recent years, but Japan’s technology is highly evaluated regarding skillful combustion technology that controls generation of pollutants such as dioxin on a wide scale from low calorie to high calorie waste.

Waste incineration electric power generation facilities made in Japan, as can be seen from the operating results at plants throughout the country, can run stably for a long period of time and historically, incineration treatment for waste equivalent to that with a large amount of water and low amount of calories which is general in many Southeast Asian countries are has been performed. Also, it was designed in consideration of continuing appropriate and simple operation management by preparing a manuals.

Also, historically the incineration technology of various Japanese companies has been introduced by European manufacturers, but Japan has upgraded the technology to suit the high level environmental standards and construction conditions, currently surpassing the technology of the European manufacturers. Also, as shown in Figure 3.3 Number of waste incinerators introduced throughout the world, Japan has constructed more than half of the units in the world and is also certainly superior in number of years running at over 50 years.

On the other hand, in waste incineration electric power generation facility, power is generated by generating steam by collecting heat with the boiler and economizer from the combustion furnace flue gas and then running the turbine. Power generation efficiency can be improved by taking the following measures in this facility.

- By setting flue gas economizer outlet temperature to a low temperature and maximizing the amount of boiler heat recovery.
- Appropriate boiler steam condition (Boiler outlet, approximately 4.8 MPa and 420 degC) focused on electric power generation is adopted.
- Returning part of the flue gas to the incinerator, reduces the amount of blowing air to furnace, improving the thermal efficiency. (See section 3.3.2.1)
- The nitrogen oxide (NOx) in flue gas can be eliminated by selective catalytic reduction and since there is no selective catalytic reduction system and the flue gas reheater is also unnecessary, the steam required in flue gas reheating equipment can also be used in electric power generation. (See section 3.3.2.2)

3.3.2 Technology of JFE Engineering’s stoker furnace

3.3.2.1 Hot air combustion system which achieves low air ratio combustion

With normal stoker furnaces, the gas flow and temperature field in the furnace are heterogeneous, so the more air than the theoretical value must be provided for combustion stabilization.

Japan’s high-temperature air combustion system forms a stable combustion zone in the upper waste layer and promotes the thermal decomposition of waste by blowing a gaseous mixture of high-temperature air and combustion flue gas into the upper waste layer in the combustion chamber. Therefore, stable combustion is possible even with a low air ratio (closer air volume to the theoretical air volume). As a result, generation of nitrogen oxide (NOx), carbon monoxide (CO) and dioxins is controlled and heat loss is significantly reduced due to reduced amount of flue gas, improving generated output (see Figure 3.4 to 3.7). Considering that the performance of competitors in other countries is at about the same level as JFE Engineering’s past results, we can say that Japan’s technology is superior.

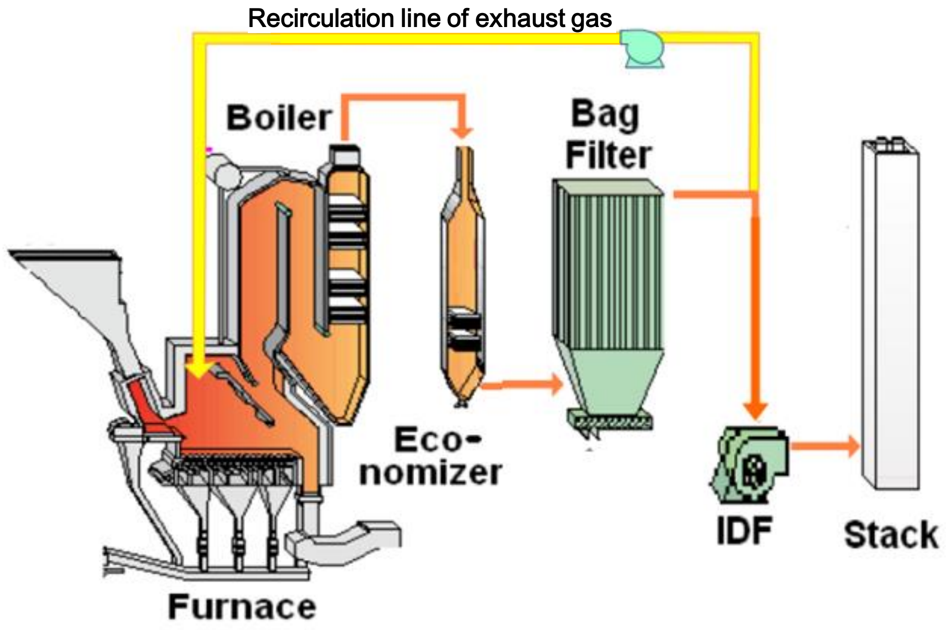


Figure 3.4 Exhaust gas recirculation system

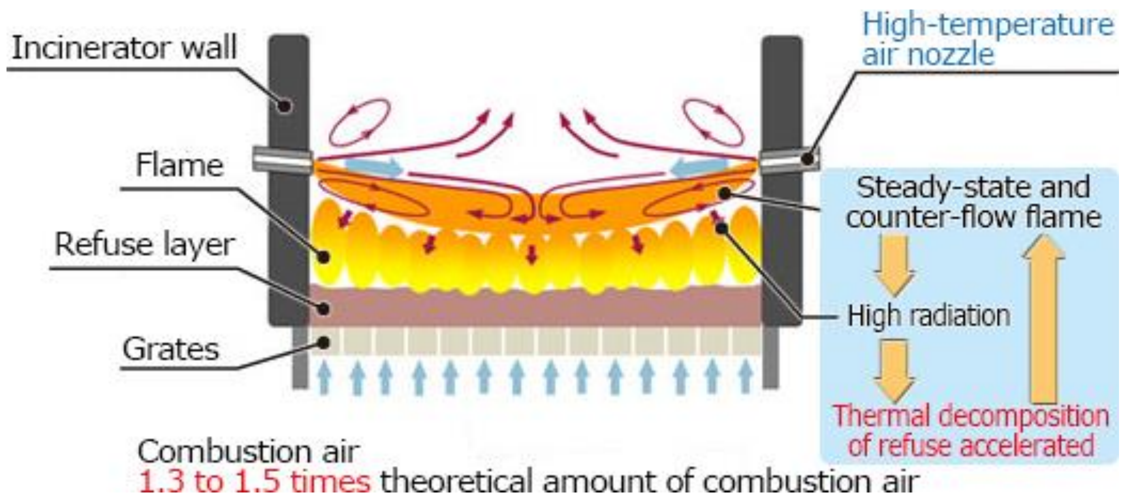


Figure 3.5 Hot air combustion system

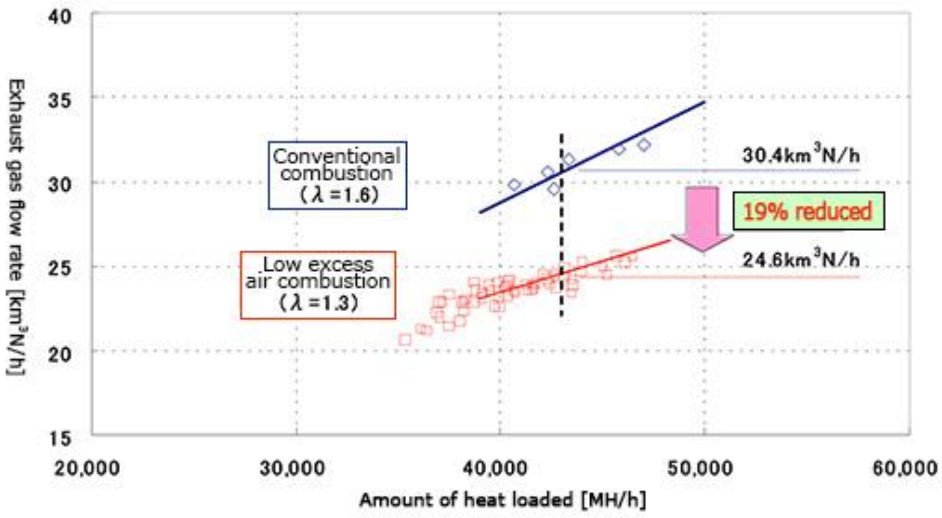


Figure 3.6 Improved air ratio due to the hot air combustion system

(Comparison of results of JFE Engineering)

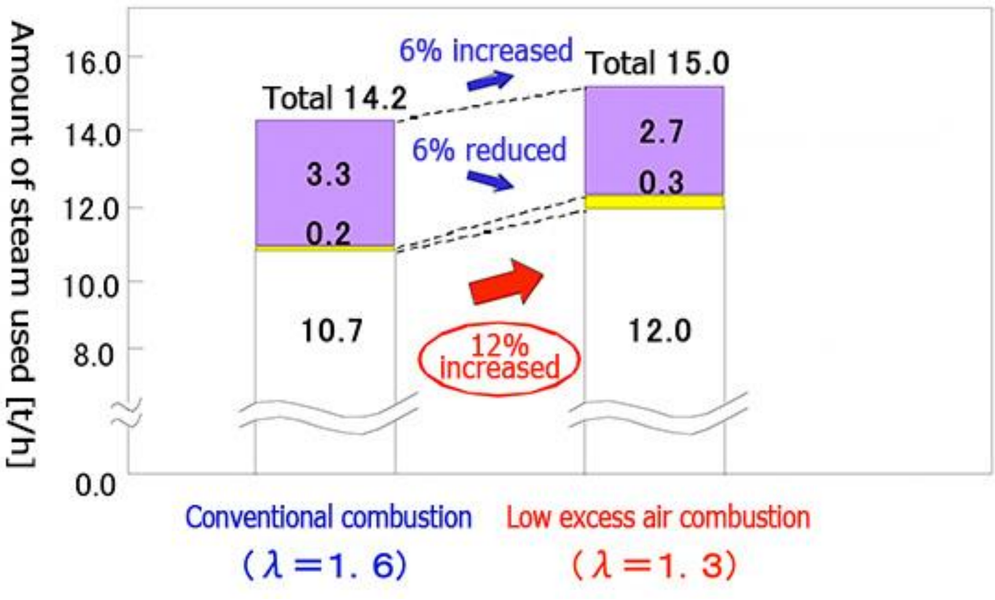


Figure 3.7 Improved power output due to the hot air combustion system

(Comparison of results of JFE Engineering)

3.3.2.2 Application of two-way gas flow

The JFE Engineering's stoker furnace can keep CO and NOx discharge in flue gas extremely low due to application of a two-way gas flow. Figure 3.8 shows those mechanisms and also explains the following characteristics.

- When waste is heated, unburned gas (steam and combustible gas, etc.) is generated in the dry zone by pyrolysis and then combustible gas is burned in the combustion zone, thereby generating combustion gas.
- In the intermediate ceiling installed in the combustion chamber, unburned gas and combustion gas is divided into two and both collide with each other in the gas mixing chamber, causing agitational mixing combustion.
- The NOx generated in the combustion zone reacts with reducible ammonia (NH3) and hydrogen cyanide (HCN) generated from the drying zone in the secondary combustion zone and is reductively decomposed (self-denitrification). This eliminates the need for the latter selective catalytic reduction system and the flue gas reheating equipment is also no longer necessary, so generated output is maximized.
- In the secondary combustion zone, due to the high-temperature combustion gas, sufficient retention time and mixing/agitation, dioxins generation is significantly controlled.
- Because complete combustion is promoted, boiler corrosion is reduced from the reduced gas.

This technology is the original of JFE Engineering and is superior to competitors in other countries.

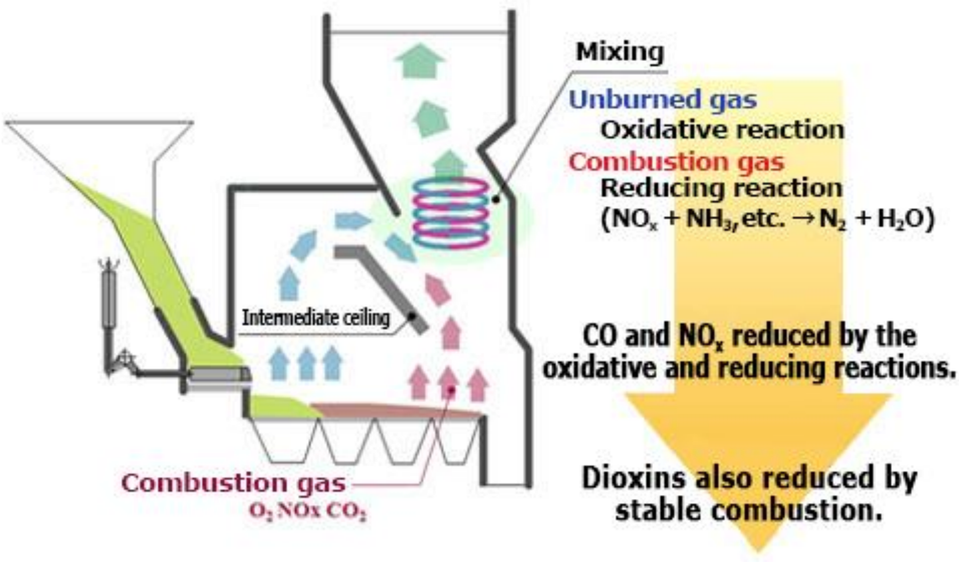


Figure 3.8 Mechanism of two-way gas flow furnace

3.3.2.3 Long-term stable operation with highly reliable grates

Based on long years of experience in Japan, improving grate materials and structure can further improve the durability of the grates. In addition to contributing to long-term, stable operation, this technology leads to a favorable position over competitors in other countries.

- Adoption of high chrome heat-resistant cast steel for grate materials → Improved heat and abrasion resistance
- Adoption of a structure that thickens the main parts of the grate → Improved abrasion resistance
- Enlarging the fin for grate cooling → Prevents corrosion by lowering the temperature of the grate
- Change in area of sliding surface → Reduced friction

Chapter 4 Planning of Waste to Energy Plant

4.1 Basic plant planning

4.1.1 Facility flow

As mentioned in the previous chapter, this investigation uses a stoker furnace and evaluates the feasibility of it. Facility flow when a stoker furnace is used is shown in Figure 4.1.

The pit and crane method is used as receiving equipment for the waste. The waste pit that treats 1,000 tons of waste per day at this facility can store up to 10 days waste. The stoker furnace is equipped with the JFE hyper stoker system, the latest technology of JFE Engineering. Flue gas generated in the stoker furnace is heat recovered in the boiler and economizer and then sent to the bag filter. The flue gas treatment in this facility uses the dry method and removes hydrogen chloride (HCl) and sulfur oxide (SOx) in the flue gas through slaked lime. Eliminate soot in the flue gas through the bag filter. Flue gas passed through the bag filter is sent through the stack by the induced draft fan and discharged outside the system.

The steam generated by recovering heat in the boiler equipment is partially used as process steam and the rest generates electric power in the turbine generator. A portion of the generated electricity is used within the facility and the rest is transmitted outside the system and sold to power companies.

The bottom ash generated from this facility is packed into a container using the ash cooling equipment and then transported to a nearby landfill. Also, after the fly ash is mixed with chelating agent in the kneader and stabilization treatment is performed, it is packed into the container and processed at a nearby sanitary landfill.

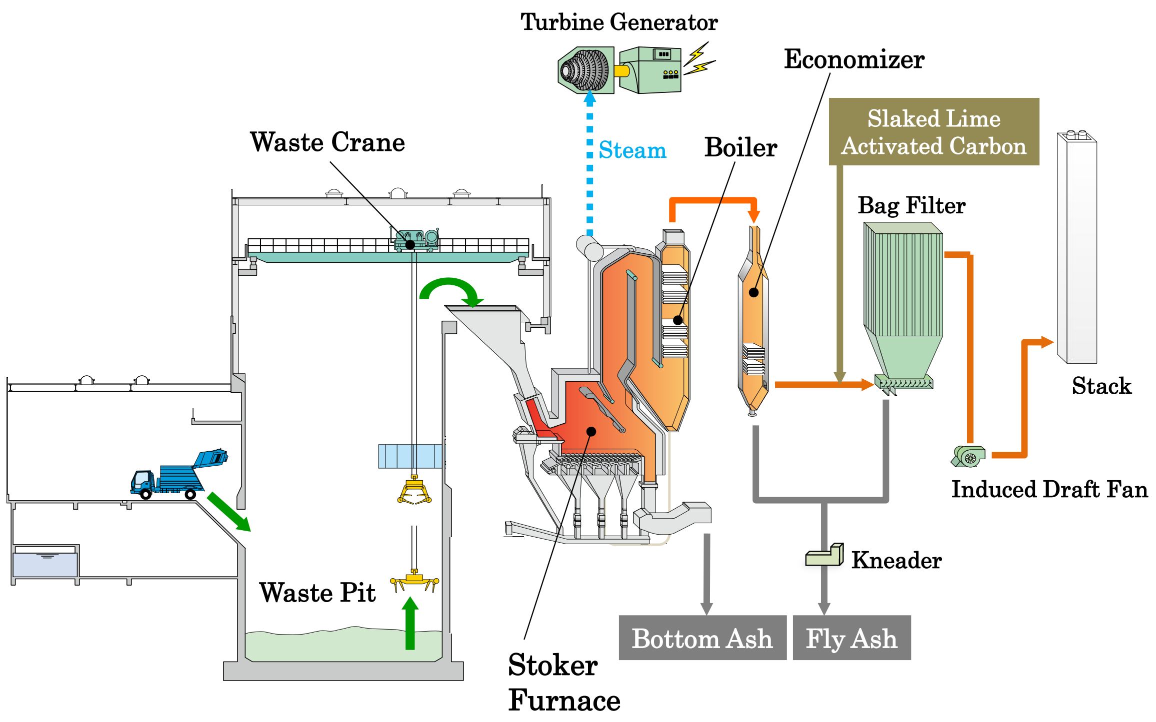


Figure 4.1 Summary of incinerator flow

4.1.2 Workings of each equipment

4.1.2.1 Combustion Equipment

(1) Waste charging hopper/chute

The waste charging hopper has three vertical sides with a wide outlet that prevents the inserted waste from bridging. The combination with the chute that has a waste seal high enough to prevent blowout of the combustion gas in the incinerator facilitates smooth provision of waste to the furnace. Also, there is a bridge release device installed for cases in which the inserted waste bridges.

(2) Waste feeder

The waste inserted from the waste charging hopper is supplied into the furnace effectively and smoothly through the hydraulic drive flat pusher type waste feeder.

The amount of supply from this waste feeder is controlled and set by automatic combustion control or remote operations.

(3) Stoker system (combustion stoker)

The combustion device is made up of a movable grate and fixed grate. The grate model is a JFE hyper grate with a cooling fin in the grate part and has strong cooling effects from air for combustion (primary air). Operation of the movable grate is oil hydraulic and speed is controlled/set using automatic combustion control or remote operation.

Also, the bottom of the grate supplies air for drying and combustion, so it is split into several blocks and the amount of air supplied to each block is adjusted and set individually using automatic combustion control or remote control.

(4) Incinerator main body

In the incinerator in this investigation, the JFE two-way stoker furnace with an intermediate ceiling is used. The two-way stoker furnace is compatible with a wide range of waste quantity, so it is optimum for Indonesia which has rainy and dry seasons, fluctuating waste quantity and expects increase in calorific value with future economic growth.

The primary combustion chamber is a boiler water-cooled wall structure that maximizes waste heat recovery. Inside the furnace is all lined with highly heat resistant refractory materials and a water-cooled wall structure or air-cooled wall structure is constructed in places where the clinker attachments occur easily.

The intermediate ceiling separates flue gas into the main and sub flue gas ducts and joins them again at the secondary combustion chamber (gas mixing chamber). Upon collision of those flue gases, the turbulent mixing effects promote complete combustion and controls the dioxins and nitrogen oxides (NOx). Also, since radiant heat can be effectively used on waste layers, better ash quality can be achieved, which greatly reduces the burden on the environment at the final disposal site.

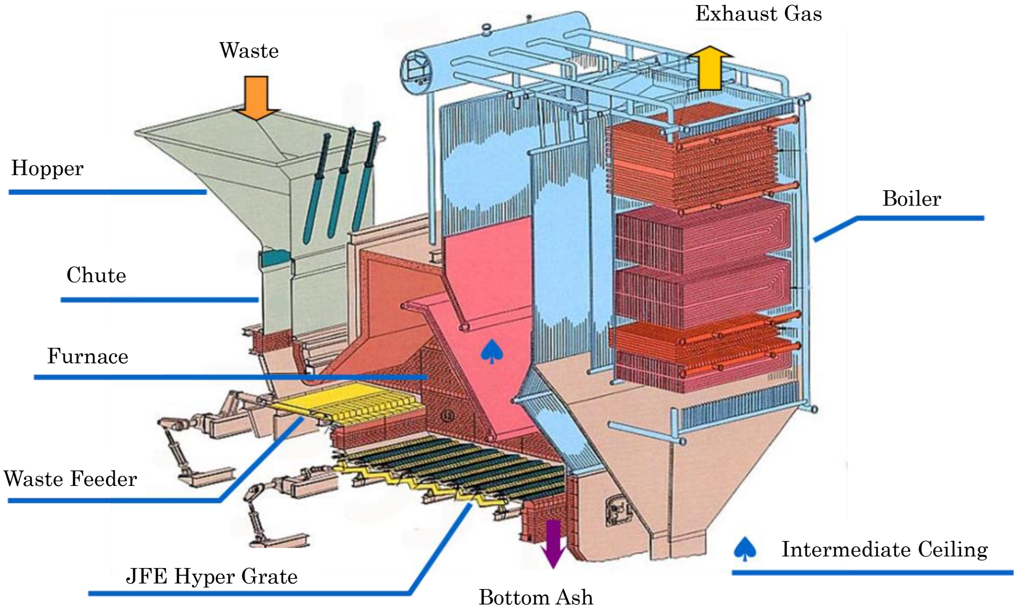


Figure 4.2 Structural drawing of JFE stoker furnace

4.1.2.2 Automatic combustion control (ACC) system

Conventional Automatic Combustion Control (ACC) systems maintained stability of the combustion state by feedback control that adjusted each operation amount based on the amount of control obtained from the waste incineration process.

However, while the feedback control shows good response over long-term fluctuation, short-term and momentary fluctuations do not have sufficient response, which is a disadvantage.

There, JFE incorporates fuzzy control into the conventional automatic combustion control system and uses the Hybrid ACC system, which allows for response even to short-term fluctuations.

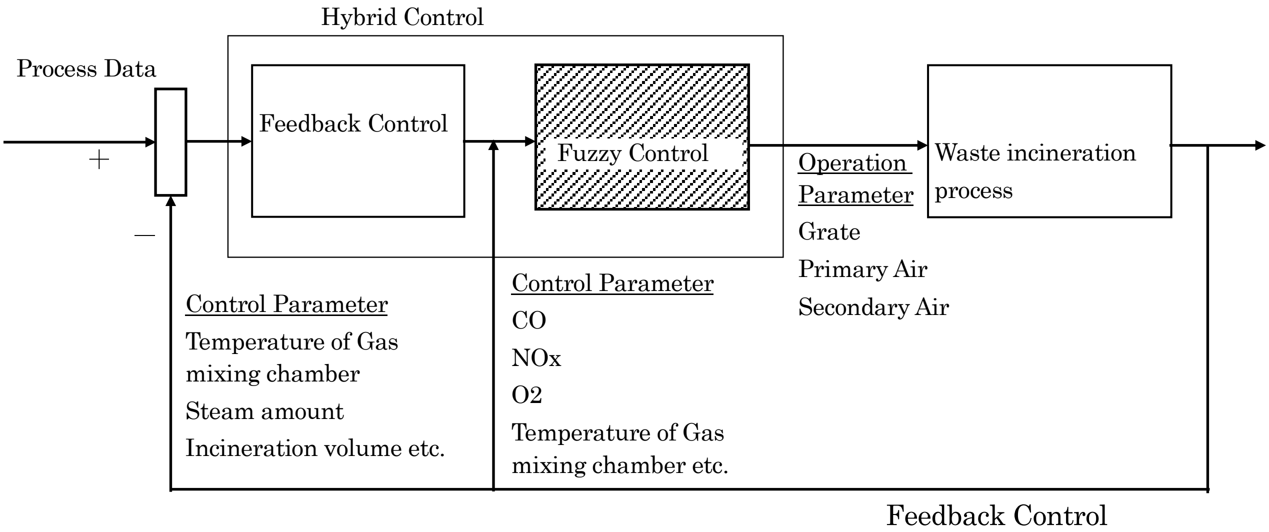


Figure 4.3 Overview of JFE Hybrid ACC

4.1.2.3 Combustion Gas Cooling Facilities

The purpose of the boiler is to cool down flue gas from waste combustion and to convert the collected calories to steam to make use of waste heat effectively. A single drum gravity circulation boiler is used in this plan.

Hot water that is deaerated in a deaerator and preheated by an economizer is supplied to the boiler drum. The boiler water then flows down by natural circulation through the flowing down tube and is transferred to the distribution tube, then to the heating tube, where it is heated and rises due to the difference in the gravity. It is returned to the drum again and steam is separated from water content.

After being heated by the superheater, the high-pressure saturated steam from the boiler drum is sent to the established steam turbine and used in electric power generation.

Three element control method is adopted for this boiler: feedwater amount, drum level and steam generation amount. This is an optimal method for controlling incineration boiler and the condition of which changes greatly depending on the waste quantity. These controls are automatically performed by setting the steam generation volume.

In the location of the boiler heat transfer pipe (superheater/economizer), there is a soot blower installed to remove dust, etc., from the transfer pipe. Boiler peripheral equipment and accessories include deaerator, demineralizer, boiler chemical injection system, continuous blow unit and boiler water monitoring unit.

4.1.2.4 Flue gas treatment facilities

(1) Temperature reducing device

With the waste incineration plant, it is normal to install the gas cooling tower as a gas cooling device. The gas cooling tower is equipment that cools combustion gas flowing from the boiler or economizer outlet using latent heat from water steam. Cooling the gas temperature quickly using the gas cooling tower prevents de novo synthesis of dioxins.

As this facility plays the important role of securing feasibility from revenue from selling electricity, it is designed for the boiler outlet temperature to remain around 160 degC and there is no gas cooling tower, in order to maximize generated output.

(2) Acid gas (HCl: hydrogen chloride, SOx: sulfur oxides, HF: hydrogen fluoride) eliminator device

In this investigation, the dry procedure of transferring or shooting powder slaked lime in the flue gas duct in front of the filter dust collector is used and is constructed of the slaked lime silo, slaked lime volumetric feeding equipment and shooting blower, etc.

Reaction product calcium chloride ($CaCl_2$) and calcium sulfuric acid ($CaSO_4$) are collected in granulated form from the filter dust collector.

(3) Device that removes dioxins

In this investigation, drying treatment is used to transfer/shoot the powdered slaked lime for removing the aforementioned acid gas and powdered activated carbon through the flue gas duct in front of the filter dust collector.

Powdered activated carbon shot out adsorbs gas dioxins in the flue gas. This powdered activated carbon and granulated dioxins are collected and removed by filter dust collection equipment.

Also, the JFE incinerator can control dioxins generation just by managing the combustion control appropriately with the effects of the aforementioned two-way structure, which contributes greatly to reducing the powder activated carbon volume.

(4) Device that removes dust and soot

In this investigation, the filter dust collector (bag filter) is used to remove fly ash from the flue gas generated from the incinerator, the aforementioned reactive materials to powdered agents and granulated dioxins from the flue gas.

The method of casting dust away from the filter dust collector is the pulse jet type and the collected dust is cast away using compressed air shot out from the nozzle at regular intervals.

The casted off dust is discharged from the lower hopper via the dust collector conveyor and carried to the fly ash silo on the fly ash conveyor.

(5) Nitrogen oxides (NOx) defibrillator

In the JFE stoker furnace used in this investigation, furnace is strongly affected by the aforementioned two-way effect, so the current emission standards can be complied with if there is appropriate combustion control. Therefore, in this plan, these device settings are not planned.

4.1.2.5 Heat recovery device

① Steam turbine

Waste heat (flue gas) that is generated during waste incineration is collected as steam by the boiler and the steam turbine/generator from that steam is run to generate electric power. In this plan, condensing extraction turbines are used and the extraction is used as steam for the deaerator process.

② Low-pressure steam condenser

This equipment is a system to cool down, condensate and liquefy all of steam used at the steam turbine. In this plan, an air condenser that doesn't require a lot of cooling water is used.

4.1.2.6 Ash handling equipment

(1) Bottom ash (incineration ash)

Ash that has been completely incinerated is dropped into the ash cooling equipment through the bottom ash chute and after extinguishing fire and humidifying, it is held temporarily in the ash container and regularly transported to the final disposal site by truck. In this plan, semi wet ash cooling equipment is used for the ash cooling equipment.

(2) Fly ash

According to Indonesia's Chemical Substance Control Law, in Government Ordinance No. 74, 2001, dangerous and hazardous materials (B3: Bahan Berbahaya dan Beracun) were regulated. B3 is categorized as shown below as substances that can be used, substances with restricted use or substances that are prohibited.

a. Explosive
b. Oxidizing
c. Extremely flammable
d. Highly flammable
e. Flammable
f. Extremely toxic
g. Highly toxic
h. Moderately toxic
i. Harmful
j. Corrosive
k. Irritant
l. Dangerous to the environment
m. Carcinogenic
n. Teratogenic
o. Mutagenic

Disposal of the aforementioned materials requires treatment at a processing facility that is recognized as a hazardous waste processing facility located in Bogor, outside of Jakarta. It is unclear at this time whether the aforementioned B3 is applicable to fly ash generated from the incinerator. But if it is necessary to transport it to a specified processing facility for which B3 is applicable then it is not viable without a significant economic blow to the processing business, and it is considered to be unrealistic. Therefore, in this FS, after fly ash undergoes heavy metal stabilization treatment with chelating agent, it is presumed to be allowed to be filled in the sanitary landfill.

The overall flow of heavy metal stabilization treatment of fly ash is shown in Figure 4.3. Fly ash discharged from the boiler, economizer and bag filter are transferred to the fly ash reservoir via an ash conveyor. A fixed amount of fly ash is supplied from the fly ash reservoir to the kneader and the amount of chelating agent suitable for that supply is put into the kneader. The fly ash mixed with the chelating agent via the kneader is stored in a container as stabilized fly ash and carried out of the system by a truck. In Denpasar, it is taken to the nearby Suwung landfill and filled in the sanitary landfill.

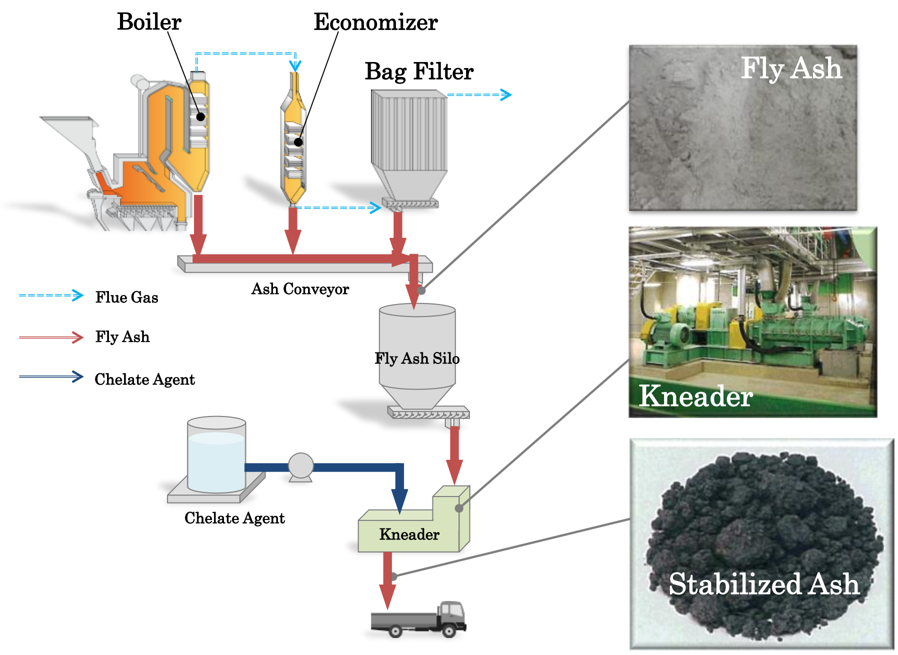


Figure 4.4 Outline flow of fly ash treatment equipment

4.1.3 Design conditions

4.1.3.1 Waste quantity/quantity

Based on the results of discussions between SARBAGITA Solid Waste Management Agency and the Denpasar City Bureau of Cleanliness, the amount of waste was set to 1,000 ton per day. Also, for waste quantity, the composition of standard waste was determined as shown in Table 4.1, according to the waste quantity analysis done at the "Incubation and Overseas Promotion of Japanese Waste Management and Recycling Industry in 2014, Waste to Energy Project for SARBAGITA in Bali, Indonesia, Environmental Baseline Survey." Furthermore, considering fluctuation in waste quantity, low quantity waste and high quantity waste composition is determined from the rules of thumb in Japan. There is a rainy season in Denpasar in which moisture content is expected to be high. The moisture content of the low quantity waste in the local hearing base is set to 60% and it is considered possible for heat treatment even at high moisture content. Also, waste quantity is determined through mutual agreement between SARBAGITA Solid Waste Management Agency and Denpasar City Bureau of Cleanliness.

Table 4.1 Waste conditions

Content		Unit	Minimum	Average	Maximum
Waste Capacity		ton/day		1,000	
Low Calorific Value		kcal/kg	1,300	1,860	2,220
Industrial Composition	Moisture	%	60.0	51,3	48.0
	Combustible	%	33.0	43.2	48.0
	Ash	%	7.0	5.5	4.0
	Total		100	100	100

Elemental Composition of Combustible Component	C	16.65	21.80	24.22
	H	2.29	3.00	3.33
	N	0.50	0.66	0.73
	S	0.03	0.04	0.04
	Cl	0.13	0.17	0.19
	O	13.40	17.53	19.49
	Total	33.0	43.2	48.0

4.1.3.2 Flue gas emission standards

In August 2016, the Ministry of Environment and Forestry defined a ministerial ordinance[1] regarding the flue gas emission standards. The following regulation values are set in this plant based on those ministerial ordinances. However, guarantee value is to be discussed with Denpasar city for the project.

Table 4.2 Emission standards

Content	Standard Value $O_2$11%, 25℃1atm		Conversion Value $O_2$12%, 0℃1atm	
Dust	120	mg/Nm3	98.9	mg/Nm3
SO_2	210	mg/Nm3	60.7	ppm
NOx (as NO_2)	470	mg/Nm3	188.9	ppm
HCl	10	mg/Nm3	5.1	ppm
CO	625	mg/Nm3	412.6	ppm
Hg	3	mg/Nm3	2.47	mg/Nm3
HF	2	mg/Nm3	1.65	mg/Nm3
Dioxin and furans	0.1	ngTEQ/Nm3	0.08	ngTEQ/Nm3

4.1.3.3 Specifications of major facilities

Table 4.3 shows specifications of major equipment.

Table 4.3 Specifications of major equipment

Facility	Content	Unit	Specification
Furnace	Type		JFE Hyper Stoker
	Capacity	tons/day/furnace	500
	Number of line	Line	2
Gas cooling facility	Type		Boiler
	Normal Steam Pressure	MPa(G)	4.8

[1] PERATURAN MENTERI LINGKUNGAN HIDUP DAN KEHUTANA REPUBLIC INDONESIA NOMOR: P.70/Menlhk/Setjen/Kum.1/8/2016 TENTANG BAKU MUTU EMISI USAHA DAN/ATAU KEGIATAN PENGOLAHAN SAMPAH SECARA TERMAL

Facility	Content	Unit	Specification
	(Outlet of superheater)		
	Normal Steam Temperature (Outlet of superheater)	deg.C	420
	Steam amount/furnace (based on average LHV waste)	t/h	54
Flue gas treatment system	Acid gas removal	-	Dry type (Slaked lime injection)
	Dioxin removal	-	Dry type (Activated carbon injection)
	Dust removal	-	Bag filter
	Nitrogen Oxide	-	Combustion Control
Power Generation	Type		Condensing extraction turbine + Generator
	Number		1
	Normal Steam Pressure (Inlet of turbine)	MPa(G)	4.6
	Normal Steam Temperature (Inlet of turbine)	degC	415
	Exhaust pressure	kPa(A)	25
	Steam amount (based on average LHV waste)	t/h	107
	Power Output (based on average LHV waste)	MW	20.0

4.1.4 Layout plan

In this investigation, the waste to energy plant is expected to be built in the space available in the existing Suwung landfill, but no specific location has been determined for construction.

The plant block planning needs to be determined in entirety with consideration for the geological surveying of the building site, utility facilities, vehicle traffic line operations and simplicity of operation and maintenance. The equipment inspections in this investigation consider the general block plans focusing on profitability and the actual block planning/engineering will be done at the detailed investigation stage when implementing the project.

Configuration overview

(1) Waste receipt is done using the ramp way method and by reducing the waste pit excavation volume,

construction costs can be reduced.

(2) A waste pit can store more than 3 days' waste treatment volume.

(3) Bottom ash and fly ash are yard retention and loader discharge and reduce the equipment costs of cranes, etc.

(4) In order to preserve the Denpasar landscape, set up a structure and install the plant indoors.

4.1.5 Overall construction schedule

The overall construction process for the construction plan and construction cost calculation is shown in the figure below. However, this doesn't take the following factors that may affect the construction process into consideration.

- Period 4 needed for environmental impact assessment of said country
- Engineering period fluctuations that need permissions for facility construction of said country
- Engineering period fluctuation needed for drawing and consent for drawing by customers in said country
- Engineering period fluctuations related to application of latest ordinances, regulations and standards
- Construction period fluctuation according to topography and ground information
- Risk of delay due to unavoidable reasons

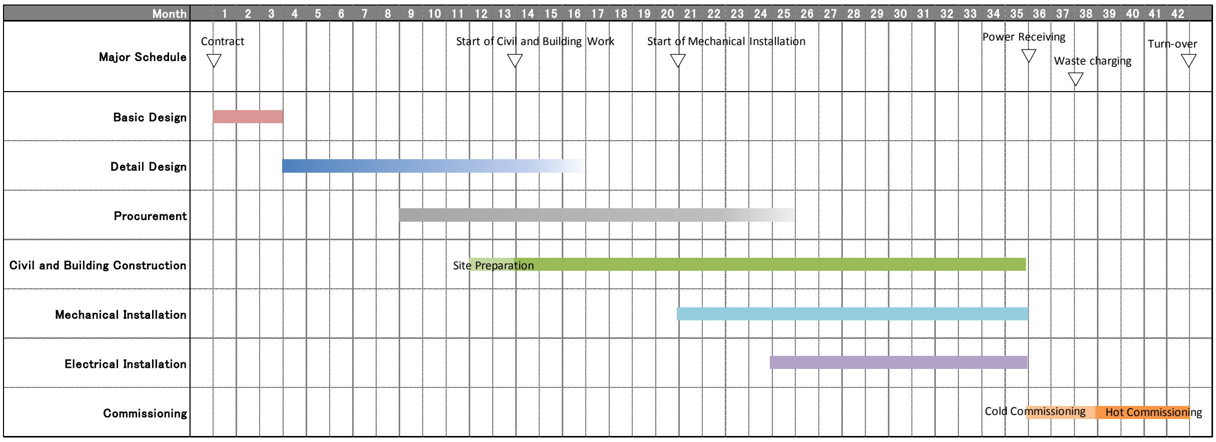


Figure 4.5 Overall schedule

4.1.6 Plant construction costs

The result of totaling construction costs of waste to energy plant are shown in Table 4.4.

Table 4.4 Construction costs of waste to energy plant

	Price (USD)
Total	118,000,000

4.2 Plant operational plan

4.2.1 Operational plan

Annual days of operation was set to 310 days, taking the necessary maintenance period into consideration for achieving long-term operation of the plant. Also, during the maintenance period for each furnace and in the event the treatable volume is exceeded, waste is assumed to be accepted by the nearby Suwung landfill.

4.2.2 Operation costs

1) SPC member

Appropriate personnel structure is required for power generation by waste facility operations. Plant operations are performed under the premise that locally employed staff is operating it. However, this takes into consideration that for the first two years, operation SV and maintenance SV are dispatched. Make it possible to acquire the necessary knowledge over two years and then localize operation management. Also, training and education through city-to-city collaboration is performed in Japan as necessary.

This plant continues running 24 hours a day and staffing includes four 12-hour shifts/day. Allocate maintenance personnel on a daily basis. A specialized technician is assigned to the power generation by waste facility because it has a boiler and turbine as well as special abilities. Furthermore, these operation costs the cost of clerks for operations into consideration. Personnel needed for incineration electric power generation plant operations based on the above conditions are shown in Table 4.5.

Table 4.5 Operator planning

Job Name	Number
COO (Chief Operation Officer)	1
O&M GM (General Manager)	1
QA/QC Manager	1
SHE Manager	1
Secretary	1
Admin Manager	1
Finance & Account Manager	1
Human Resource/General Affairs	1
Public Relation	2
General Clerk	3
Security	8
Housekeeping & Landscaping	1
Operation Manager	1

Job Name	Number
Maintenance Manager	1
Plant Operator	
Operation Leader	4
Operation Sub-leader	4
Operation worker	16
Licensed Engineer	4
Platform Operator	6
Ash Handling Driver	3
Weighing Bridge Operator	3
Plant Maintenance	
Maintenance Leader	1
Maintenance worker	3
Operation and maintenance SV	12
Total	80

2) Utility cost

Utility count required in power generation by waste facility operation is calculated based on operational plan. The amount of use for the various utilities is the amount for standard waste. In general, this will be procured locally in Indonesia, but import is being considered for certain special items.

Table 4.6 List of utilities

Content	
Water	Clean Water
	Sewage Water
Fuel	Diesel Oil
Boiler Chemical	Boiler Compounds
	Deoxidizer
Demineralizer	Hydrochloric acid
	Caustic Soda
	Sodium Sulfite
	Cation Resin
	Anion Resin
Flue Gas Treatment	Activated Carbon
	Slaked Lime

Content	
Waste Water Treatment	Hydrochloric acid
	Caustic Soda
	$FeCl_3$
	Coagulant Aid
Fly Ash Treatment	Chelate Agent
Oil and Grease	Hydraulic Oil
	Lube Oil
	Grease
	Turbine Oil

3) Operation and maintenance costs

Operation period is presumed to be 25 years and appropriate equipment maintenance is required in order to reduce the life cycle costs. From a preventive maintenance perspective, annual regular inspection and scheduled parts replacement and device updates are requisite.

4) Integration of operation cost

Yearly average operational fees for 25 years are started are shown in the table below.

Table 4.7 Operation costs

	Price (USD/year)
Total	7,000,000

4.2.3 Power generation plan

For electric power generation by waste incineration business, tipping fee and revenue from selling electricity are huge pillars of revenue for ensuring feasibility and this revenue is an absolutely necessary element for establishing the business. In this investigation, the heat recovery equipment is a high-temperature, high-pressure boiler at 4.2 MPa and 480 degC and the power generation equipment is a condensing extraction turbine, planning to improve heat recovery efficiency. Power revenue and expenditure table in this business plan is laid out below.

Table 4.8 Electric power revenue and expenditure

Content	Unit	Value
Operation days	day/year	310
Power Generation	MWh	20.0
Power Self Consumption	MWh	3.5
Power Selling	MWh	16.5
	MWh/year	122,760

Chapter 5 Stakeholders and Interested Parties

5.1 Various types of stakeholders and interested parties

This chapter organizes the stakeholders related to this examination.

5.1.1 Indonesian government central ministries and agencies

The organizational chart of the Indonesian government central ministries and agencies is shown in Figure 5.1. There are 34 central ministries and agencies in Indonesia as shown below. In Indonesia, in order to coordinate between various ministries and agencies, various agencies are organized under higher controlling agencies.

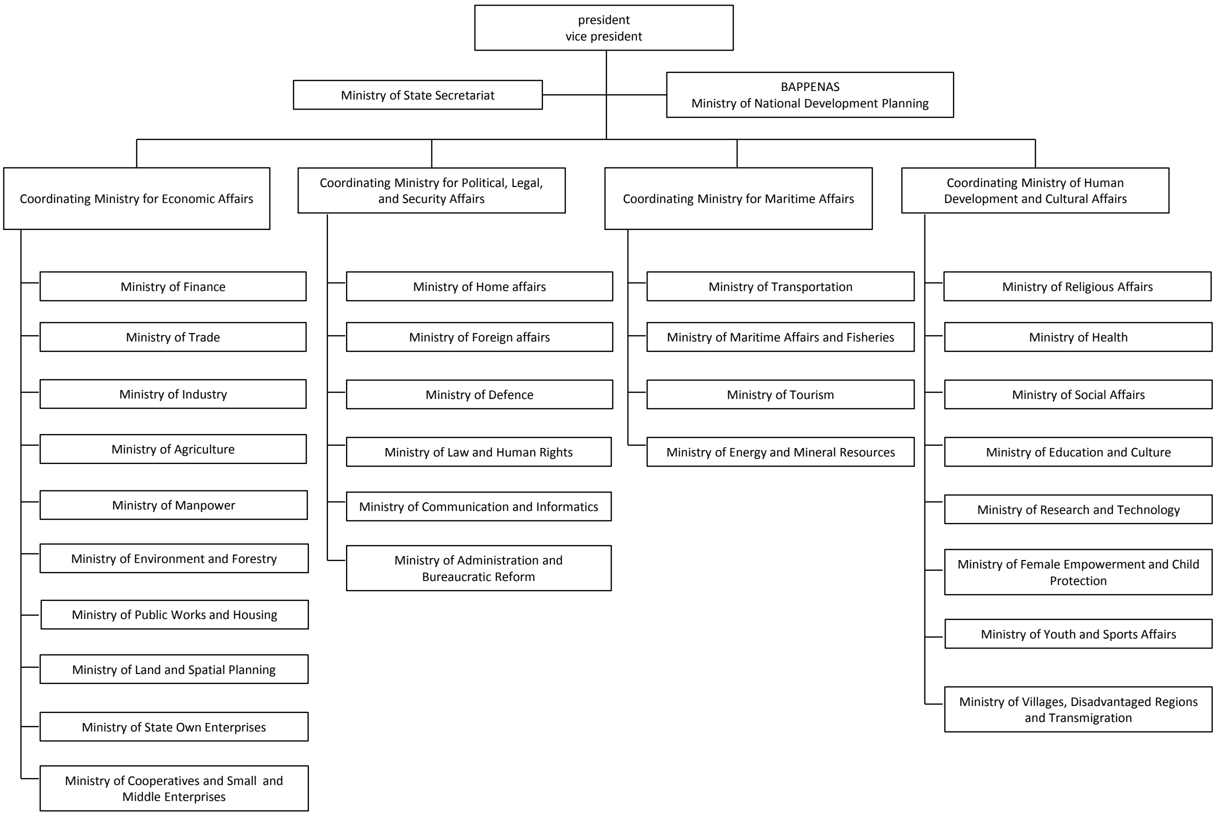


Figure 5.1 Organizational chart of central ministries and agencies in Indonesia

The agencies that are important in implementing power generation by waste business are described below.

1) Coordinating Ministry for Maritime Affairs
   - Coordination between various ministries and agencies
   - Management of ministries and agencies under the Coordinating Ministry for Maritime Affairs
   - Implementation of developing guidelines as the ministry in charge of power generation by waste business
2) Ministry of Environment and Forestry

- Policy planning, coordination and implementation of waste control (abstract side for laws, etc.)
- Authority and implementation of duties for EIA
- Policy planning, coordination and implementation of hazardous waste control

3) Ministry of Public Works and Housing
   - Policy and strategy planning for drainage and waste control (tangible side for facilities, etc.)
   - Facilitation of collection and disposal business (municipal solid waste)
4) Ministry of Finance
   - Major institution related to PPP (Public Private Partnerships)
   - Promotion of government assistance or government guarantee for businesses
5) BAPPENAS: Badan Perencanaan Pembangunan Nasional (National Development Planning Office)
   - Major institution related to PPP (Public Private Partnerships)
   - Compile plans and support project formation for PPP
   - Issue PPP BOOK
   - Integration of PPP plans and national development plan
   - Strengthen the ability of related subjects

5.1.2 Stakeholders in Bali

1.1) Overview of SARBAGITA Solid Waste Management Agency

A cleaning organization from Denpasar, Badung, Gianyar and Tabanan that manages the Suwung landfill in Denpasar. Regional population is approximately 2,200,000. The organization will be the counterpart of project forming in the future.

Currently, the amount of waste conveyed to the Suwung landfill is 800 to 1,000 tons per day as listed in Chapter 2. Currently, waste in Denpasar and Badung is conveyed to the Suwung landfill. Regarding other regions, waste is disposed in final disposal sites located in each of the regions, not the Suwung landfill and when those sites are filled to capacity, the waste is carried to the Suwung landfill, which in combination with the current amount of waste is expected to exceed 1,000 tons per day.

The result of the survey with the SARBAGITA union president was that it is SARBAGITA Solid Waste Management Agency who advances waste incineration plant planning and at the SARBAGITA Solid Waste Management Agency, approval of the representatives of each organization of SARBAGITA of each region is required for important decisions such as forming projects.

1.2) Administrative positioning of SARBAGITA Solid Waste Management Agency

The administrative wide area unions in Japan are defined as the organizations which are established by multiple normal local public agencies or special regions for the purpose of jointly running some of the administrative services and are defined as special local public entities in the Local Government Act. In Japan, the work to be done as group treatment with the establishment of special local public entities is excluded from the authority of related local public entities and is picked up by wide area union, so we can say that in Japan, wide area unions are public groups that hold the executive power and contractual rights of related business for group treatment issues. In contrast, SARBAGITA Solid Waste Management Agency is not a public group with executive rights regarding group treatment issues in Denpasar, Bali, Indonesia or related municipals.

In other words, in the event that a concession agreement was executed for building power generation by waste equipment at the Suwung landfill located in Denpasar and granting project rights to the private sector, the SARBAGITA Solid Waste Management Agency cannot become a party of such a contract because it does not fulfill the role of a Government Contract Agency as defined in Indonesia's PPP law. The party of the contract must be a state or municipality with legal contract function. In the future, when constructing business schemes and seriously considering formation of a PPP project, these points must be considered thoroughly and arrangements must be made for a party of the concession agreement.

2) Denpasar city, Bali

Suwung landfill is located in the city of Denpasar. After investigating the Denpasar Bureau of Public Cleansing, most of the waste carried to the Suwung landfill is from Denpasar and the operation rights of the Suwung landfill are held by the Denpasar Bureau of Public Cleansing, excluding some of the wastewater treatment equipment, etc., and the Denpasar Bureau of Public Cleansing is deeply involved in the operations. When planning waste incineration plant in the Suwung landfill, understanding and approval of the top decision maker for operation of the landfill site, the mayor and the vice mayor of Denpasar, is required. Because the offensive odor and accidental fires, etc., from the Denpasar Suwung landfill have had a severe effect on the tourism industry and also affect the local residents directly, Denpasar has positive intention for introduction of the intermediate treatment plant and has sufficient desire to resolve waste treatment problems by executing a concession agreement with NOEI for landfill gas electric power generation (including accepting waste and final treatment management) in the past. Also, as mentioned before, the SARBAGITA Solid Waste Management Agency is not a Government Contract Agency as stipulated by the PPP law, so they have a possible site for construction in the Suwung landfill and since the city of Denpasar controls the majority of waste conveyed to this landfill site, there is a strong possibility that they will be the contracted party in the power generation by waste business for Denpasar. It is likely they will work with an SPC (Special Purpose Company) for incineration of waste at Suwung landfill as a Government Contract Agency stipulated in Indonesia's PPP law.

5.1.3 Stakeholders required in project formation

Through this investigation, we were able to confirm the stakeholders as mentioned above, but the main stakeholders required in forming future projects are listed below.

(1) Local influential construction corporations

In order to complete construction without delay in the planned construction site, it is absolutely necessary to involve local influential construction corporations with sufficient ability and experience in Indonesia. Through this investigation, JFE Engineering Corporation contacted multiple local influential construction corporations. Among those was Company B, the largest construction company in Indonesia, with plenty of results in engineering, procurement, construction and commissioning (EPCC) in petrochemistry and energy fields and sufficient financial strength, which was selected as the consortium partner for the construction and is currently at the stage of continued detailed negotiations.

(2) Developer

In this investigation, the SARBAGITA Solid Waste Management Agency and Denpasar want a project formulated in PPP (BOT scheme) and in the future, while continuing discussions as a PPP (BOT scheme) project, it will become difficult to operate the business with a single corporate investment. Even from the perspective of the foreign investor legal regulations in Indonesia, as with the BOT business in other fields in Indonesia, equity co-investment from multiple developers is absolutely necessary and it is necessary to establish an SPC related to waste processing and construct a system to jointly operate the business. When selecting equity co-investors, it is also heavily involved in project financing as described in detail in Chapter 6, so it is necessary to select developers carefully. It is absolutely necessary for the committed investment to be fulfilled quickly and possible candidates include developers who are actually investing in and operating incineration electric power generation IPP business such as thermal electric power generation in Indonesia, and Japanese general trade companies who are experienced in the investment of the IPP field and have sufficient financial strength. Currently JFE Engineering Corporation is selecting major local companies with Japan's General Trade Company C and developer selection negotiations are expected to continue negotiations.

(3) Selection of financial institution

Financial arrangement is explained in detail in Chapter 6, but as project financing formulation is the most important issue for achieving this business, project financing formulation by governmental banks like Japan International Cooperation Agency (JICA) and Japan Bank for International Cooperation (JBIC) are necessary and it is also necessary to organize the problems for financing problems before negotiating with financial institutions.

Chapter 6 Project Finance Application

This chapter considers and examines financial arrangement method and accompanying problems while taking financial scheme of Denpasar power generation by waste into consideration.

6.1 About project finance application

Project finance is a financial method that generally uses cash flow created from a project as the source of revenue for returning loan. Therefore, unlike corporate finance, which is financing based on a corporation's credit, project finance is generally a non-recourse form of funding that does not allow for claims to the developer even in the case of said project going bankrupt, or a case-limited recourse form of funding for which the developer bears part of the risk. Also, the organization responsible for project finance is usually SPC, and financing is performed by operating the project itself as an independent company. An SPC is normally established to execute the target project and in many cases the capital for it is limited. Therefore, since financial institutions may only have the business property (operating facility) and rights of the project as the security for providing the financing, they will examine the profitability and continuity of the target business extremely severely (due diligence) as laid out below before starting project financing.

1) Profitability

In the event that the business of the lender becomes no longer profitable and is impossible to return the funds, the financial institution providing the financing has a risk of irrecoverable debts as the project finance is non-recourse financing. Therefore, the project cash flow is the most important security for the lender and sufficient examination as to whether enough profit to ensure repayment can be secured or not is an important element in project financing. Also, as the project activities are performed during the validity period, close inspections as to whether repayments can be made within the project period or not are performed.

2) Continuity

Project finance assumes project continuity during the repayment period. While more details will be provided later, how the SPC secures going concern assumed in project continuity in concession agreement (contract) as its duty is very important.

3) Risk

Risk assessments related to continuity is properly analyzed and BCP (Business Continuity

Planning) and BCM (Business Continuity Management) are drafted. It is important to draft an action plan so that business can be resumed quickly when a crisis occurs and use insurance to secure the capital necessary to continue the project even when business is interrupted due to force majeure.

Table 6.1 Differences between project finance and corporate finance

Content	Project Finance	Corporate Finance
Business Entity	SPC	Corporate body
Restriction on use	Only for a Project	No Restriction
Borrower	SPC	Corporate body
Source of revenue for returning loan	Project Cash Flow Only	Profit from all operating activities
Repayment Period	Within 10 Years	Short or Long terms Debt
Due Diligence	Project Cash Flow and Project Risks	Creditability
Collateral	Project Cash Flow and rights of Project	All of assets

4) Financing Source

Major financing source candidates assuming project finance fit into the following broad categories:

(1) Financing through public financial institutions
(2) Financing through private financial institutions
(3) Financing through insurance companies and others

As project financing is the only option for realizing power generation by waste in Denpasar, we surveyed the prerequisite conditions for various financial institutions required for project financing when implementing this F/S. Considering the characteristics of power generation by waste, we limited the survey to (1) public financial institutions and (2) private financial institutions. The following is an overview of the subjects and the details of the survey:

4-1) Financing through public financial institutions

Major public financial institutions for the financial support in exporting infrastructure may be JICA (Japan International Cooperation Agency), JBIC (Japan Bank for International Cooperation) and NEXI (Nippon Export and Investment Insurance). As project formation support by a government financial institution, the JBIC is planning a 30% increase for the next five years for Partnership for Quality Infrastructure as referenced in the Japan Revitalization Strategy 2015 for a total of approximately USD $110 billion in infrastructure investment in Asia. Therefore, since a policy to establish a new system of supplying risk capital and actively invest in high-risk projects has been announced in an attempt to strengthen JBIC function, application of public financial institutions such as JBIC and JICA is considered absolutely necessary even in project financing for the business of power generation by waste in Denpasar. As laid out below, we surveyed appropriateness of project financing for the JICA Private Sector Investment Finance Division with the implementation of this F/S.

(1) Date: October, 2016
(2) Location: JICA HQ
(3) Topic: Project finance application in Indonesia
(4) Interviewee: Private Sector Investment Finance Division
(5) Details: Necessary prerequisites and important matters for project financing

a) Credit limit risk taking is normally very difficult for municipalities in Indonesia. A sovereign guarantee (IIGF, etc.) is necessary when a material breach (unpaid disposal costs) related to business continuity is caused by Denpasar.

b) Business investment agreements, PPA (Power Purchase Agreement) and business schemes are bankable contents.

c) Hazardous waste such as fly ash (B3 (see section 4.1.2.6)) is disposed of appropriately and there are no problems in the environmental impact assessment of this project.

We came to the conclusion that if the above conditions are provided for, there is a reasonable possibility of achieving non-recourse funding.

4-2) Financing through private financial institutions

The method of applying private financial institutions includes using Japan domestic mega banks, regional banks, trust and banking corporations or overseas banks. Regarding private financial institution application, the reality is that there are various risks for infrastructure projects including country risks such as equipment requisition by the government, governance risks in facility construction and operation processes, and exchange risks when investing from overseas, along with the fact that the business of power generation by waste normally does not have a high profitability, which means that there is already a significant obstacle for financing the power generation by waste business. For implementation of this FS, we surveyed multiple domestic banks in Japan (private and foreign financial institutes) regarding the possibility of project financing. In all cases the answer was that financing in a non-recourse form is difficult due to the fact that private financial institutes would not have the right to make claims against the developer in regards to the power generation by waste business in Indonesia, and we confirmed that private institution financing would be extremely difficult in project financing.

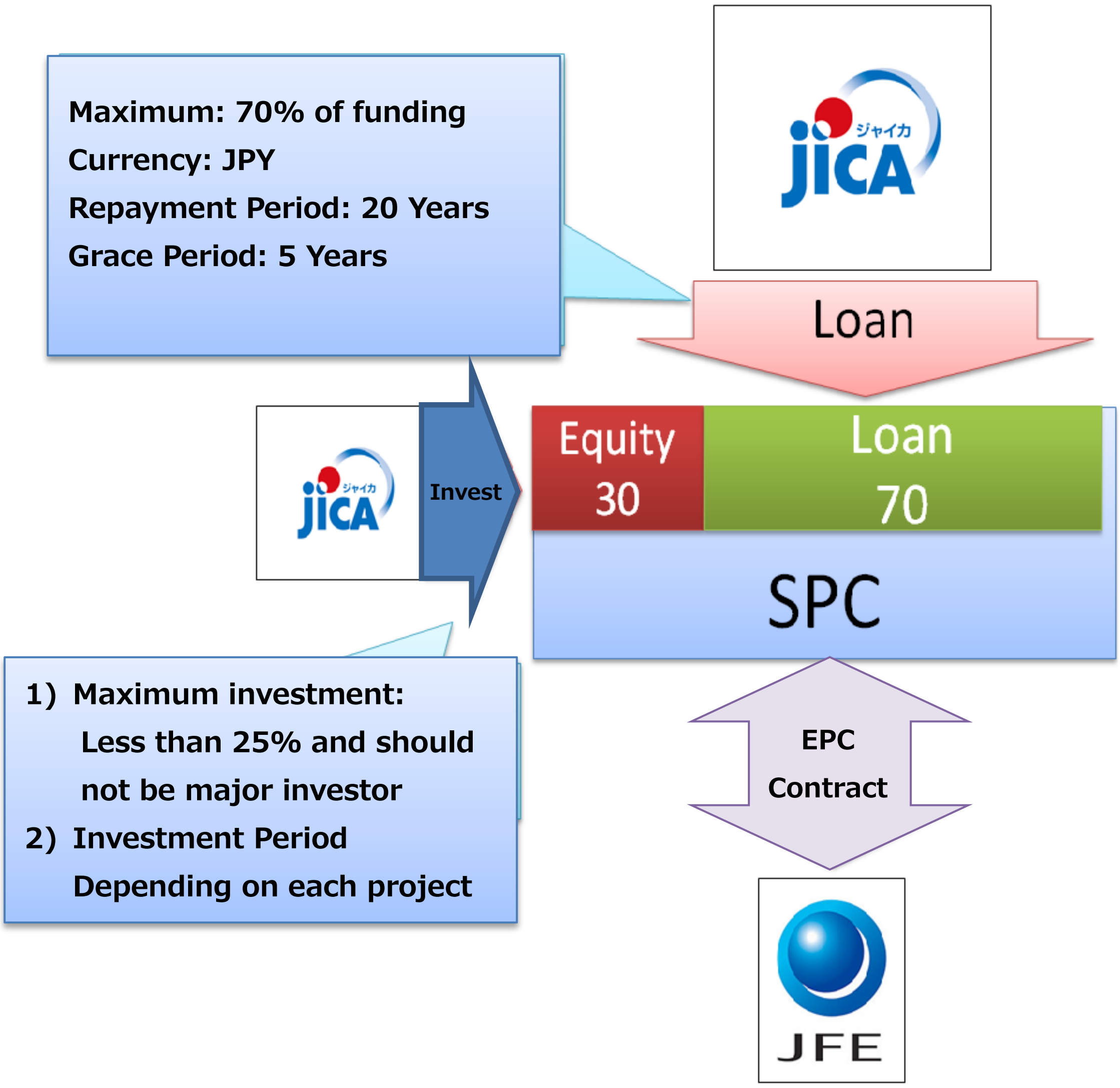


Figure 6.1 JICA investment scheme (estimate)

6.2 Advantages to project finance application

Advantages for borrower and lender in project finance application are laid out below:

1） Advantages for borrower

1.1) Dispersion of risk

Financing in the form of project finance, as a rule, does not put the burden of fulfillment of an obligation (repayment) due to unprofitability of the project on the developer. Therefore, there are many cases in which private sector business organizers may participate in projects such as the power generation by waste project, for which corporate finance is normally not possible. Also, by breaking up said project risks and then distributing them equally among contributors, it is possible to disperse and reduce developer risk.

1.2) Reduced financial burden

When financing using the corporate finance method, there is a risk of increase in debt-equity ratio on the balance sheet leading to decreased financial strength and obstacles occurring in new corporate financing. However, the SPC investment corporation can have the advantage of reducing various financial burdens by applying project finance. Also normally project finance is not calculated as a debt on the balance sheet so there are many cases in which it is not a new financing obstacle.

2） Advantages for lender

2.1) High profitability

The high interest rate level of the project finance compensates for the fact that the risk-taking element is stronger compared to corporate finance, so the lender can expect a high return.

2.2) Competitiveness

Financial institutions with a goal of improving international competitiveness can take advantages of participating project financing because those that take initiative in arranging project finance in the infrastructure sector are rated extremely highly.

6.3 Security package structure

As mentioned before, certain repayment of debt from project cash flow generated from the business is an absolute necessity for project financing and it is necessary to construct a business scheme that will definitely be able to repay loans. Therefore, financial institutions take initiatives to build a security package with the purpose of continuity and maintenance for project financing. The security package is a security mechanism in project finance and in many cases Step in Right to the business in the financial agreement is established for the lender's speedy assurance of the required collateral and rights below, for project continuity and maintenance.

(1) Management and securing of project cash flow
(2) Securing additional financing from sponsors
(3) Obtaining all the rights necessary for project continuity (Various contractual status, SPC stock, etc.)

In this way, the financial institutions who are the lenders in the project finance secure the necessary rights for continuity and financing collection and create in advance a structure that enables smooth step-in. In this way, with optimization of business risk management as a condition, project financing by financial institutions becomes possible.

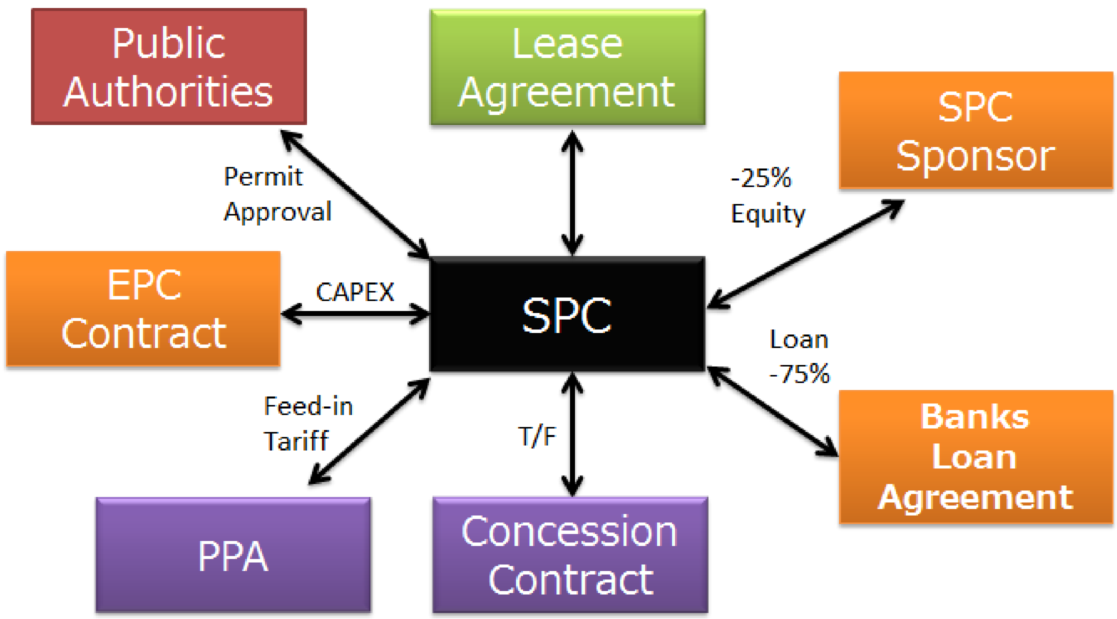


Figure 6.2 Security package structure

6.4 Possibility to apply project finance

In order to realize the power generation by waste project for Denpasar, BOT commercialization in a private finance initiative form that complies with the Indonesia PPP law is necessary, which is described in Chapter 2, project financing is absolutely necessary for BOT commercialization. In this section, the possibility of project financing in the Denpasar power generation by waste project is considered.

1） Risk analysis in project financing

As described above, construction of a security package by the financial institution is absolutely necessary in project financing and the importance of the risk and agreement to project financing is immeasurable. In general, risk should be assigned to those who can process it the most appropriately and a detailed awareness of risk is required for that. Therefore, first we will extract the risk items in the power generation by waste project in Denpasar and then consider any agreements as protection for those risks.

1.1） Risks from the project planning stages to completion/running of the project

Since the revenue and expenditure plan of the project assumes that this project will run with the planned performance within the planned period within the planned project budget, in the event of a delay in completion due to interruption, there will be a deep influence on the cash flow which raises serious doubts regarding the continuity of the project. The power generation by waste business requires starting commercial operation within the determined time frame with the determined level of performance, just like other electric power generation/production plants. The followings are the risk factors in completion of the project and start of commercial operation in Denpasar power generation by waste project.

（1） Risk attributable to developer

a） Investment and credit risk

（2） Risk attributable to the project owner and off taker (power purchaser)

a） Risk related to the ability to carry out plans

b） Risk of nonfulfillment of financial obligations

（3） Risk attributable to EPC contractor

a） Project Management

b） Other issues attributable to adaptive technology

(4) Other external factors that lead to risk after project completion (country risk)

a) Risks attributable to the country and government

b) Force majeure incidents

c) Other business environment changes

(5) Facility management risk

2) Risk reduction measures

Consider the following risk reduction measures for the risks extracted in the previous paragraph from the project planning stage to completion.

2.1) Risk attributable to developer

Consider the overview of risk attributable to the project developer and risk reduction measures as follows:

2.1.1) Investment and credit risk

Investment risk is the risk of whether each developer will execute the funding obligation based on the prior consent to the establishment of SPC and since preparing investment is absolutely necessary when starting the project, it is important to reduce any risks with the investment from developers.

2.1.2) Risk reduction measures (investment and credit risk)

In order to reduce investment and credit risk, it is absolutely necessary to run a prior inspection of the investor at the stage of selecting the developer and perform thorough due diligence of the investing firm through an external private sector investigator such as Duns & Bradstreet or COFACE for the (1) financial strength and (2) the project implementation system of the developer. Also, in the event there is an unavoidable problem with the credit of the SPC developer corporation, there will likely be cases that require building of a scheme to compensate for financial risks of the investing corporation in ways like requesting guarantee of an financial institution (B/G = Bank Guarantee, Stand by L/C) for the contribution performance in prior consent of SPC establishment.

2.2) Risk attributable to project owner

This section considers the overview of risks attributable to the project owner and risk reduction measures as follows:

2.2.1) Risk related to the ability to carry out plans

Risk related to the ability to carry out plans attributable to the project owner is categorized as follows:

(1) Risk related to the bidding process structure

(2) Risk related to bidding evaluation system structure

A basic concept in PPP projects is that in order for country/regional municipalities to provide high quality services to the private sector at low cost, it is necessary in public purchases to somehow procure high quality goods and services based on the basic concept of Value for Money (VFM), which is "(regarding fixed cost) procuring items with the most value," and it is important to secure as much competitiveness as possible to achieve this. It is necessary to engage in bidding in order to secure competitiveness, but in normal PPP projects, the processes described in Figure 6.3, executing feasibility studies, selecting advisers and determining the details of the business scheme and contract, need to be followed before bidding. Advisers and consultants are selected for financial, legal and technical decisions, the contents of the business scheme and contract are determined, technical specifications are set and finally the bidding conditions and contract details are considered. Therefore, it is important to select a consultant or adviser with sufficient specialized knowledge in the aforementioned fields and construct a bidding system. In addition, in order to form PPP projects in Indonesia, as mentioned in Chapter 2, it is necessary to go through the process in compliance with ordinances and a close partnership with the central ministries and agencies of Indonesia is required. Therefore, if a municipality with no knowledge or experience starts bidding while the bidding system is still unstructured, it is difficult to eliminate inferior and unqualified vendors with a high possibility that the bid may end unfavorably. There are many cases of unsuccessful PPP project bidding in Indonesia and with the power generation by waste project, a bid was made in 2014 initiated by the city of Batam for a PPP project BOT scheme of the power generation by waste project (1,000 tons/day), but it ended poorly for multiple reasons such as insufficient considerations for the bidding conditions, the central sovereign guarantee (IIGF) being inapplicable and site obstacles. In the event projects are promoted without the proper bidding system structure, including in the Denpasar power generation by waste project, there is a high possibility of unsuccessful bidding and risk of selecting unqualified vendors.

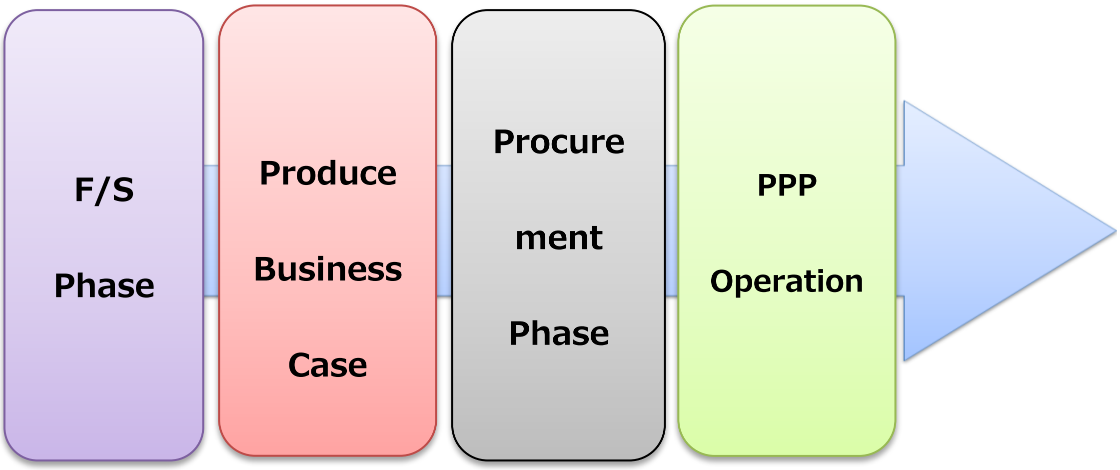


Figure 6.3 PPP implementation process

2.2.2) Risk reduction measures (risk related to the ability to carry out plans)

In order to eliminate as much risk as possible in the bidding process structure and bidding value system, it is important to keep in mind that it is absolutely necessary to understand the correct bidding process in accordance with PPP law and necessary to take the following measures:

(1) External consultant application for PPP planning/bidding

Sufficient prior considerations for the process described in Chapter 2 are absolutely necessary for formation of PPP project. Before the bid announcement, it is necessary to implement Outline Business Case (OBC), in OBC consider the business scheme, business range, city's financial margin and ability to pay and clarify the total costs that Denpasar, the project owner, will cover, such as disposal costs. If it is difficult to secure financial resources then it is necessary to apply for supplements from the central government. Using external consultants with years of experience in project formation in the PPP field in Indonesia such as P.T. SMI and IFC (International Financial Corporation) would be effective as an OBC measure or a method to proceed with PPP projects appropriately according to Indonesia law. Therefore, it is considered necessary to propose the use of such external consultants to the city of Denpasar in the power generation by waste project as well.

(2) Application of technical consultants

A current major matter of concern shared among the power generation by waste business projects in Indonesia is that, while heat treatment of household general waste (MSW) is also referenced in Presidential Decree No. 18 which is described in detail in Chapter 2, guidelines for selection of adaptive technology are undeveloped. Currently in Denpasar, various technologies, such as composting waste or plasma gasifying and melting furnace, are being proposed by private corporations from around the world and many of those proposals likely include technologies that are inappropriate or with no previous results. In PPP projects as well, before the bidding announcement the evaluation and selection of adaptive technology should be performed. If a prior qualification investigation and bid are executed without proper selection of the target technology, appropriate evaluation will not be performed and there is a risk that an incompetent technology will be selected. In order to select competent technology, it is absolutely necessary to have technical knowledge of heat treatment of waste, so it is necessary for Denpasar to use a technical consultant with sufficient technical knowledge.

2.2.3) Risk of nonfulfillment of financial obligations

In Denpasar power generation by waste business, a concession agreement for the intermediate treatment of waste using the power generation by waste plant will be concluded between Denpasar, the project owner, and SPC. In the unlikely event that Denpasar, the project owner, causes a material breach in the concession agreement, there is a very high possibility that this will affect SPC business cash flow (business continuity/maintenance). The following is one example of material breach related to SPC continuity.

(1) Interrupted and insufficient trash supply

Providing the amount of waste stipulated in the power generation by waste concession agreement between the project owner and SPC is the responsibility of Denpasar, the project owner. In the event of interruption of supply of waste or a situation in which the supply does not satisfy the capacity of the plant, SPC will suffer loss of profit (electricity sale loss), which will have a severe effect on cash flow and may hinder business continuity.

(2) Delayed or outstanding payment of disposal costs

SPC comes up with costs for plant operations through selling of electricity to a power company and tipping fees, and that revenue is the repayment source for the financing (project finance), so in the event disposal costs are not paid appropriately, there is a high possibility that it will have a severe effect on cash flow and is expected to affect the business continuity.

(3) Removal of inappropriate waste

In the event waste other than the one listed on the concession agreement is brought in, causing breakdown or malfunction at the plant that generates additional costs and hinders operations, there is a high possibility that it will have a severe effect on cash flow and is expected to affect the business continuity.

2.2.4) Risk reducing measures (risk of nonfulfillment of financial obligation)

(1) Arranging risk sharing

Regarding reducing business risks resulting from the project owner, in order to stabilize business, it is first important to extract and categorize the details of the risks in the entire period of PFI business and share the risks appropriately between the party and the project owner, following the PFI business principle, “the party that can manage that risk most appropriately shall bear it”. As laid out below, implement arrangements for the risk sharing plan when implementing Denpasar power generation by waste business using private finance initiative business (BOT scheme).

Table 6.2 Risk sharing in waste to energy business

Phase	Items	Contents	Risk Allocation	
			Owner	SPC
Common Risks	Escalation	Escalation Risks for Utility, Labor, Fuel costs	○	
	Increasing interest rate	Risk for Increasing interest rate		○
	Change in Law	The additional costs arising from Extension of time., Change of specification, Suspension of project due to change in law	○	
	Authority Approval	The additional cost arising from delay of obtaining of required authority approval to be obtained by Owner	○	
		The additional cost arising from delay of obtaining of required authority approval to be obtained by SPC		○
	Local inhabitants	Opposition by local inhabitants	○	
	Force Majeure	The additional cost due to Force Majeure	○	△
Construction Phase	EIA	The cost arising from suspension of project as a result of EIA	○	
	Reconnaissance survey	The additional cost due to inadequacy of the survey to be carried out by SPC		○
	Engineering	The additional cost arising from defect of Engineering of Plant		○
	Change of design	The additional cost due to change of the design by the Owners convenience	○	
		The additional cost due to change of the design by the SPC's convenience		○
	Extension of time	The additional cost due to extension of time by the Owner's convenience	○	
		The additional cost due to extension of time by the SPC's convenience		○

Phase	Items	Contents	Risk Allocation	
			Owner	SPC
	Delay on time for completion	The additional cost due to delay on time for completion by the Owner's default	○	
		The additional cost due to delay on time for completion by the SPC's default		○
		The additional cost due to delay on time for completion by Force Majeure	○	△
Operation Phase	Change of operating condition	The additional cost due to change of operating condition by the Owner's default or convenience	○	
	Delay on payment	Delay on payment of T/F	○	
	Performance of the Plant	Failure of performance guarantee		○
	Waste volume	The loss arising from insufficient volume of waste	○	
	Waste condition	The additional cost arising from change of contract waste condition	○	
	Inapplicable waste	The additional cost arising from inapplicable waste	○	
	Maintenance	The additional cost arising from Operation and Maintenance to be done by SPC		○
	Damage from deterioration	The additional cost arising from deterioration		○
	Third party Liability	Third party liability arising from Noise and Odor from plant		○
	Fire accident	Damage from fire accident	△	△
Transfer of Ownership	The cost of transfer of ownership	The cost arising from transfer of ownership of plant after concession period		○

Phase	Items	Contents	Risk Allocation	
			Owner	SPC
	Repair fee	The cost of repair due to transfer of ownership	△	△

Notes: Defrayer ○: Main, △: Sub

(2) Conclusion of concession agreement based on risk sharing plan

In general PFI business requires estimating all risks that may occur during the business period and allocating such business risks according to management ability of each stakeholder, then each stakeholder taking responsibility for managing their risks. This is based on the idea that overall business risk costs may be reduced if "the party that can manage that risk most appropriately shall bear it" as mentioned above. Having an SPC bear risks that it does not have the capacity for (or that it should not be bearing) leads to increase in business costs, resulting in hindrance to bankable project status and it is one of the major factors that make project financing difficult. Even in Denpasar power generation by waste concession agreement, it is necessary to appropriately share business risks and it is absolutely necessary that the securing prerequisites and all required conditions necessary for SPC business continuity are comprehended in the concession agreement for project financing.

(3) Concession agreements and sovereign guarantee

In order to reduce business risk attributable to the project owner, it is important to execute a concession agreement based on appropriate risk sharing after arranging business risks as shown in Table 6.2 as well as to secure provisions required for SPC continuity in the agreement. However, even if these rights are ensured in the concession agreement, if the project owner fails to quickly fulfill liabilities due to financial credit limit problems, difficulties in SPC business continuity are expected. Therefore it is expected to have a massive effect on SPC business continuity such as delayed or impossible payment of disposal costs or insufficient or impossible supply of waste. In order to reduce such risks, in addition to ensuring rights in the agreement as mentioned above, it is absolutely necessary to construct a scheme that the central government, which is in a higher position, guarantees fulfillment of liabilities in the concession agreement in place of Denpasar in the event the incidents occur. This application of the guarantee system applicable to sovereign guarantee, which is an IIGF that can be applied in Indonesia PPP projects, as mentioned in Chapter 2, is absolutely necessary for solid securing of SPC business continuity for project financing.

2.3.) Risk attributable to EPC contractor

This section includes an overview of risk attributable to EPC contractors and the risk reduction measures related to construction of the power generation by waste plant as follows:

2.3.1) Risk of delay in completion or insufficient performance

The project construction agreement is called the EPC contract and it includes engineering, procurement of materials and construction. By building project structure into the EPC agreement, it is possible for the developer to transfer risks related to construction to the EPC contractor. At a power generation by waste plant, generally a single contractor takes responsibility for the entire EPC and completes the project, passing it on to the SPC side (Taking Over) at the stage when it is possible to start commercial production after commissioning.

Also, normally the EPC contractor is selected using the lump sum contract method in full turnkey, which is a contract method with a total cost of EPC confirmed in construction contract, in the electric power generation plant field. In the event construction is delayed or cannot be completed and the issue is attributable to the contractor, it affects operations of the plant and also severely affects the cash flow. However, contract damages in EPC due to delayed or inability of the EPC contractor to execute construction are normally limited and loss of profit due to plant unable to run is exempt. Also, since the limitation of liability is definitely set in the EPC agreement, in the event a risk occurs that construction is no longer possible when building the plant, this will have a negative impact on SPC cash flow and there is a high possibility that it will severely affect business continuity.

2.3.2) Risk reduction measures (risk of delay in completion or insufficient performance)

In order to reduce the risk of delayed construction or insufficient performance caused by the EPC contractor, it is extremely important to select established technology and perform sufficient due diligence regarding the target technology and most of all, to carefully examine whether the EPC contractor has sufficient experience and results. In the power generation by waste field, which burns MSW, the most widely used technology worldwide with the most operational results that allows stable intermediate treatment of household refuse is the stoker system combustion furnace as described in Chapter 3. And in Denpasar power generation by waste business as well, MSW is expected for the waste to be processed, so it can be asserted that the optimum technology is stoker system combustion furnace. In the past in Denpasar, NOEI installed Kompogas power generation equipment at the Suwung landfill, but it was abolished without running even once. Also, due to the high number of failed cases of waste processing business by inappropriate technology and unqualified waste processing corporations throughout the world, in terms of SPC cash flow, it is important to select an EPC contractor with appropriate technology and sufficient construction ability and execute an EPC agreement that prevents construction costs from exceeding the initial budget (cost overruns).

2.3.3) Construction agreement formation for Denpasar power generation by waste business

In the Denpasar power generation by waste construction agreement, the plan is to install the new refuse treatment system independently developed by JFE Engineering, Hyper 21 Stoker System, which achieves highly efficient/low public nuisance incineration treatment, as mentioned in Chapter 2. In the past 50 years, JFE Engineering has established about 500 power generation by waste plants all over the world. The company’s business is well-established with highly reliable technology and plenty of experience. Also, as mentioned in Chapter 5, JFE Engineering Corporation has constructed a relationship with the biggest Indonesian construction corporation, Company B, to promote plant construction work for Denpasar power generation by waste business smoothly without delay. Company B is the largest EPC contractor in Indonesia and has a plethora of construction success in full turnkey in Indonesia including large coal-fired power plants and petroleum refining equipment. In addition to construction, Company B also has sufficient financial credit and is able to manage construction investment with its own capital, which is proved in the financial statements included in external credit bureau reports. This means that the risk of nonfulfillment of financial obligations or bankruptcy during construction of Company B is extremely low. Also, the construction formation is expected to be joint order acceptance in EPC consortium according to Joint and Several Liability as described in Figure 6.4.2.

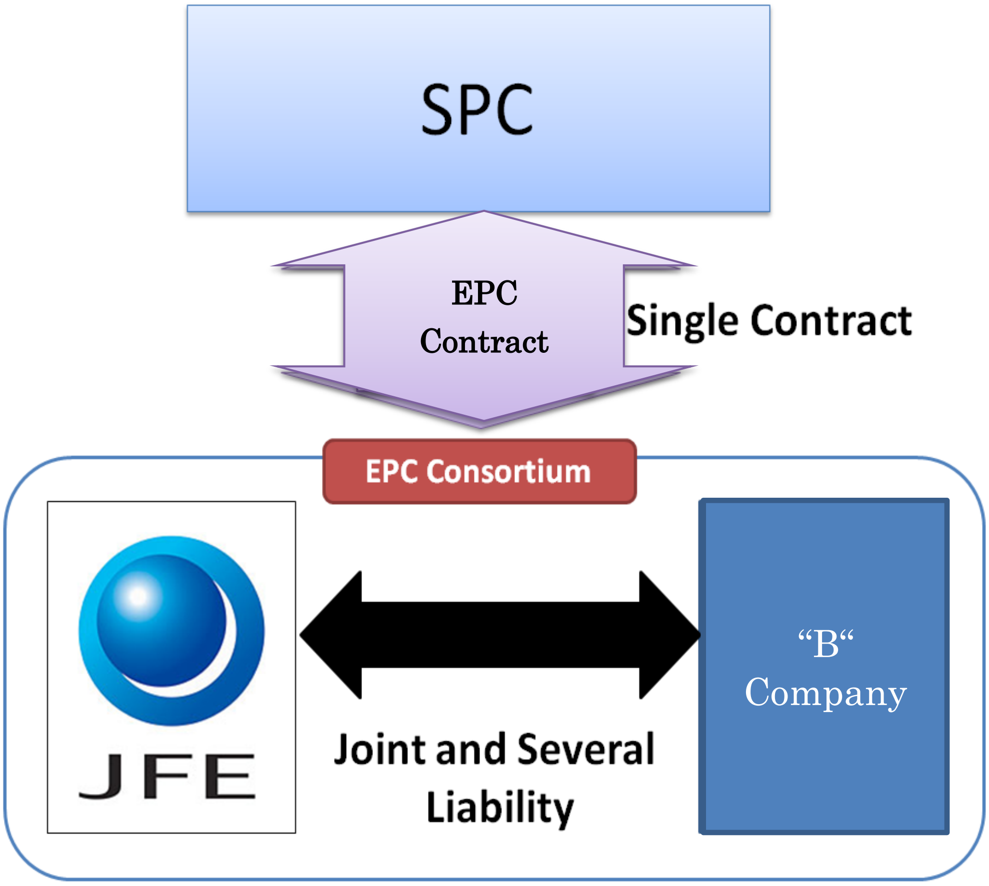


Figure 6.4 Plant construction formation estimate chart

2.4) Other, risk attributable to external factors after completion of power generation by waste plant

This section includes an overview of risk attributable to external factors after completion of the power generation by waste plant and considers the risk reduction measures as follows:

2.4.1) Country risk

Country risk is risk related to the country where the project is implemented and in developing countries in Southeast Asia, country risk is a large problem for SPC. Sometimes in projects in developing countries, there is a possibility of risks that are uncontrollable by SPC and such risks can be categorized as laid out below.

(1) Political risk

Political risk is categorized as issues due to political changes such as forced abolition of business, requisition or nationalization, and extreme danger such as war, revolution or civil war.

(2) Economic risk

Economic risk is represented by inflation and exchange risk. There is also a risk of worsened SPC profitability due to crashed currency rates and increased operation costs caused by sudden inflation from unstable economic situations.

(3) Legal risk

Legal risk is a risk of worsened profitability due to changes in ordinances or accounting tax system.

2.4.2) Risk reduction measures (country risk)

Regarding risks that cannot be controlled by SPC, as described in Appendix Table 6.4-2, when it is difficult to secure SPC profit due to such risks, it is necessary to construct a scheme with compensation for loss for business continuity. First, when loss is incurred due to such risks, clarify whether the issue is covered by insurance or not and then check in advance if the risk can be covered through Nippon Export and Investment Insurance (NEXI), a private insurance company, an international financial company, or any other entity that handles insurance products for overseas loans and investments. For risks that are not covered by insurance companies it is necessary to conclude a concession agreement that allow quick compensation for losses suffered by SPC by the project owner or central government. In addition, in the event risks that cannot be controlled by SPC are treated as its responsibility in the concession agreement, it means that the business continuity is questionable and it might be difficult to formulate project finance.

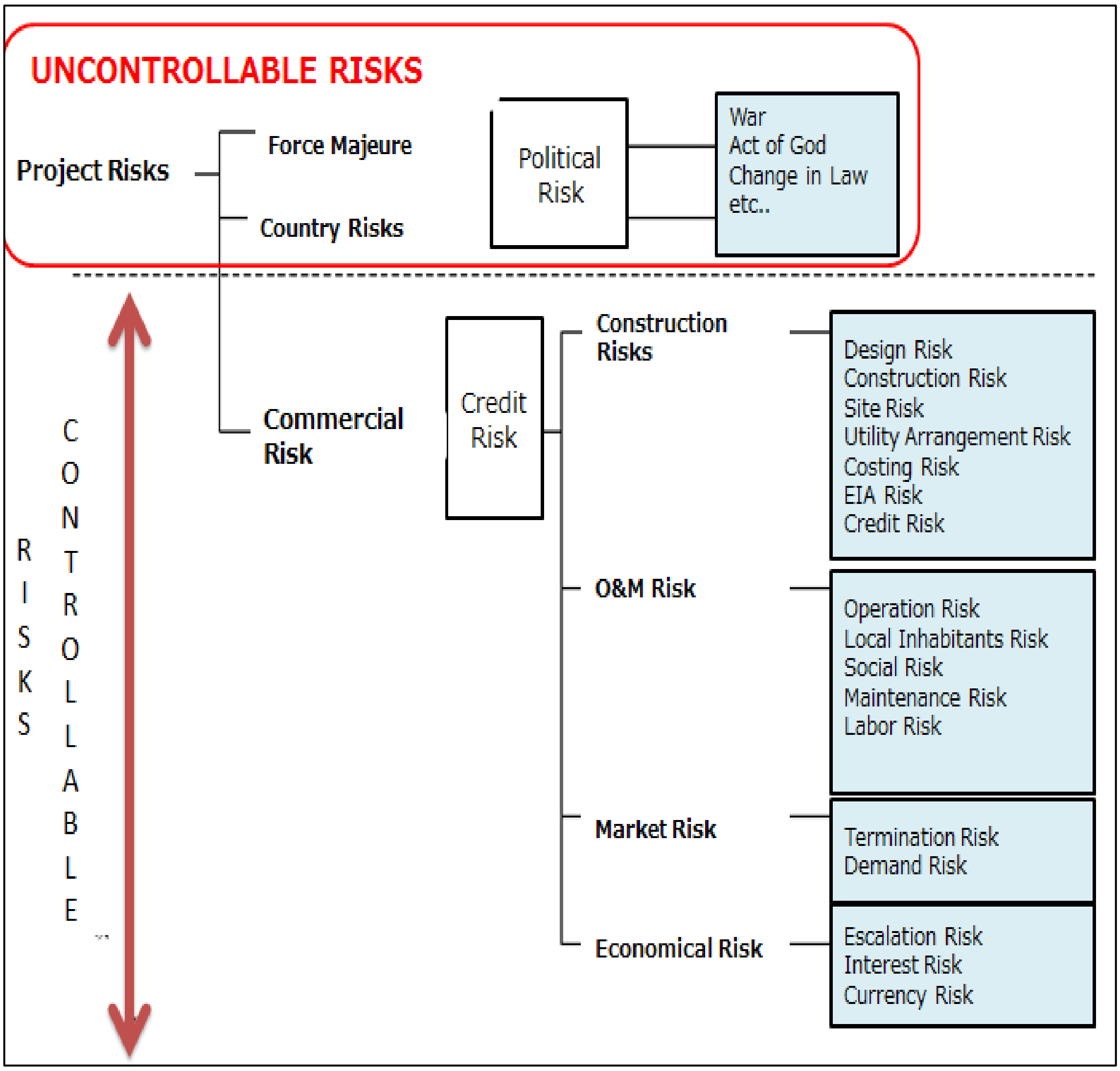


Figure 6.5 Risk classifications

2.5) Facility management risk

This section includes an overview of risks attributable to facility management and considers the risk reduction measures after completion of the plant as follows:

2.5.1) Facility management risk

Facility management risk is risk related to operation and maintenance of a facility and after completion of the plant it is necessary for SPC to construct a system to maintain operation of equipment during the concession period. In the Denpasar waste project, the concession agreement expects for it to last 25 years and since the business revenue and expenditure plan for the expected plant operating period has been created according to the rated capacity, corporate contribution to plant maintenance and operational technology is absolutely necessary. In developing nations, plants are not operated and maintained appropriately after the installation so that plant equipment breaks or has reduced lifespan, which causes a large number of problems leading bad operation ratio. There are many cases of sudden accidental suspension of operations in power generation by waste plants as well in developing countries. Also, while the normal lifespan for a power generation by waste plant in Japan is 25 years or so, in Southeast Asian countries such as Malaysia and Thailand, there are many cases that the plants experience low operation ratio or suspended operations due to breakdowns in the plant as well as complete stop of operations due to abandoned operations by unqualified operators, within 10 years after starting the operations; the economic loss and environmental pollution caused by such short-term suspension of plant operations are big problems. For the Denpasar power generation by waste project, there is a fear of significant damage to the tourism industry after such incidents occur. The biggest cause of risks related to plant operations is attributable to breakdowns and malfunctions of equipment caused by lack of knowledge or skill of the plant operators in terms of operation and maintenance management. In the event such a situation occurs, considering loss of revenue related to disposal costs and selling of electricity to a power company due to decreased operation ratio and additional costs due to plant breakdown, there is a high possibility that this significantly worsens SPC cash flow.

2.5.2) Risk reduction measures (facility management risk)

As the Denpasar power generation by waste business expects operations in BOT scheme, it is extremely important to prevent reduced operation ratio and maintain operations according to the business plan during the concession period in order to maintain cash flow of the power generation by waste plant. In order to do that, it is absolutely necessary to construct a power generation by waste plant operation and maintenance system. JFE Engineering is a corporation with sufficient knowledge, technology and results in operation and maintenance of power generation by waste plants and has achieved operation and maintenance of over 50 projects in Japan. By applying the preventive maintenance technology of JFE Engineering, which has produced results in operation and maintenance of many power generation by waste plants, to the power generation by waste business in Denpasar, it will be possible to ensure reliability and extended lifespan of the plant as well as it will be possible to estimate the remaining life of plant components with a high level of accuracy. Therefore, it will be possible to repair and replace plant equipment and components at the appropriate timing and prevent sudden accidents due to equipment malfunction or breakdown, allowing the plant to operate efficiently and greatly contributing to improvement in maintenance of SPC cash flow. Also, constructing a scheme for efficient and stable plant operation in the Denpasar power generation by waste business, by actively considering the application of Veolia and Suez, which are major French corporations related to water treatment and environment in Europe that have successful results in plant operations in overseas countries including ones in Southeast Asia, is an extremely important issue in project financing.

The following scheme is expected for operation maintenance systems, but the plant operation and maintenance system is still under consideration. The following scheme is in the consideration stage.

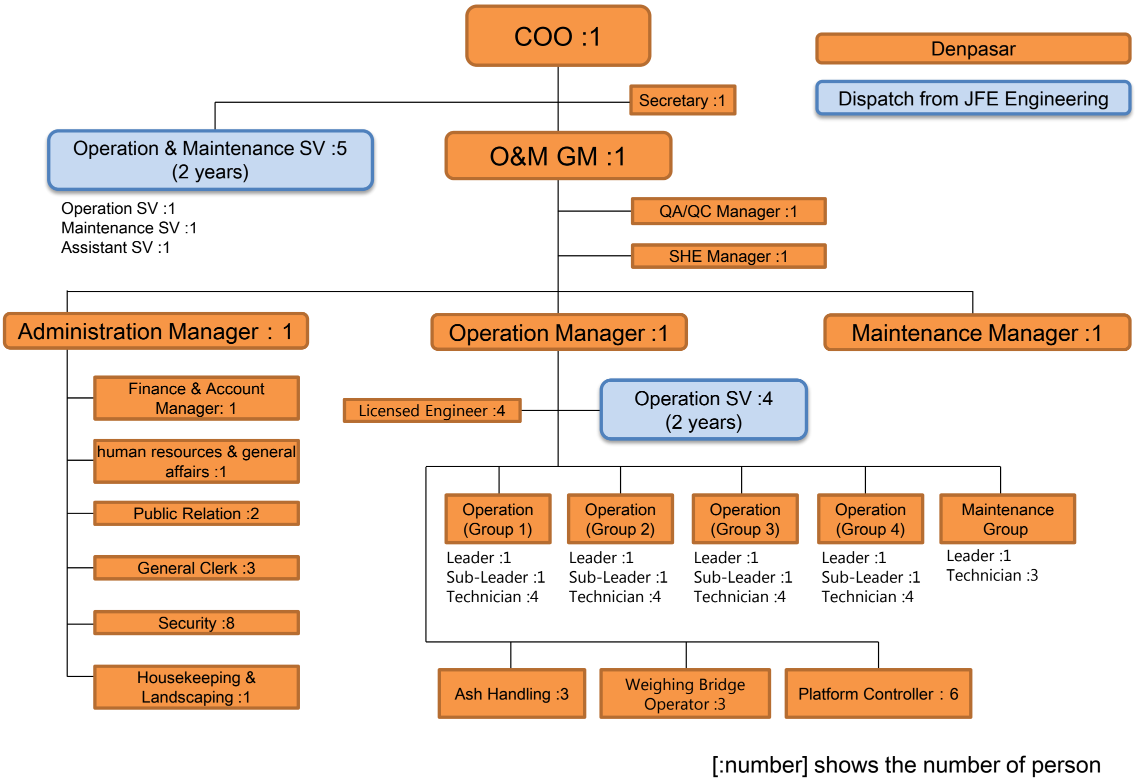


Figure 6.6 O&M structure image

3) Summary and conclusion of this chapter

This chapter examines and observes the financial arrangement issues and hindrances while considering financing formulation methods that are required for implementing the plans for the Denpasar power generation by waste business. Project finance, which will put less burden on the SPC investing corporation, is preferable as a financial arrangement method for Denpasar power generation by waste business. As mentioned above, project finance is a non-recourse method and as the repayment source is only the cash flow created by the project, it is important to somehow increase the probability of cash flow.

Therefore, after inspecting closely and extracting expected risks in the project, it is most important, according to the PFI basic principle that, "the party that can manage that risk most appropriately shall bear it," to transfer each of the said risks to the party who can bear it most effectively, based on the appropriate risk sharing plan, in the form of a contract between the parties, who are SPC and the project owner. Also, it is absolutely necessary to construct an agreement scheme that ensures implementation of the most important rights in the concession agreement, required for SPC to continue business, “Payment of tipping fees” and “Payment of electric fees at the FIT price” over the concession period.

Therefore, it is extremely important to formulate this project as BOT business as a PPP project based on the Indonesia PPP law, and promote formation of a joint project with Denpasar, in accordance with the processes stipulated in the Indonesia PPP law, to apply IIGF, the sovereign guarantee in Indonesia, to this project. Even for formulating a project with the bankable conditions required to formulate project finance, it is required to fulfill the conditions above and it is an important issue that must be resolved to realize this project.

Chapter 7 Business Structure

7.1 Implementation structure

Denpasar is considering implementation of the business as a PPP business using BOT format. The implementation system is drawn out in Figure 7.1.

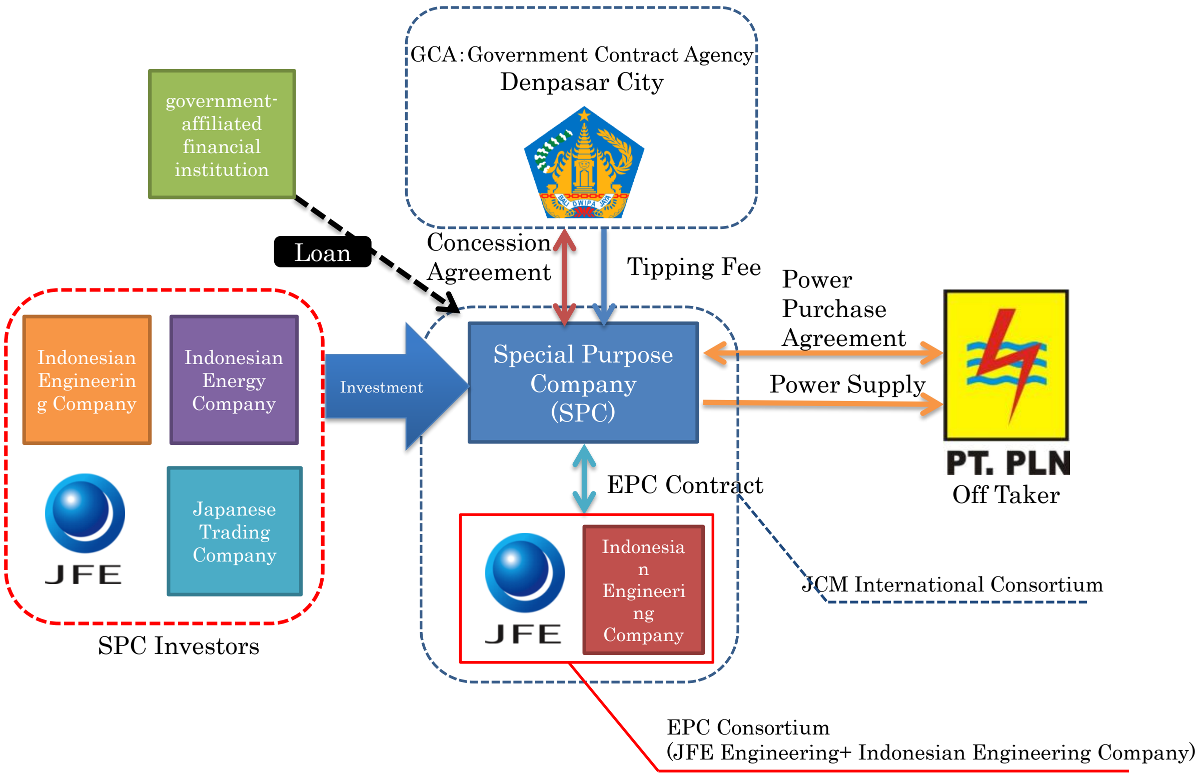


Figure 7.1 Implementation structure (draft)

The various roles are explained below.

1) GCA: Government Contract Agency

Period of agreement granting PPP business rights to the private sector. Regarding the waste to energy facility, GCA is applicable to the regional government and in this project Denpasar is the GCA.

2) SPC: Special Purpose Company

The SPC in this project is a company that was established to own, operate and maintain the waste to energy facility. Execute a concession agreement with Denpasar regarding waste processing service. Operational conditions such as the business period, the range of SPC administration and the tipping fee settings are determined between the SPC and GCA. Also, execute a PPA: Power Purchase Agreement with the local power company, sell the surplus power generated by the waste processing facility and operate the business using the revenue from selling electricity.

3) EPC consortium

Waste to energy plant construction duties are ordered by SPC and for this project JFE Engineering accepts the order. Also, create a partnership with an Indonesian major engineering company who is well-versed in local law and construction industry and start local construction.

4) JCM international consortium

In the event a waste to energy plant construction is implemented as the project of JCM subsidy project for equipment of plant, it is requested to form a JCM international consortium as the JCM subsidy project for equipment of plant. The operator in Japan and the operator in said country form an international consortium. In this case, the operator in Japan is JFE Engineering Corporation and the operator in said country is SPC. In the JCM subsidy project for equipment of plant, there is an obligation for plant operation for statutory service lifetime period of equipment and MRV (Measurement, Reporting and Verification) that reports GHG reduction. GHG reduction calculations are described in the JCM methodology in Chapter 9.

5) PT PLN

PT PLN is Indonesian national electric power company. A PPA is concluded between SPC and PT PLN and electric power is purchased and sold. The electric power pricing is as described in Chapter 2, section 2.4.2.

6) SPC developer

The following four companies are assumed as developers for the SPC.

(1) Major Japanese trading house

A major Japanese trading house with a lot of experience in PPP and EPC businesses overseas. They are cooperating partners in this business interested in waste to energy business in Indonesia.

(2) Major Indonesian engineering company

A major Indonesian engineering company which has a business relationship with JFE Engineering. It is extremely interested in waste to energy business in Indonesia and is showing intention to invest.

(3) Major Indonesian energy company

A major Indonesian energy company showing intention to participate in waste to energy project in Indonesia with intent to invest.

(4) JFE Engineering

In order to run business without delay, participation of a corporation with business know-how is desired. JFE Engineering not only builds plants, but also has experience in operating and maintaining plants. That know-how seems to play a role in SPC operation and it is considering investment.

7) Government-run financial institutions

A government-run financial institution financing the SPC.

7.2 Requisites for implementing special purpose company business

Major conditions for SPC developers to invest in this PPP business are laid out below.

Table 7.1 Conditions required for implementing business (for Indonesia)

No.	Guarantee Content	Summary
①	Sovereign guarantee	Sovereign guarantee by Indonesian central government for the revenue from tipping fee and power selling
②	Waste quantity	Revenue guarantee(Tipping fee, Power selling) for waste quantity
③	Waste characteristics	Revenue guarantee for plant stoppage or low availability due to the charging of unacceptable waste such as incombustible waste, bulky waste, hazardous waste etc.
④	Minimum LHV of waste	Revenue guarantee in case that monthly average calorific value of waste exceed the lower limit which is decided in advance
⑤	Feed in tariff (Power purchase agreement)	Revenue for full amount purchase during concession period based on feed in tariff
⑥	Land preparation	Project site preparation, Utility preparation(water, gas, road etc.)
⑧	Power selling fee based on available capacity payment	Payment guarantee for power selling as long as power generation system is available

(1) Payment guarantee from the Indonesian central government agencies

It is required that the payment from Denpasar, which is the GCA that concluded the waste processing services agreement with the SPC, is guaranteed by the Indonesian central government agencies. In other words, in the event that Denpasar loses the ability to pay, the Indonesian central government agencies pay the SPC instead of Denpasar, based on the concession agreement. Payment includes tipping fee and revenue from selling electricity.

There are many cases that a financing source (banks, etc.) finances the SPC and it is considered to be a guaranteed matter required for business establishment.

In Indonesia, in order to establish PPP projects, a guarantee system called IIGF (Indonesia Infrastructure Guarantee Fund) is set up and the power generation by waste business established as a PPP business is included in the application scope.

(2) Waste volume guarantee

Even in the case where the amount of waste determined by Denpasar in the waste processing services agreement concluded with SPC isn't transported to SPC, payment of the already determined tipping fee is required. Also, reduced incineration occurs simultaneously with reduced generated output, so it is required along with reduction of revenue from selling electricity accompanying reduced waste.

Since SPC revenue depends on tipping fee and revenue from selling electricity, this is an absolutely necessary guarantee for continuing business.

(3) Waste quality guarantee

Defines waste that cannot be conveyed in the concession agreement. Representative examples of waste that cannot be conveyed would be waste that is larger than a certain size or dangerous goods. Guarantee for facility operation suspension occurring from this kind of conveyance of waste that cannot be conveyed and reduced revenue due to lowered operation ratio is required.

(4) Minimum guaranteed calorific value of conveyed waste

The calorific value of waste mostly depends on the generated output so it is an extremely important factor. A guarantee is required for reduced revenue from selling electricity in the event that the monthly (or determined period) average of waste calorific value calculated in waste to energy plant drops below the minimum calorific value determined in advance. This guarantee request is an absolutely necessary guarantee for continuing business.

(5) Application of feed-in tariff of electric power

It is just as described in Chapter 2, section 2.4.2, but there is a purchase guarantee for the entire amount of electric power throughout the entire business period based on application of the feed-in tariff of electric power.

(6) Ensured project site

Provision of ensured project site and basic infrastructure preparations (water supply and sewage systems, gas, electric power, roads, etc.) are required. Since the Denpasar bureau of public cleansing is managing appropriately at the Suwung landfill, which is the current planned construction site, there are no apparent illegal aliens working as waste pickers, but in case of opposition, Denpasar will be required to withdraw. For basic integrated network infrastructure, connection point, scope of construction as well as transmission line need to be considered in future investigations.

(7) Payment of fees from selling electricity to a power company based on available capacity payment

Fees from selling electricity to a power company payments must be made as long as the power generation equipment capacity can be operated. In other words, guarantee for revenue from selling electricity for the entire capacity of the power generation equipment that can be operated is required as long as the waste to energy plant can transmit power, then even if it is due to the electric power company and power cannot be transmitted.

The above contents must be negotiated between GCA and SPC and it is necessary for both parties to consent as appropriate risk allocation. For the SPC developer, risk of unrecognized required matters is evaluated quantitatively and reflected as the cost of business, so in order to ensure appropriate profitability, a higher tipping fee or selling price is required. Appropriate risk allotment leads to smooth business operation at appropriate costs.

Chapter 8 Feasibility Evaluation

8.1 Feasibility evaluation

This chapter evaluates the feasibility of the project in achieving the waste to energy business in Denpasar.

8.1.1 Business prerequisites

The prerequisites when evaluating the feasibility of the waste to energy project in Denpasar are laid out below.

(1) The total project period will be 29 years. (Breakdown: 4-year Construction period, 25-year operation period)

(2) The concession period and period for selling electricity to a power company is 25 years and the unit price for selling electricity is fixed for 25 years.

*USD Cent 18.77/kwh

(3) Risk of commodity price fluctuation during construction is borne by SPC.

(4) Risk of commodity price fluctuation during the operation period is outside of the risks borne by SPC. The requisites on the inflation slide in the concession agreement apply to costs for operation and maintenance and other facility management, maintenance and repair costs, and other operational costs.

(5) The power generation equipment of the waste incineration plant applies the most advanced power generation efficiency of JFE Engineering Corporation as of February 2017.

(6) The project site is provided to the SPC free of charge during the continuity period of the business and no rental or other fees are charged for the land.

(7) Significant fluctuations in waste calories are outside of the risks borne by SPC, so this is not expected.

(8) Taxation for SPC establishment of waste to energy business in Denpasar only takes into account corporate tax (25%) related to SPC operations.

(9) Removing items inappropriate for incineration is outside of the SPC risk scope.

(10) Processing related to incineration residue, is laid out in Table 8.1 below, and bottom ash and fly ash are landfilled in the Suwung landfill.

. The disposal site and off-island conveyance in Bali and other regions are not expected.

Table 8.1 Scope of work related to incineration residue

Residue	Production	Treatment	Payment	Transportation Fee	Landfilling Fee
Bottom Ash	88 tons/day	Landfilling	SPC	100,000 IDR/ton	
Fly Ash	33 tons/day	Chelate Agent Treatment	SPC	100,000 IDR/ton	

8.1.2 Financing conditions

1) Financing method

The details of financing method in the waste to energy project in Denpasar as described in Chapter 6, estimate financing according to the project financing method. Gross business expenses include an estimated 25% equity from SPC developers and the remaining 75% debt is provided by long-term loan contributions from financial institutions such as JICA and JBIC.

Also, the financing method is still under consideration and the premise during considerations in this chapter is just temporary values independently set by JFE Engineering Corporation.

2) Project finance procurement costs

The following is assumed for interest and risk premium as project finance procurement costs.

Table 8.2 Project finance procurement cost

Content	Condition	Remark
Repayment Period	15 years	
Repayment Grace Period	5 years	
Interest	3%	Assumption of JICA investment
Arrangement Fee	1%	On Total Debt
Other Financial Cost	0.5%	On Total Debt

8.1.3 Specifications of waste to energy plant

Specifications of waste to energy plant for the Denpasar waste to energy project has been installed are laid out in Table 8.3 below as described in detail in Chapter 4.

Table 8.3 Specifications of waste to energy plant equipment

Item	Specification	Remark
Waste Capacity	1000tons/day	500 tons x 2 lines
	310,000 tons/year	Annual waste amount
Annual operation days	310 days	Periodic inspection 1.5month x 2 lines/year
Availability	84.9%	
Steam amount	107t/h	
Power output	20MWh	20MWh x 1 line based on average LHV of waste
Power self-consumption	3.5MWh	based on average LHV of waste
Power selling	16.5MWh	Power selling/day based on average LHV of waste
	122,760MWh	Annual power selling based on average LHV of waste

8.1.4 Fuel (waste quality) setting

Fuel (waste quality) settings in the waste to energy business in Denpasar are described in detail in Chapter 4. Values analyzed by "2014 Japan Recycling Industry Overseas Development power generation by waste basic environmental research commercialization promotion operation waste quantity investigation: SARBAGITA, Bali, Indonesia power generation by waste business basic environmental research" are laid out in Table 8.4 below as standards.

Table 8.4 Fuel (waste quality)

Content		Unit	Minimum	Average	Maximum
Waste Capacity		ton/day	1,000		
Low Calorific Value		kcal/kg	1,300	1,860	2,220
Industrial Composition	Moisture	%	60.0	51,3	48.0
	Combustible	%	33.0	43.2	48.0
	Ash	%	7.0	5.5	4.0
	Total		100	100	100

8.1.5 Construction fees

Waste to energy plant construction cost in the Denpasar waste to energy business is laid out in Table 8.5 below.

Table 8.5 Construction fees

	Price (USD)
Total	118,300,000

8.1.6 Operation maintenance repair fees

Operational cost including labor costs, maintenance costs, utility costs, consumable costs and other necessary expenses for the waste to energy plant in Denpasar is laid out in Table 8.6.

Table 8.6 Operational costs

	Price (USD/year)
Total	7,000,000

8.1.7 Costs related to environmental assessment

The construction of the waste to energy plant for the waste to energy business in Denpasar, environmental assessment for the situation of the target area in accordance with related laws and regulations of Indonesia is necessary. Currently, as there is no successful construction of waste to energy plants in Indonesia for the environmental impact assessment method for the construction of the waste to energy plants, it is a future problem to confirm the procedural flow and time needed for procedures, etc. The plan is to confirm with the Ministry of Environment and Forestry of the country and facilities related to the Coordinating Minister for Maritime Affairs, who is in charge of promoting waste to energy business. However, since the Environmental Impact Assessment is generally the responsibility of the operator and there are costs that should be covered by operations, various environmental assessment costs in the construction of coal fired power plant facility in the country have been calculated as overall costs as reference at JPY 40,000,000.

8.1.8 Expenses related to commissioning

Costs related to waste to energy plant commissioning are laid out in Table 8.7 below. Also, waste to energy plant operation time during commissioning is expected to be 1,000 hours. Regarding handling of power generation during the commissioning period, electricity is sold to PLN at the FIT price and costs related to commissioning are offset by that sale.

Table 8.7 Commissioning costs

Content	Expenditure (USD)
1) Commissioning expenditure	▲5,000,000
2) Power selling revenue during commissioning	3,000,000
1)-2)	▲2,000,000

8.1.9 Insurance fees

Various insurance related to implementation of the waste to energy plant business are laid out in Table 8.8 below. Also, since we referenced rate of the major Japanese insurance companies for the insurance rate and the insurance costs are approximated.

Table 8.8 Various insurance fees

Category	Rate	Expenditure	Remark
Fire insurance	Civil and building construction cost x rate	Including in OPEX	
Mechanical insurance	Power generation equipment cost x 65% x rate	Including in OPEX	Only mechanical portion
Workers compensation insurance	N/A	Including in OPEX	

8.1.10 Public charges

Regarding taxes related to waste to energy plant business, only the taxes listed in Table 8.9 below are taken into consideration and business tax, fixed property tax or other taxes are not taken into consideration in this F/S. Close investigation of tax matter costs is one of the matters under consideration going forward.

Table 8.9 Corporate tax

Category	Rate	Expenditure
Corporate tax	25%	N/A

8.2 Profitability evaluation

8.2.1 Prerequisites for profitability evaluation

Important prerequisites for profitability evaluation described in the previous paragraph are as shown in Table 8.10.

Table 8.10 Prerequisites for profitability evaluation

Content	Condition	Remark
Concession period	25 years	
Owned capital	25%	
Borrowed capital	75%	
Financing method	Project finance	
Repayment period	15 years	Grace period : 5 years
Repayment method	Level-line repayment	
Borrowing rate	3%	
Interest rate	N/A	Deposit interest rate for retained earnings
Corporate tax	30%	
Escalation	N/A	
Land rental fee	N/A	

8.3 Sensitivity analysis

8.3.1 Fluctuations in economic indicators due to the price of selling electricity to a power company

The following Table 8.11 describes the impact on the economic indicators on project cash flow due to the decline (-2% in Case 1 through -20% in Case 5) in the price of selling electricity to a power company in implementing the waste-to-energy project in Denpasar.

Table 8.11 Impacts of the fluctuations in the price of selling electricity to a power company

Power Selling Price (USDC)	Base Case	Case.1	Case.2	Case.3	Case.4	Case.5	Case.6 (at the time of former FS)
	Present	▲2%	▲5%	▲10%	▲15%	▲20%	▲
	18.77	18.39	17.83	16.89	15.95	15.02	IDR135,000
Tipping Fee (IDR)	IDR300,000.-						
FIRR	12.17	11.85	11.37	10.56	9.74	8.91	3.4
EIRR	20.69	19.98	18.95	17.24	15.55	13.9	4.2
DSCR							
Minimum	1.30	1.27	1.22	1.15	1.07	0.9	0.55
Average	1.74	1.70	1.65	1.56	1.48	1.39	0.89
Maximum	1.98	1.94	1.88	1.78	1.69	1.59	1.02
Evaluation	Feasible	Feasible	Feasible	Feasible	MODE	NOT	NOT

* Case 6 was studied at IDR135,000, the Base Case in the FY2014 feasibility study. Exchange rates to be applied are based on 1st March, 2017.

Evaluation basis for sensitive analysis

NOT FEASIBLE	MODERATELY	FEASIBLE

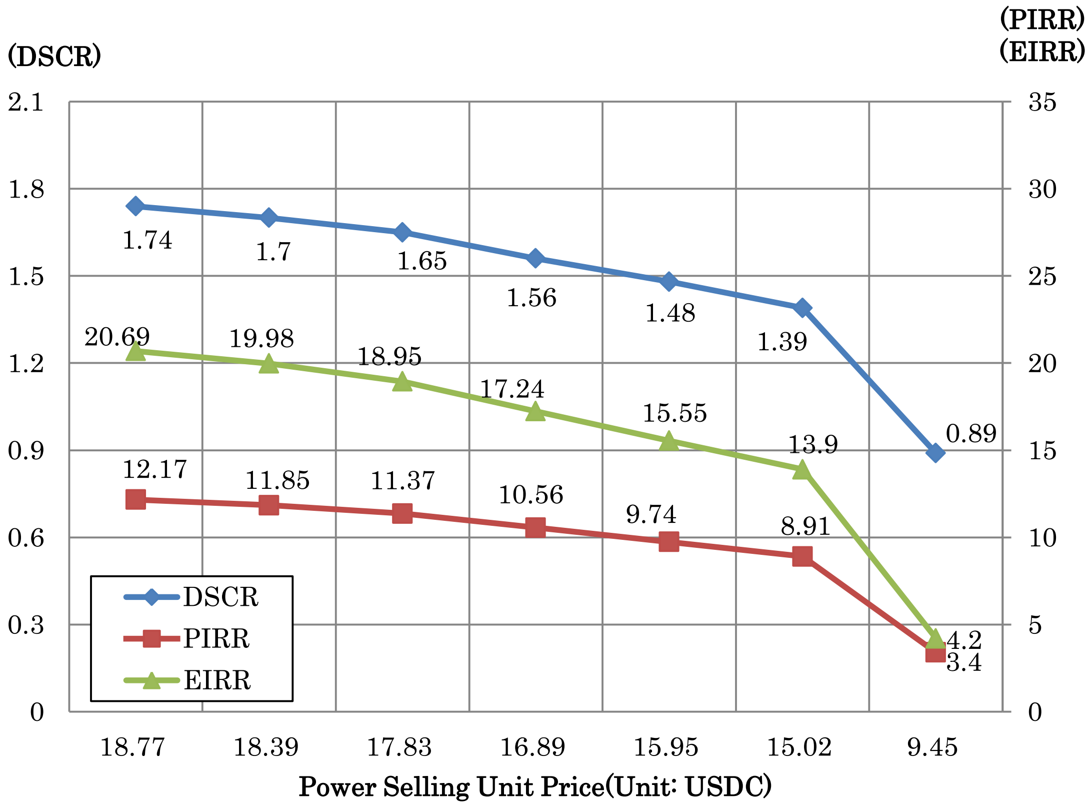


Figure 8.1 Impacts of the fluctuations in the price of selling electricity to a power company

8.3.2 Changes in the economic indicators due to tipping fee fluctuations

The following Table 8.12 describes the impact on economic indicators on project cash flow due to the decline in the tipping fee contract unit price in implementing the waste-to-energy project in Denpasar. In this study, it was examined assuming the decline in disposal cost as described in Table 8.12 by setting the waste disposal unit price in the waste-to-energy project planned in the Special Capital Region of Jakarta as the upper limit in Case 1. Since the tipping fee is assumed to be paid in the local currency (IDR), the exchange rate in this section should be used as the exchange rate to be applied and that the risk of loss due to exchange rate fluctuations will not be taken into consideration.

Table 8.12 Impacts of tipping fee fluctuations

Tipping Fee (IDR)	Case.1	Case.2	Case.3	Case.4	Case.5	Case.6	Case.7
	Maximum	▲10%	▲30%	▲50%	▲70%	▲80%	0
	350,000	315,000	245,000	175,000	105,000	70,000	
Power Selling Price	18.77 (USDC)						
FIRR	12.97	12.39	11.32	10.22	9.09	8.51	7.33
EIRR	22.40	21.20	18.83	16.52	14.24	13.12	10.89
DSCR							
Minimum	1.37	1.32	1.22	1.12	1.01	0.96	0.86
Average	1.82	1.76	1.64	1.53	1.41	1.35	1.24
Maximum	2.07	2.0	1.87	1.74	1.61	1.55	1.41
Evaluation	Feasible	Feasible	Feasible	Feasible	MODE	NOT	NOT

Evaluation basis for sensitive analysis

NOT FEASIBLE	MODERATELY	FEASIBLE

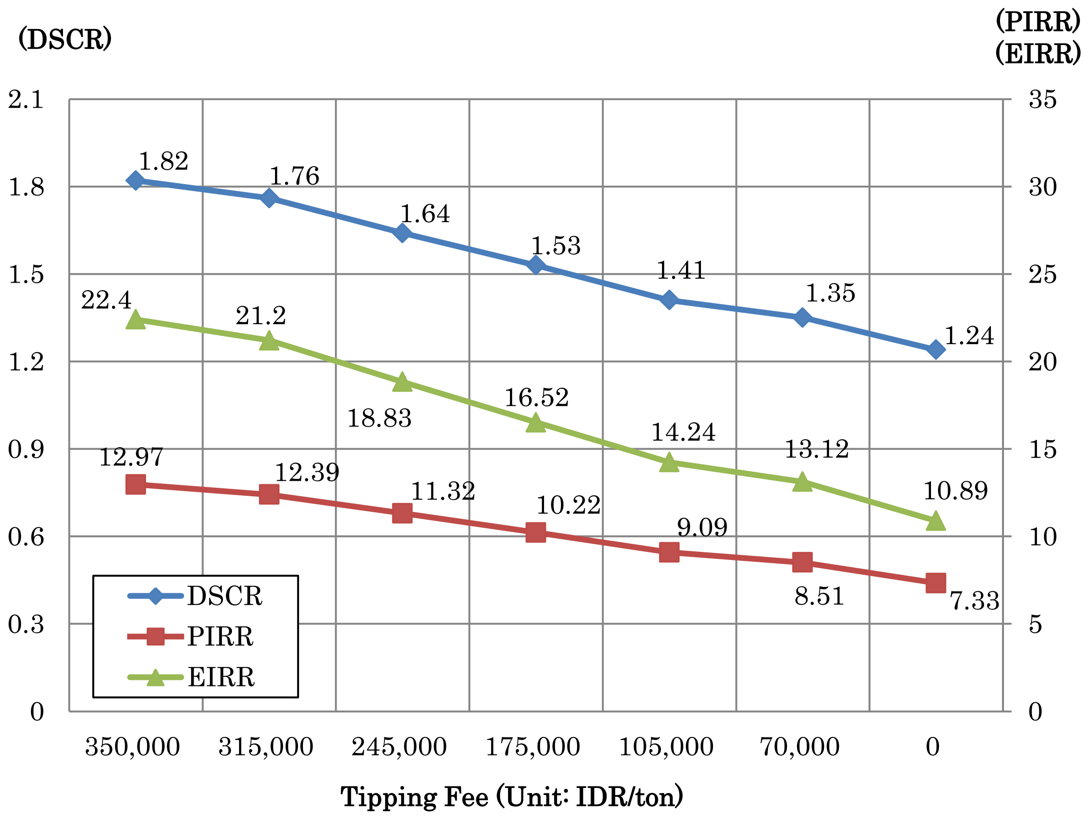


Figure 8.2 Impacts of tipping fee fluctuations

8.3.3 Sensitivity analysis based on the application of Viability Gap Funding (VGF)

As detailed in the Chapter 2 the VGF is the financial support program for assisting the establishment of projects concerning PPP Projects in the Republic of Indonesia. When the application is granted, the financial support to a maximum of 49% of the capital expenditure will be offered to the target project. In this section, the impact on economic indicators on project cash flow when the VGF is applied is described as follows: Several variables such as the price of selling electricity to a power company are involved, however, the sensitivity analysis on PIRR and DSCR was performed without considering fluctuations in the unit price of selling electricity to a power company (USDC 18.77) based on the following cases:

<Criteria in shading in sensitive analysis>

NOT FEASIBLE	MODERATELY	FEASIBLE

Table 8.13 PIRR when VGF is applied

VGF application ratio / Tipping fee(ton)	49%(Max.)	▲10%	▲20%	▲30%	▲40%
IDR350,000.-	25.98	21.91	18.84	16.61	14.43
IDR300,000.-	24.73	20.83	17.88	15.53	13.62
IDR250,000.-	23.48	19.75	16.90	14.65	12.80
IDR200,000	22.23	18.65	15.92	13.75	11.97
IDR150,000	20.96	17.45	14.93	12.84	11.13
IDR100,000	19.68	16.42	13.92	11.92	10.27
IDR50,000	18.39	15.29	12.9	10.97	9.39
IDR0	17.09	14.14	11.85	10.02	8.50

Table 8.14 EIRR when VGF is applied

VGF application ratio / Tipping fee(ton)	49%(Max.)	▲10%	▲20%	▲30%	▲40%
IDR350,000.-	56.61	45.17	36.88	30.66	25.86
IDR300,000.-	52.91	42.10	34.30	28.45	23.94
IDR250,000.-	49.24	39.08	31.75	26.28	22.05
IDR200,000	45.61	36.10	29.25	24.14	20.02
IDR150,000	42.03	33.16	26.80	22.05	18.37
IDR100,000	38.51	30.29	24.40	19.99	16.57
IDR50,000	35.06	27.47	22.04	17.97	14.80
IDR0	31.67	24.72	19.73	15.98	13.05

Table 8.15 DSCR when VGF is applied

VGF application ratio / Tipping fee(ton)	49%(Max.)	▲10%	▲20%	▲30%	▲40%
IDR350,000.-	3.38	2.88	2.50	2.21	1.99
IDR300,000.-	3.23	2.74	2.39	2.11	1.90
IDR250,000.-	3.07	2.61	2.27	2.01	1.80
IDR200,000	2.92	2.48	2.16	1.91	1.71
IDR150,000	2.76	2.35	2.04	1.81	1.62
IDR100,000	2.61	2.22	1.93	1.71	1.53
IDR50,000	2.45	2.08	1.81	1.61	1.44
IDR0	2.30	1.95	1.70	1.51	1.35

8.3.4 Sensitivity analysis based on the application of JCM subsidy for equipment of plant

The JCM (Joint Crediting Mechanism) subsidy for equipment of plant project is a project for implementing the greenhouse effect emission reduction projects in developing nations by using Japan's excellent low-carbon technologies (including projects in collaboration with the projects financed and invested by Japan International Cooperation Agency (JICA) and other government-run financial institutions) through the application of measurement, reporting and verification (MRV) methodologies. With the aim of allocating the emission reductions calculated by this as the Japan's emission reductions through the Joint Credit Mechanism (JCM), the JCM developer (international consortium) will receive the subsidy for equipment of plant up to one billion yen, with the upper limit being one half of the initial investment cost.

In this section, in addition to the adaptation of VGF described in the previous section, we studied the impact on economic indicators on project cash flow when one billion yen, the upper limit of JCM subsidy for equipment of plant, is applied to the waste-to-energy project in Denpasar as follows: Several variances are involved, and one of the variances, the price of selling electricity to a power company, was fixed in the same way as in the previous section as below: The JCM subsidy for equipment of plant will be paid in Japanese yen, and for the Japanese Yen to US Dollar currency exchange rate, the Telegraphic Transfer Middle Rate (TTM) by the Bank of Tokyo-Mitsubishi UFJ as of March 1st, 2017 is used as below: Handling of each variance are as described below:

1) Price of selling electricity to a power company: 18.77 USDC/kwh (fixed price)
2) Exchange rate (JCM): USD = JPY 112 (as of March 1st, 2017)
3) Tipping fee: Variances of the IDR 350,000-IDR0 are set.
4) JCM subsidy for equipment : 1 billion JPY

Table 8.16 PIRR when the JCM subsidy for equipment of plant is applied

Power Selling Price (USDC)	Base Case	Case.1	Case.2	Case.3	Case.4	Case.5	Case.6 (at the time of former FS)
	Present	▲15%	▲20%	▲25%	▲30%	▲35%	▲
	18.77	15.95	15.02	14.07	13.13	12.20	IDR135,000
Tipping Fee (IDR)	IDR300,000.-						
PIRR	13.29	10.75	9.88	8.98	8.06	7.13	4.23
EIRR	23.18	17.58	15.79	13.99	12.22	10.5	5.5
DSCR							
Minimum	1.39	1.14	1.06	0.98	0.90	0.82	0.59
Average	1.86	1.58	1.49	1.40	1.31	1.22	0.95
Maximum	2.12	1.81	1.70	1.60	1.50	1.39	1.10
Evaluation	Feasible	Feasible	Feasible	NOT	NOT	NOT	NOT

Evaluation basis for sensitive analysis

NOT FEASIBLE	MODERATELY	FEASIBLE

Table 8.17 EIRR when the JCM subsidy for equipment of plant is applied

Tipping Fee (IDR)	Case.1	Case.2	Case.3	Case.4	Case.5	Case.6	Case7	Case.8
	Maxim um	▲10%	▲30%	▲50%	▲70%	▲80%	▲90%	0
	350,000	315,000	245,000	175,000	105,000	70,000	35,000	
Power Selling Price	18.77 (USDC)							
PIRR	14.08	13.52	12.40	11.25	10.07	9.46	8.85	8.23
EIRR	25.05	23.74	21.16	18.63	16.16	14.95	13.74	12.54
DSCR								
Minimum	1.47	1.41	1.30	1.19	1.08	1.03	0.97	0.92
Average	1.95	1.88	1.76	1.64	1.51	1.45	1.39	1.32
Maximum	2.22	2.15	2.01	1.87	1.73	1.66	1.59	1.52
Evaluation	Feasible	Feasible	Feasible	Feasible	Feasible	MODE	NOT	NOT

Evaluation basis for sensitive analysis

NOT FEASIBLE	MODERATELY	FEASIBLE

Chapter 9 JCM Proposed Methodology

9.1 JCM Proposed Methodology Form

JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	

Form for submitting the proposed methodology

Host Country	Republic of Indonesia
Name of the methodology proponents submitting this form	JFE Engineering Corporation
Sectoral scope(s) to which the Proposed Methodology applies	1. Energy industries (renewable - / non-renewable sources) 13. Waste handling and disposal
Title of the proposed methodology, and version number	Power generation and avoidance of landfill gas emissions through combustion of municipal solid waste (MSW), ver. 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information
Date of completion	dd/mm/yyyy

History of the proposed methodology

Version	Date	Contents revised
01.0	dd/mm/yyyy	First edition

A. Title of the methodology

Power generation and avoidance of landfill gas emissions through combustion of municipal solid waste (MSW), ver. 01.0

B. Terms and definitions

Terms	Definitions
Municipal solid waste (MSW)	A heterogeneous mix of different solid waste types, usually collected by municipalities or other local authorities. MSW includes household waste, garden/park waste and commercial/institutional waste.
Solid waste disposal site (SWDS)	Designated areas intended as the final storage place for solid waste.
Fresh waste	Solid waste that intended for disposal in a SWDS but has not yet been disposed.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Installation of MSW incinerators avoids emissions of methane associated with disposed organic waste in a SWDS, and electricity generated by the project facility displaces electricity from a grid or captive power generator which is generated using fossil fuels resulting in GHG emission reductions.
Calculation of reference emissions	Reference emissions are calculated as a sum of the following emissions: ● CH_4 emissions from SWDS: Calculated from the amount of MSW and fraction of each waste type incinerated in the incinerator using the first order decay (FOD) model; and ● CO_2 emissions from a grid or captive power generator: Electricity generated by the project facility multiplied by the emission factor of displaced electricity.
Calculation of project	Project emissions are calculated as a sum of the following

emissions	emissions: ● CO_2 emissions from combustion of fossil carbon contained in MSW: The amount of MSW multiplied by the fraction of fossil carbon content and the conversion factor of carbon; ● N_2O emissions from combustion of waste: The amount of MSW multiplied by the N_2O emission factor associated with incineration; ● CO_2 emissions from electricity used to operate the project facility: Electricity used to operate the project facility multiplied by the emission factor of electricity; and ● CO_2 emissions from auxiliary fossil fuel consumption associated with incineration: The amount of fossil fuel consumption associated with incineration multiplied by the emission factor of the fossil fuel.
Monitoring parameters	● Amount of waste (wet basis); ● Quantity of electricity generated by the project facility; ● Quantity of electricity consumed by the project facility; and ● Quantity of auxiliary fossil fuel consumption.

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	The project newly installs an incinerator, waste heat recovery boiler, exhaust gas treatment equipment and turbine generator.
Criterion 2	The project incinerates fresh municipal solid waste (MSW) and generates electricity from steam produced in a waste heat recovery boiler.
Criterion 3	Emissions of NO_2 and CO at the stack of incinerator are designed to be less than or equal to the following levels: - NO_2: 470mg/Nm^3@11%O_2, and - CO: 625mg/Nm^3@11%O_2
Criterion 4	There is a plan to operate the project facility for more than 5 years.

E. Emission Sources and GHG types

Reference emissions

Emission sources	GHG types
Decomposition of waste at SWDS	CH_4
Electricity generation	CO_2
Project emissions	
Emission sources	GHG types
Combustion of fossil carbon contained in waste	CO_2
Incineration of waste	N_2O
Electricity use by the project facility	CO_2
Consumption of auxiliary fossil fuels needed to be added into incinerator	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

A project which applies this methodology incinerates MSW and generates electricity. In Indonesia, MSW is usually disposed in open dump sites without recovering landfill gas. Therefore, BaU for MSW treatment is open dumping and BaU emissions are CH_4 emissions from open dumping of MSW and CO_2 emissions from fossil fuels combusted to generate electricity which would be displaced by the project.
To assure net emission reductions, the model correction factor which accounts for uncertainty of the model to calculate emissions from decomposition of MSW is set conservatively.

F.2. Calculation of reference emissions

$$RE_p = RE_{CH4,p} + RE_{elec,p}$$

Where:

RE_p = Reference emissions during the period *p* [tCO_2e/p]

$RE_{CH4,p}$ = Reference emissions from decomposition of MSW at the SWDS during the period *p* [tCO_2e/p]

$RE_{elec,p}$ = Reference emissions from electricity generation during the period *p* [tCO_2e/p]

Reference emissions from decomposition of MSW at the SWDS during the period *p* ($RE_{CH4,p}$) is accounted only from the next calendar year after its disposal at the SWDS (or incineration) due to delay in generation of CH_4 from the time of disposal at the SWDS.

$$RE_{CH4,p} = \sum_{y=p\_start}^{p\_end} \left[\varphi \times (1-f) \times GWP_{CH4} \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{i=1}^{y-1} \sum_{j} \left\{ W_i \times p_j \times DOC_j \times e^{-k_j(y-1-i)} \times \left(1-e^{-k_j}\right) \right\} \right]$$

Where:

$RE_{CH4,p}$	=	Reference emissions from decomposition of MSW at the SWDS during the period *p* [tCO_2e/p]
y	=	The N[th] year from the first disposal (or incineration), extending from the first year of the period *p* (*y*=*p_start*) to the last year of the period *p* (*y*=*p_end*). If *y* is equal to 1, methane generation cannot be accounted.
p_start	=	The N[th] year from the first disposal (or incineration), which is the first year of the period *p*
p_end	=	The N[th] year from the first disposal (or incineration), which is the last year of the period *p*
φ	=	Model correction factor to account for model uncertainties
f	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere
GWP_{CH4}	=	Global Warming Potential of methane [tCO_2e/tCH_4]
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	=	Fraction of methane in the SWDS gas [volume fraction]
DOC_f	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS [weight fraction]
MCF	=	Methane correction factor
i	=	The N[th] year from the first disposal (or incineration), extending from the first year in the time period in which MSW is disposed at the SWDS (*i* = 1) to year *y* (*i* = *y*)
W_i	=	Quantity of MSW fed into incinerator in the year *i* [t]
p_j	=	Fraction of the waste type *j* [weight fraction]
DOC_j	=	Fraction of degradable organic carbon in the waste type *j* [weight fraction]
k_j	=	Decay rate for the waste type *j* [1/yr]
j	=	Type of waste

$$RE_{elec,p} = EG_{elec,p} \times EF_{elec}$$

Where:

$RE_{elec,p}$	=	Reference emissions from electricity generation during the period *p* [tCO_2e/p]
$EG_{elec,p}$	=	Quantity of electricity generated by the project facility during the period *p* [MWh/p]
EF_{elec}	=	Emission factor for electricity generation [tCO_2e/MWh]

G. Calculation of project emissions

$$PE_p = PE_{COM\_CO2,p} + PE_{COM\_N2O,p} + PE_{EC,p} + PE_{FC,p}$$

Where:

PE_p	=	Project emissions during the period *p* [tCO_2e/p]
$PE_{COM\_CO2,p}$	=	Project emissions of CO_2 from combustion of fossil carbon contained in waste associated with incineration during the period *p* [tCO_2e/p]
$PE_{COM\_N2O,p}$	=	Project emissions of N_2O from combustion of waste associated with incineration during the period *p* [tCO_2e/p]
$PE_{EC,p}$	=	Project emissions from electricity consumption by the project facility during the period *p* [tCO_2e/p]
$PE_{FC,p}$	=	Project emissions from auxiliary fossil fuel consumption associated with incineration during the period *p* [tCO_2e/p]

$$PE_{COM\_CO2,p} = EFF_{COM} \times \frac{44}{12} \times \sum_{j} \sum_{i=p\_start}^{p\_end} \left(W_i \times p_j \times DC \times FCC_j \times FFC_j\right)$$

Where:

$PE_{COM\_CO2,p}$	=	Project emissions of CO_2 from combustion of fossil carbon contained in waste associated with incineration during the period *p* [tCO_2e/p]
EFF_{COM}	=	Combustion efficiency of incinerator [fraction]
$\frac{44}{12}$	=	Conversion factor [tCO_2/tC]
i	=	The N^{th} year from the first incineration
p_start	=	The N^{th} year from the first incineration, which is the first year of the period *p*
p_end	=	The N^{th} year from the first incineration, which is the last year of the period *p*
W_i	=	Quantity of MSW fed into incinerator in the year *i* [t]
p_j	=	Fraction of the waste type *j* [weight fraction]
DC	=	Dry matter content of MSW [%]
FCC_j	=	Fraction of total carbon content in waste type *j* [tC/t]

FFC_j = Fraction of fossil carbon in total carbon content of waste type *j* [weight fraction]
j = Type of waste

$$PE_{COM\_N2O,p} = \sum_{i=p\_start}^{p\_end} W_i \times EF_{N2O} \times GWP_{N2O}$$

Where:

$PE_{COM\_N2O,p}$ = Project emissions of N_2O from combustion of waste associated with incineration during the period *p* [tCO_2e/p]
i = The N[th] year from the first incineration
p_start = The N[th] year from the first incineration, which is the first year of the period *p*
p_end = The N[th] year from the first incineration, which is the last year of the period *p*
W_i = Quantity of MSW fed into incinerator in the year *i* [t]
EF_{N2O} = Emission factor for N_2O associated with incineration [tN_2O/t waste]
GWP_{N2O} = Global Warming Potential of nitrous oxide [tCO_2e/tN_2O]

$$PE_{EC,p} = EC_p \times EF_{elec}$$

Where:

$PE_{EC,p}$ = Project emissions from electricity consumption by the project facility during the period *p* [tCO_2e/p]
EC_p = Quantity of electricity consumed by the project facility during the period *p* [MWh/p]
EF_{elec} = Emission factor for electricity generation [tCO_2e/MWh]

$$PE_{FC,p} = \sum_{fuel} \left(FC_{fuel,p} \times NCV_{fuel} \times EF_{CO2,fuel}\right)$$

Where:

$PE_{FC,p}$ = Project emissions from auxiliary fossil fuel consumption associated with incineration during the period *p* [tCO_2e/p]
$FC_{fuel,p}$ = Quantity of fuel combusted during the period *p* [kL or m^3/p]
NCV_{fuel} = Net calorific value of fuel [GJ/kL or m^3]
$EF_{CO2,fuel}$ = CO_2 emission factor of fuel [tCO_2/GJ]
$fuel$ = Type of fuel

H. Calculation of emissions reductions

$ER_p = RE_p - PE_p$

Where:

ER_p	=	Emission reductions during the period *p* [tCO_2e/p]
RE_p	=	Reference emissions during the period *p* [tCO_2e/p]
PE_p	=	Project emissions during the period *p* [tCO_2e/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
φ	Model correction factor to account for model uncertainties Default value: 0.80 The conservative value was selected from the default values $\varphi_{default}$ in the tool.	CDM Methodological Tool "Emissions from solid waste disposal sites" (Version 07.0)
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere Default value: 0	Decided taking into consideration the situation in Indonesia
GWP_{CH4}	Global Warming Potential of methane [tCO_2e/tCH_4] Default value: 25	Table 2.14, of the errata to the contribution of Working Group I to the Fourth Assessment Report of the IPCC
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) Default value: 0.1	CDM Methodological Tool "Emissions from solid waste disposal sites" (Version 07.0)
F	Fraction of methane in the SWDS gas [volume fraction] Default value: 0.5	CDM Methodological Tool "Emissions from solid waste disposal sites" (Version 07.0)

DOC_f	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS [weight fraction] Default value: 0.5	CDM Methodological Tool "Emissions from solid waste disposal sites" (Version 07.0)
MCF	Methane correction factor Select one of the followings taking into consideration the situation of the project. (1) In case of a water table above the bottom of the SWDS, estimate the MCF using the following equation. $$MCF = MAX\left\{\left(1-\frac{2}{d_y}\right), \frac{h_{w,y}}{d_y}\right\}$$ $h_{w,y}$ = Height of water table measured from the base of the SWDS [m] d_y = Depth of SWDS [m] (2) In case that the SWDS does not have a water table above the bottom of the SWDS, select the applicable value from the following: ● 1.0 for anaerobic managed solid waste disposal sites. These have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste; ● 0.5 for semi-aerobic managed solid waste disposal sites. These have controlled placement of waste and will include all of the following structures for introducing air to the waste layers: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system; ● 0.8 for unmanaged solid waste disposal sites– deep. This comprises all SWDS not meeting the criteria of managed SWDS and which have	CDM Methodological Tool "Emissions from solid waste disposal sites" (Version 07.0)

<table>
<tr>
<td></td>
<td>depths of greater than or equal to 5 meters;
● 0.4 for unmanaged-shallow solid waste disposal sites or stockpiles that are considered SWDS. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters. This includes stockpiles of solid waste that are considered SWDS.</td>
<td></td>
</tr>
<tr>
<td>DOC_j</td>
<td>Fraction of degradable organic carbon in the waste type j [weight fraction]
Default values for DOC_j:
<table>
<tr><th>Waste type j</th><th>DOC_j
[% wet waste]</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Nappies</td><td>24</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table>
</td>
<td>CDM Methodological Tool “Emissions from solid waste disposal sites” (Version 07.0) and Table 2.4, chapter 2, volume 5 of 2006 IPCC guidelines for National GHG Inventories</td>
</tr>
<tr>
<td>k_j</td>
<td>Decay rate for the waste type j [1/yr]
Default values for k_j:
<table>
<tr><th colspan="2">Waste type j</th><th>k_j
[1/yr]</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (nonfood) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.40</td></tr>
</table>
The default values k_j for Tropical (Mean annual temperature>20 degree C) and Wet (Mean annual precipitation>1000mm) were selected taking into consideration the climate condition of Indonesia.</td>
<td>CDM Methodological Tool “Emissions from solid waste disposal sites” (Version 07.0)</td>
</tr>
<tr>
<td>p_j</td>
<td>Fraction of the waste type j [weight fraction]
Before the validation of a proposed project, take at</td>
<td>Study conducted by the project participants</td>
</tr>
</table>

	least one sample in each season (both rainy and dry) from MSW transported to a SWDS within the same municipality where the project facility is to be constructed, weigh each waste fraction (measure on wet basis) taking into consideration of the waste type *j*, as provided in the table for FCC_j and FFC_j, and average each waste fraction *j* among the samples.	
EF_{elec}	Emission factor for electricity generation [tCO_2e/MWh] When the project facility displaces and consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When the project facility may displace and consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factor with lower value. **[CO_2 emission factor]** For grid electricity: The most recent value available from the source stated in this table at the time of validation For captive electricity: 0.8* [tCO_2/MWh] *The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.	**[Grid electricity]** The data is sourced from “Emission Factors of Electricity Interconnection Systems”, National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of Energy and Mineral Resources, Indonesia, unless otherwise instructed by the Joint Committee. **[Captive electricity]** CDM approved small scale methodology AMS-I.
EFF_{COM}	Combustion efficiency of incinerator [fraction] Default value: 1 (100%)	Table 5.2, chapter 5, volume 5 of 2006 IPCC guidelines for National GHG Inventories
FCC_j	Fraction of total carbon content in waste type *j* [tC/t] Default values for FCC_j: <table><tr><td>Waste type *j*</td><td>FCC_j [% dry waste]</td></tr></table>	CDM approved consolidated baseline and monitoring methodology ACM0022 “Alternative

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>Paper/cardboard</td><td>50</td></tr>
<tr><td>Textiles</td><td>50</td></tr>
<tr><td>Food waste</td><td>50</td></tr>
<tr><td>Wood</td><td>54</td></tr>
<tr><td>Garden and Park waste</td><td>55</td></tr>
<tr><td>Nappies</td><td>90</td></tr>
<tr><td>Rubber and Leather</td><td>67</td></tr>
<tr><td>Plastics</td><td>85</td></tr>
<tr><td>Metal*</td><td>NA</td></tr>
<tr><td>Glass*</td><td>NA</td></tr>
<tr><td>Other, inert waste</td><td>5</td></tr>
</table>
*Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common.
</td>
<td>waste treatment processes” (Version 02.0)</td>
</tr>
<tr>
<td>FFC_j</td>
<td>
Fraction of fossil carbon in total carbon content of waste type j [weight fraction]
Default values for FFC_j:
<table>
<tr><td>Waste type j</td><td>FFC_j [%]</td></tr>
<tr><td>Paper/cardboard</td><td>5</td></tr>
<tr><td>Textiles</td><td>50</td></tr>
<tr><td>Food waste</td><td>-</td></tr>
<tr><td>Wood</td><td>-</td></tr>
<tr><td>Garden and Park waste</td><td>0</td></tr>
<tr><td>Nappies</td><td>10</td></tr>
<tr><td>Rubber and Leather</td><td>20</td></tr>
<tr><td>Plastics</td><td>100</td></tr>
<tr><td>Metal*</td><td>NA</td></tr>
<tr><td>Glass*</td><td>NA</td></tr>
<tr><td>Other, inert waste</td><td>100</td></tr>
</table>
*Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common.
</td>
<td>CDM approved consolidated baseline and monitoring methodology ACM0022 “Alternative waste treatment processes” (Version 02.0)</td>
</tr>
<tr>
<td>DC</td>
<td>Dry matter content of MSW [%]
Before the validation of a proposed project, take at least one sample in each season (both rainy and dry) from MSW transported to a SWDS within the same municipality where the project facility is to be constructed, weigh each sample in wet and dry basis, calculate the fraction of dry matter content for each sample, and average the values obtained.</td>
<td>Study conducted by the project participants</td>
</tr>
<tr>
<td>EF_{N2O}</td>
<td>Emission factor for N_2O associated with incineration [tN_2O/t waste]
Select one of the following default values taking into consideration the situation of the project.
Default values for EF_{N2O}:</td>
<td>CDM approved consolidated baseline and monitoring methodology ACM0022 “Alternative waste treatment</td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><th>Type of waste</th><th>Technology / Management practice</th><th>EF_{N2O} [tN_2O/t waste wet basis]</th></tr>
<tr><td>MSW</td><td>Continuous and semicontinuous incinerators</td><td>$1.21*50*10^{-6}$</td></tr>
<tr><td>MSW</td><td>Batch-type incinerators</td><td>$1.21*60*10^{-6}$</td></tr>
</table>
</td>
<td>processes” (Version 02.0) and Table 5.6, chapter 5, volume 5 of 2006 IPCC Guidelines for National GHG Inventories</td>
</tr>
<tr>
<td>GWP_{N2O}</td>
<td>Global Warming Potential of nitrous oxide
[tCO_2e/tN_2O]
Default value: 298</td>
<td>Table 2.14, of the errata to the contribution of Working Group I to the Fourth Assessment Report of the IPCC</td>
</tr>
<tr>
<td>NCV_{fuel}</td>
<td>Net calorific value of fuel [GJ/kL or m^3]
Decide from the specifications described on invoices or other commercial/contractual evidence.</td>
<td>Invoices or other commercial/contractual evidence</td>
</tr>
<tr>
<td>$EF_{CO2,fuel}$</td>
<td>CO_2 emission factor of fuel [tCO_2/GJ]
Select a value for the fuel combusted by the project from the IPCC default values at the upper limit of the uncertainty at a 95% confidence interval.</td>
<td>Table 1.4, chapter 1, volume 2 of 2006 IPCC Guidelines for National GHG Inventories. Upper value is applied.</td>
</tr>
</table>

9.2 JCM Proposed Methodology Spreadsheet

JCM Proposed Methodology Spreadsheet Form (input sheet) [Attachment to Proposed Methodology Form]

Table 1: Parameters to be monitored *ex post*

(a) Monitoring point No.	(b) Parameters	(c) Description of data	(d) Estimated Values	(e) Units	(f) Monitoring option	(g) Source of data	(h) Measurement methods and procedures	(i) Monitoring frequency	(j) Other comments
(1)	W_i	Quantity of MSW fed into incinerator in the year *i*	see "PMS(input) (2)" sheet	t	Option C	Measuring apparatus	Amount of MSW to be incinerated is measured on wet basis by a measuring apparatus which is equipped to conveying equipment for the incinerator such as hopper, crane and conveyor. Measured continuously and aggregated anually for the year *i*	Continuously	input values in "PMS(input)(2)" sheet
-	p_start	The Nth year from the first disposal (or incineration), which is the first year of the period *p*		-	Option C	monitored data	Count the number of the year (Nth year) from the first disposal (or incineration), which is the first year of the period *p*.		
-	p_end	The Nth year from the first disposal (or incineration), which is the last year of the period *p*		-	Option C	monitored data	Count the number of the year (Nth year) from the first disposal (or incineration), which is the last year of the period *p*.		
(3)	$EG_{elec,p}$	Quantity of electricity generated by the project facility during the period *p*		MWh/p	Option B or C	Electricity meter	If all of the generated electricity by the project facility other than the electricity used for itself is sold and the project facility consumes only electricity generated by itself and/or purchased, the option B is apllied and the invoice for the sold electricity is used. In other cases, the option C is applied and the quantity of electricity generated by the project facility is measured by the electricity meter. The meter is replaced or calibrated at an interval following the regulations in the country in which the meter is commonly used or according to the manufacturer's recommendation, unless a type approval, manufacturer's specification, or certification issued by an entity accredited under international/national standards for the electricity meter has been prepared	Continuously	
(4)	EC_p	Quantity of electricity consumed by the project facility during the period *p*		MWh/p	Option B or C	Electricity meter	If all of the generated electricity by the project facility other than the electricity used for itself is sold and the project facility consumes only electricity generated by itself and/or purchased, the option B is apllied and the invoice for the purchased electricity is used. In other cases, the option C is applied and the quantity of electricity consumed by the project facility is measured by the electricity meter. The meter is replaced or calibrated at an interval following the regulations in the country in which the meter is commonly used or according to the manufacturer's recommendation, unless a type approval, manufacturer's specification, or certification issued by an entity accredited under international/national standards for the electricity meter has been prepared	Continuously	
(5)	$FC_{fuel,p}$	Quantity of fuel combusted during the period *p*		kL or m^3/p	Option C	Volume meters	The quantity of fuel combusted is measured by a flow meter. The meter is replaced or calibrated at an interval following the regulations in the country in which the meter is commonly used or according to the manufacturer's recommendation, unless a type approval, manufacturer's specification, or certification issued by an entity accredited under international/national standards for the flow meter has been prepared by the time of installation.	Continuously	

Table 2: Project-specific parameters to be fixed *ex ante*

(a) Parameters	(b) Description of data	(c) Estimated Values	(d) Units	(e) Source of data	(f) Other comments
MCF	Methane correction factor		Fraction	Select one of the followings taking into consideration the situation of the project. Estimate using the equation in the methodology or select the applicable value from the following: 1.0, 0.5, 0.8 or 0.4.	
p_{paper}	Fraction of the waste type "Paper/cardboard"		Weight fraction	Before the validation of a proposed project, take at least one sample in each season (both rainy and dry) from MSW transported to a SWDS within the same municipality where the project facility is to be constructed, weigh each waste fraction (measure on wet basis) taking into consideration of the waste type *j*, as provided in the table for FCC_j and FFC_j, and average each waste fraction *j* among the samples.	
$p_{textiles}$	Fraction of the waste type "Textiles"				
p_{food}	Fraction of the waste type "Food waste"				
p_{wood}	Fraction of the waste type "Wood"				
p_{garden}	Fraction of the waste type "Garden and park waste"				
$p_{nappies}$	Fraction of the waste type "Nappies"				
p_{rubber}	Fraction of the waste type "Rubber and leather"				
$p_{plastics}$	Fraction of the waste type "Plastics"				
p_{metal}	Fraction of the waste type "Metal"				
p_{glass}	Fraction of the waste type "Glass"				
p_{other}	Fraction of the waste type "Other, inert waste"				
EF_{elec}	Emission factor for electricity generation		tCO_2e/MWh	When the project facility displaces and consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When the project facility may displace and consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factor with lower value. [CO_2 emission factor] For grid electricity: The most recent value available at the time of validation from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of Energy and Mineral Resources, Indonesia, is applied unless otherwise instructed by the Joint Committee. For captive electricity: The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.	

DC	Dry matter content of MSW		%	Before the validation of a proposed project, take at least one sample in each season (both rainy and dry) from MSW transported to a SWDS within the same municipality where the project facility is to be constructed, weigh each sample in wet and dry basis, calculate the fraction of dry matter content for each sample, and average the values obtained.	
EF_{N2O}	Emission factor for N_2O associated with incineration		tN_2O/t waste wet basis	Select one from the following default values taking into consideration the situation of the project. Default values for EF_{N2O}: Type of waste/ Technology/Management practice/ EF_{N2O} [tN_2O/t waste wet basis] MSW/ Continuous and semicontinuous incinerators/ $1.21*50*10^{-6}$ MSW/ Batch-type incinerators/ $1.21*60*10^{-6}$	
NCV_{fuel}	Net calorific value of fuel		GJ/kL or m	Decide from the specifications described on invoices or other commercial/contractual evidence.	
$EF_{CO2,fuel}$	CO_2 emission factor of fuel		tCO_2/GJ	Select a value for the fuel combusted by the project from the IPCC default values at the upper limit of the uncertainty at a 95% confidence interval.	

Table3: *Ex-ante* estimation of CO_2 emission reductions

CO_2 emission reductions	Units
0	tCO_2/p

[Monitoring option]

Option A	Based on public data which is measured by entities other than the project participants (Data used: publicly recognized data such as statistical data and specifications)
Option B	Based on the amount of transaction which is measured directly using measuring equipments (Data used: commercial evidence such as invoices)
Option C	Based on the actual measurement using measuring equipments (Data used: measured values)

JCM Proposed Methodology Spreadsheet Form (Input Sheet) [Attachment to Proposed Methodology For

Table 1: Parameters to be monitored *ex post*

(a)	Monitoring point No.	(1)
(b)	Parameters	W_i
(c)	Description of data	Quantity of MSW fed into incinerator in the year *i*
(e)	Units	t
(f)	Monitoring option	Option C
(g)	Source of data	Measuring apparatus
(h)	Measurement methods and procedures	Amount of MSW to be incinerated is measured on wet basis by a measuring apparatus which is equipped to conveying equipment for the incinerator such as hopper, crane and conveyor. Measured continuously and aggregated anually for the year *i* .
(i)	Monitoring frequency	Continuously
(j)	Other comments	
(d)	Estimated Values	
	Year 1	
	Year 2	
	Year 3	
	Year 4	
	Year 5	
	Year 6	
	Year 7	
	Year 8	
	Year 9	
	Year 10	
	Year 11	
	Year 12	
	Year 13	
	Year 14	
	Year 15	
	Year 16	
	Year 17	
	Year 18	

JCM Proposed Methodology Spreadsheet Form (Calculation Process Sheet)

[Attachment to Proposed Methodology Form]

1. Calculations for emission reductions	Fuel type	Value	Units	Parameter
Emission reductions during the period *p*		0.0	tCO_2/p	ER_p
2. Selected default values, etc.				
Methane correction factor		0	Fraction	MCF
Emission factor for N_2O associated with incineration		0	tN_2O/t waste wet basis	EF_{N2O}
3. Calculations for reference emissions				
Reference emissions during the period *p*		0.0	tCO_2/p	RE_p
Reference emissions from decomposition of MSW at the SWDS during the period *p*	-	0.0	tCO_2e/p	$RE_{CH4,p}$
Reference emissions from electricity generation during the period *p*	Electricity	0.0	tCO_2e/p	$RE_{elec,p}$
4. Calculations of the project emissions				
Project emissions during the period *p*		0.0	tCO_2/p	PE_p
Project emissions of CO_2 from combustion of fossil carbon contained in waste associated with incineration during the period *p*	-	0.0	tCO_2e/p	$PE_{COM\_CO2,p}$
Project emissions of N_2O from combustion of waste associated with incineration during the period *p*	-	0.0	tCO_2e/p	$PE_{COM\_N2O,p}$
Project emissions from electricity consumption by the project facility during the period *p*	Electricity	0.0	tCO_2e/p	$PE_{EC,p}$
Project emissions from auxiliary fossil fuel consumption associated with incineration during the period *p*	-	0.0	tCO_2e/p	$PE_{FC,p}$

[List of Default Values]

Default values for calculating $RE_{CH4,p}$ other than DOC_j and k_j

Description	Value	Units	Parameter
Model correction factor to account for model uncertainties	0.80	-	φ
Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere	0	-	f
Global Warming Potential of methane	25	tCO_2e/tCH_4	GWP_{CH4}
Oxidation factor	0.1	-	OX
Fraction of methane in the SWDS gas (volume fracti	0.5	volume fraction	F
Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS	0.5	weight fraction	DOC_f

Fraction of degradable organic carbon in the waste type *j*

Waste type *j*	DOC_j	Units
Wood and wood products	43	% wet waste
Pulp, paper and cardboard (other than sludge)	40	% wet waste
Food, food waste, beverages and tobacco (other than sludge)	15	% wet waste
Textiles	24	% wet waste
Garden, yard and park waste	20	% wet waste
Nappies	24	% wet waste
Glass, plastic, metal, other inert waste	0	% wet waste
Sludge	5	% wet waste

Decay rate for the waste type *j*

Waste type *j*	k_j	Units
Slowly degrading: Pulp, paper, cardboard (other than sludge), textiles	0.07	1/yr
Slowly degrading: Wood, wood products and straw	0.035	1/yr
Moderately degrading: Other (nonfood) organic putrescible garden and park waste	0.17	1/yr
Rapidly degrading: Food, food waste, sewage sludge, beverages and tobacco	0.4	1/yr

Fraction of total carbon content in waste type *j*

Waste type *j*	FCC_j	Units
Paper/cardboard	50	% dry waste
Textiles	50	% dry waste
Food waste	50	% dry waste
Wood	54	% dry waste
Garden and Park waste	55	% dry waste
Nappies	90	% dry waste
Rubber and Leather	67	% dry waste
Plastics	85	% dry waste

Metal*	NA	% dry waste
Glass*	NA	% dry waste
Other, inert waste	5	% dry waste

Fraction of fossil carbon in total carbon content of waste type *j*

Waste type *j*	FFC_j	Units
Paper/cardboard	5	%
Textiles	50	%
Food waste	-	%
Wood	-	%
Garden and Park waste	0	%
Nappies	10	%
Rubber and Leather	20	%
Plastics	100	%
Metal*	NA	%
Glass*	NA	%
Other, inert waste	100	%

Default values for calculating project emissions

Description	Value	Units	Parameter
Combustion efficiency of incinerator (fraction)	1	-	EFF_{COM}
Global Warming Potential of nitrous oxide	298	tCO_2e/tN_2O	GWP_{N2O}

Default values for emission factor for N_2O associated with incineration

Waste / Technology/Management practice	EF_{N2O}	Units
MSW/ Continuous and semicontinuous incinerators	6.05E-05	tN_2O/t waste wet basis
MSW/ Batch-type incinerators	7.26E-05	tN_2O/t waste wet basis

JCM Proposed Methodology Spreadsheet Form (Calculation Process Sheet)

[Attachment to Proposed Methodology Form]

2. Selected default values, etc.

j	1	2	3	4	5	6	7	8	9	10	11
	Paper/cardboard	Textiles	Nappies	Wood	Garden and park waste	Food waste	Glass	Plastics	Rubber and leather	Metal	Other, inert waste
p_j	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DC						0.0%					
DOC_j	40%	24%	24%	43%	20%	15%	0%	0%	0%	0%	0%
k_j	0.07	0.07	0.07	0.035	0.17	0.4					
FCC_j	50%	50%	90%	54%	55%	50%	0%	85%	67%	0%	5%
FFC_j	5%	50%	10%	0%	0%	0%	0%	100%	20%	0%	100%

3. Calculations for reference emissions

Weight

	Paper/cardboard	Textiles	Nappies	Wood	Garden and park waste	Food waste	Glass	Plastics	Rubber and leather	Metal	Other, inert waste
Total (Dry basis)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year 18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DOC

	Slowly degrading: Pulp, paper, cardboard (other than sludge), textiles	Slowly degrading: Wood, wood products and straw	Moderately degrading: Other (nonfood) organic putrescible garden and park waste	Rapidly degrading: Food, food waste, sewage sludge, beverages and tobacco
Year 1	0.0	0.0	0.0	0.0
Year 2	0.0	0.0	0.0	0.0
Year 3	0.0	0.0	0.0	0.0
Year 4	0.0	0.0	0.0	0.0
Year 5	0.0	0.0	0.0	0.0
Year 6	0.0	0.0	0.0	0.0
Year 7	0.0	0.0	0.0	0.0
Year 8	0.0	0.0	0.0	0.0
Year 9	0.0	0.0	0.0	0.0
Year 10	0.0	0.0	0.0	0.0
Year 11	0.0	0.0	0.0	0.0
Year 12	0.0	0.0	0.0	0.0
Year 13	0.0	0.0	0.0	0.0
Year 14	0.0	0.0	0.0	0.0
Year 15	0.0	0.0	0.0	0.0
Year 16	0.0	0.0	0.0	0.0
Year 17	0.0	0.0	0.0	0.0
Year 18	0.0	0.0	0.0	0.0

Decayed DOC

							y	
	Slowly degrading: Pulp, paper, cardboard (other than sludge), textiles	Slowly degrading: Wood, wood products and straw	Moderately degrading: Other (nonfood) organic putrescible garden and park waste	Rapidly degrading: Food, food waste, sewage sludge, beverages and tobacco	Subtotal	Total	The N^th year from the first disposal (or incineration), extending from the first year of the period *p* (*y*=*p_start*) to the last year of the period *p* (*y*=*p_end*)	Total for the monitoring period
Year 1	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Year 2	0.0	0.0	0.0	0.0	0.0		0	
Year 3	0.0	0.0	0.0	0.0	0.0		0	
Year 4	0.0	0.0	0.0	0.0	0.0		0	
Year 5	0.0	0.0	0.0	0.0	0.0		0	
Year 6	0.0	0.0	0.0	0.0	0.0		0	
Year 7	0.0	0.0	0.0	0.0	0.0		0	
Year 8	0.0	0.0	0.0	0.0	0.0		0	
Year 9	0.0	0.0	0.0	0.0	0.0		0	
Year 10	0.0	0.0	0.0	0.0	0.0		0	
Year 11	0.0	0.0	0.0	0.0	0.0		0	
Year 12	0.0	0.0	0.0	0.0	0.0		0	
Year 13	0.0	0.0	0.0	0.0	0.0		0	
Year 14	0.0	0.0	0.0	0.0	0.0		0	
Year 15	0.0	0.0	0.0	0.0	0.0		0	
Year 16	0.0	0.0	0.0	0.0	0.0		0	
Year 17	0.0	0.0	0.0	0.0	0.0		0	
Year 18	0.0	0.0	0.0	0.0	0.0		0	

JCM Proposed Methodology Spreadsheet Form (Calculation Process Sheet)

[Attachment to Proposed Methodology Form]

Slowly degrading: Pulp, paper, cardboard (other than sludge), textiles

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
Year 1		0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313	0.0292	0.0272	0.0254	0.0237	0.0221
Year 2			0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313	0.0292	0.0272	0.0254	0.0237
Year 3				0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313	0.0292	0.0272	0.0254
Year 4					0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313	0.0292	0.0272
Year 5						0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313	0.0292
Year 6							0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336	0.0313
Year 7								0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360	0.0336
Year 8									0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386	0.0360
Year 9										0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414	0.0386
Year 10											0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444	0.0414
Year 11												0.0676	0.0630	0.0588	0.0548	0.0511	0.0476	0.0444
Year 12													0.0676	0.0630	0.0588	0.0548	0.0511	0.0476
Year 13														0.0676	0.0630	0.0588	0.0548	0.0511
Year 14															0.0676	0.0630	0.0588	0.0548
Year 15																0.0676	0.0630	0.0588
Year 16																	0.0676	0.0630
Year 17																		0.0676
Year 18																		

Slowly degrading: Wood, wood products and straw

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
Year 1		0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234	0.0226	0.0218	0.0211	0.0203	0.0196
Year 2			0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234	0.0226	0.0218	0.0211	0.0203
Year 3				0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234	0.0226	0.0218	0.0211
Year 4					0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234	0.0226	0.0218
Year 5						0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234	0.0226
Year 6							0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242	0.0234
Year 7								0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251	0.0242
Year 8									0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260	0.0251
Year 9										0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269	0.0260
Year 10											0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279	0.0269
Year 11												0.0344	0.0332	0.0321	0.0310	0.0299	0.0289	0.0279
Year 12													0.0344	0.0332	0.0321	0.0310	0.0299	0.0289
Year 13														0.0344	0.0332	0.0321	0.0310	0.0299
Year 14															0.0344	0.0332	0.0321	0.0310
Year 15																0.0344	0.0332	0.0321
Year 16																	0.0344	0.0332
Year 17																		0.0344
Year 18																		

Moderately degrading: Other (nonfood) organic putrescible garden and park waste

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
Year 1		0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241	0.0203	0.0172	0.0145	0.0122	0.0103
Year 2			0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241	0.0203	0.0172	0.0145	0.0122
Year 3				0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241	0.0203	0.0172	0.0145
Year 4					0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241	0.0203	0.0172
Year 5						0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241	0.0203
Year 6							0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286	0.0241
Year 7								0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339	0.0286
Year 8									0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401	0.0339
Year 9										0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476	0.0401
Year 10											0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564	0.0476
Year 11												0.1563	0.1319	0.1113	0.0939	0.0792	0.0668	0.0564
Year 12													0.1563	0.1319	0.1113	0.0939	0.0792	0.0668
Year 13														0.1563	0.1319	0.1113	0.0939	0.0792
Year 14															0.1563	0.1319	0.1113	0.0939
Year 15																0.1563	0.1319	0.1113
Year 16																	0.1563	0.1319
Year 17																		0.1563
Year 18																		

Rapidly degrading: Food, food waste, sewage sludge, beverages and tobacco

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
Year 1		0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040	0.0027	0.0018	0.0012	0.0008	0.0005
Year 2			0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040	0.0027	0.0018	0.0012	0.0008
Year 3				0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040	0.0027	0.0018	0.0012
Year 4					0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040	0.0027	0.0018
Year 5						0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040	0.0027
Year 6							0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060	0.0040
Year 7								0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090	0.0060
Year 8									0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134	0.0090
Year 9										0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200	0.0134
Year 10											0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299	0.0200
Year 11												0.3297	0.2210	0.1481	0.0993	0.0666	0.0446	0.0299
Year 12													0.3297	0.2210	0.1481	0.0993	0.0666	0.0446
Year 13														0.3297	0.2210	0.1481	0.0993	0.0666
Year 14															0.3297	0.2210	0.1481	0.0993
Year 15																0.3297	0.2210	0.1481
Year 16																	0.3297	0.2210
Year 17																		0.3297
Year 18																		

Chapter 10 Future tasks and conclusions of the Feasibility Study

This feasibility study is prepared for Feasibility Study of Joint Crediting Mechanism Project under City to City collaboration by Clean Authority of TOKYO who has a capability of operation and maintenance of Waste to Energy (WTE) Power plant in order to promote a recycling-oriented society and to realize most appropriate urban waste combustion technology in Bali Province. The following is the summary of the conclusion and the future tasks which should be resolved.

10.1 Future tasks

1) Power purchase agreement with PT. PLN

   As stated in the Chapter 8, the fluctuation of the electricity tariff brings serious negative impact on SPC's project cash flow. The results of the comical feasibility study is feasible if the tariff of electricity is guaranteed that is USDC 18.77 defined by" Minister degree 44" published by Ministry of Energy and Mineral Resources. However, the electricity tariff is often determined through negotiation between SPC and PT PLN, even the electricity tariff is defied in the law. Therefore, the further clarification and/or improvement of flame work of Power purchase agreement shall be required for realization of WTE project in Indonesia. The background of this problem is that Indonesia has no regulation or special law concerning financial support to renewable energy project, and there is no incentive for PLN to make a PPA contract by using electricity tariff specified by the law. This is one of the major problems that prevent to promote WTE project in Indonesia.

2) New presidential degree substituted for Presidential degree No.18

   After this F/S is commenced, the "Presidential degree No.18 has been revoked by the order of the Indonesian supreme court. We've confirmed from related Ministry that the related Ministry is now preparing for alternative presidential degree in order to promote WTE project in Indonesia. The following is the major problems on Presidential degree No.18 which should be resolved by the new presidential degree.

   1) The definition of the thermal treatment shall be specified
   2) No guidance/instruction of the detailed selection (tender) process for thermal treatment of MSW
   3) Local government does not have enough knowledge concerning appropriate waste combustion technology and official tender process

   In order to realize WTE project not only Denpasar City but also in whole area of Indonesia, it is essential to define the new presidential degree or related law having more clear guideline explaining more detailed selection process and definition for combustion technology of MSW to be introduced in Indonesia.

3) Financial support for Tipping Fee
   As stated in Chapter 8, the economic feasibility study has been conducted under the assumption that VGF will be applied to the WTE project in Denpasar City. By utilization of the financial support or related subsidy such as VGF and JCM by Indonesian and Japanese Government, the required Tipping Fee might be decreased as stated in Chapter 8. However, there are few PPP Project applying VGF and the process of application of VGF is not still clear. In addition, the establishment of the financial support for Tipping Fee borne by the local government greatly contribute for realization of WTE project in Indonesia.

10.2 Conclusion

The conclusion of this feasibility study is that the WTE project in Denpasar is economically feasible if the Presidential degree No.18 and Minister Degree 44 is applied and it is expected that the state of the art technology developing from Japan can be utilized in order to realize a recycling-oriented society in Indonesia. Since expected project scheme is BOT under 25 years operation period and from the point of view of sustainable MSW treatment during the concession period, we conclude that the most appropriate combustion technology applied to this project is “Stoker Furnace Technology” which is the most wildly known as most proven technology for combustion of MSW.

Meanwhile, there is a serious concern that the realization of WTE project in Indonesia itself is now threatened by the change in law concerning the above stated presidential degree No.18 and ministry degree No. 44. We convince that an integrated strategic approach by the Japanese and Indonesian governments with private sector will become increasingly important in order to overcome all difficulties and obstacles, and to assist the establishment of the appropriate guideline and/or law related to “Feed in Tariff for Renewable Energy Project” and “Introduction of Thermal Treatment Technology of MSW”.