MOEJ/GEC JCM Feasibility Study (FS) 2014
Summary of the Final Report

"Introduction of Waste to Energy Plant in Yangon City"

(Implementing Entity: JFE Engineering Corporation)

1. Overview of the Proposed JCM Project

<table>
<tr><td>Study partners</td><td colspan="4">1, Pollution Control and Cleansing Department (PCCD), Yangon City Development Committee (YCDC) : Counterpart of Project in Host Country
2, Mitsubishi UFJ Research and Consulting Co., Ltd. : Subcontractor for JCM methodology development
3, JFE Techno-Research Corporation : Subcontractor for Preliminary Research</td></tr>
<tr><td>Project site</td><td colspan="4">Yangon City, Myanmar</td></tr>
<tr><td>Category of project</td><td colspan="4">Waste, Biomass</td></tr>
<tr><td>Description of project</td><td colspan="4">Through the introduction of a Waste to Energy plant, the reduction of CH4 emissions from landfill disposal site, and the substitution of the fossil fuel-based electricity will reduce GHG emission, improve electricity shortage and achieve appropriate waste treatment.</td></tr>
<tr><td rowspan="2">Expected project implementer</td><td>Japan</td><td colspan="3">JFE Engineering Corporation</td></tr>
<tr><td>Host country</td><td colspan="3">Pollution Control and Cleansing Department (PCCD), Yangon City Development Committee (YCDC)</td></tr>
<tr><td>Initial investment</td><td colspan="2">1,920,000,000JPY</td><td>Date of groundbreaking</td><td>October, 2015</td></tr>
<tr><td>Annual maintenance cost</td><td colspan="2">93,000,000JPY</td><td>Construction period</td><td>18 Months</td></tr>
<tr><td>Willingness to investment</td><td colspan="2">Basically approved</td><td>Date of project commencement</td><td>April, 2017</td></tr>
<tr><td>Financial plan of project</td><td colspan="4">The initial investment and operation cost will be covered in their totality by Yangon city's budget subject to the obtention of the relevant JCM subsidy</td></tr>
<tr><td>GHG emission reductions</td><td colspan="4">4,663 tCO2e；GHG emission reductions at 4th year after project start (2020)
<table>
<tr><td>GHG emission reductions</td><td>4,663 tCO2e</td></tr>
<tr><td>Reference emissions</td><td>12,073 tCO2e</td></tr>
<tr><td>(CH4 emissions from landfill site)</td><td>(7,496 tCO2e)</td></tr>
<tr><td>(CO2 emissions from electricity)</td><td>(4,576 tCO2e)</td></tr>
<tr><td>Project emissions</td><td>7,409 tCO2e</td></tr>
<tr><td>(CO2 emissions from waste incineration)</td><td>(4,913 tCO2e)</td></tr>
<tr><td>(N2O emissions from waste incineration)</td><td>(369 tCO2e)</td></tr>
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		(CO2 emissions from electricity)	(2,102 tCO2e)	
		(CO2 emissions from fossil fuel consumption)	(26 tCO2e)	

2. Study Contents

(1) Project development and implementation

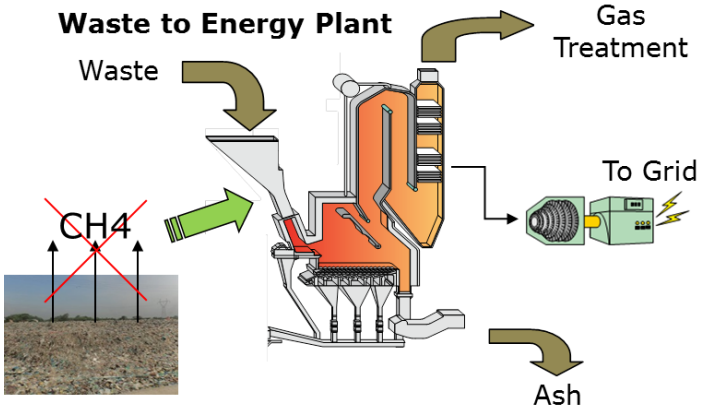
1) Project planning

a. Project Background:

Throughout the discussions between the Pollution Control and Cleansing Department (PCCD) at Yangon City Development Committee (YCDC) and JFE Engineering Corporation (JFE) after the completion of the "Feasibility Study of Installation, Operation and Maintenance of Waste to Energy (WTE) Plant in Greater Yangon (2012, 2013)", JFE's proposal of the introduction of a Waste to Energy Plant under the "JCM (the Joint Crediting Mechanism) Model Project" scheme, has been deemed optimal by PCCD for the optimization of the solid waste management system in Yangon City.

b. Project Description:

The proposed project plans to introduce a Waste to Energy Plant at a Yangon City-owned site near the Mingalardon temporary waste dumping site, located 35km north from central area of the city. The Plant will incinerate 60tons/day of municipal solid waste which are currently dumped into two adjacent temporary waste dumping sites (Mingalardon and Shwe Pyi Thar). The waste heat from the incinerator will be utilized to generate electricity through a steam turbine generator. The introduction of the proposed Plant will achieve the reduction of the CH4 emissions from the landfill sites; and the substitution of the electricity generated through fossil fuel combustion will further reduce GHG emissions.



Site of Study

c. Project Implementation Scheme:

The project implementation body will be comprised of the Pollution Control and Cleansing Department (PCCD), Yangon City Development Committee (YCDC),

and with JFE Engineering Corporation. Together, they will cooperate in the development of a project plan, financial plan, MRV structure etc.

d. Planned initial investment:

1,920,000,000JPY (1MMK=0.12JPY, 1USD=119.61JPY)

Half the amount of initial investment (8 billion Myanmar Kyat) will be financed by YCDC's budget subject to the obtention of the JCM subsidy program.

e. Planned annual maintenance cost:

	1st year	2nd year and later
Expense	153 million JPY	108 million JPY
Income	15 million JPY	15 million JPY
Balance	138 million JPY	93 million JPY

2) Permits and Licenses for the project development and implementation

According to YCDC, the relevant permits and authorizations for the construction of the Plant will be obtained through the existing draft document of Building Standards Law of Myanmar.

The Environmental Impact Assessment (EIA) Law is not yet officially established in Myanmar. However, at the time of the investment permit application required by the Foreign Investment Law, the Draft of Law will be applicable as the guideline for the EIA. YCDC has already appointed The Myanmar Engineering Society (MES) to carry out the EIA for the Project.

3) Advantage of Japanese technology

The Waste to Energy technology in Japan is a very well established waste treatment technology with more than 300 track records, dating as far back as 1965 when the first such plant was constructed. Today these

plants generate 7.21 billion kwh/year since the first plant in 1965.

Recently, Chinese, Korean and Indian companies have entered the business of waste treatment facility development. However, the Japanese Waste to Energy has obtained remarkable reviews due to its advanced technology which is capable of achieving the reduction in the emission of various pollutants, such as Dioxins.

Although the initial investment for the installation of a Waste to Energy facility with Japanese technology is usually higher than that related to Chinese, Korean or Indian technologies, this higher initial investment can be overcome through JCM subsidy or another financial supporting scheme. In addition, a Japanese Waste to Energy Plant can be stably and safely operated for a long period of time, thereby rendering Japanese WTE plants economical in long-termed lifecycle cost.

4) MRV structure

The project plans to monitor the following items:

1) Amount of waste (wet basis);
2) Fraction of each waste type (wet basis);
3) Gross electricity generated and sold by the project facility;
4) Gross electricity purchased by the project facility; and
5) Quantity of auxiliary fossil fuel consumption.

For all monitoring items, manuals will be prepared to give instructions on the proper placement of measuring equipment, measurement, and recording to ensure appropriate monitoring. The draft structural scheme of the MRV structure including operation management is presented to the Yangon city and there is a mutual understanding that the city personnel would play a main role in the operation of the plant. In particular, staff will collect data recorded through measuring equipment, a team leader will confirm, approve and report to the responsible division for archiving the date.

As operation management of a Waste to Energy Plant and a management of the JCM project are a new initiative to personnel of the Yangon city, capacity building will be given to both staff and management level personnel of the Yangon city in parallel to the project construction period. In addition, during the test run of the plant, staff of JFE Engineering will provide on-the-job training.

5) Environmental integrity and Sustainable development in host country

Besides considering the current draft of regulations and laws in Myanmar, the proposed Waste to Energy Plant will include technologies and facilities which will perform in accordance to the strictly regulated Japanese emission standards.

This Project will achieve the reduction of the environmental impact, such as air pollution and water pollution

with an appropriate waste management system. In addition, the Leapfrog Development to Low-Carbon and Recycle-Oriented society will be materialized in Yangon City. Two small sized Waste to Energy Plants (about 50tpd each) and one large sized Plant are also planned to be introduced in the future.

The impact of GHG emission reduction by the materialization of Waste to Energy Plants is expected to expand in other large cities in Myanmar, such as the one million-populated Mouramyain City or the 0.3 million Mandalay City, because waste management issues have gradually begun surfacing. Implementation of this Project will be expected to facilitate the introduction of Waste to Energy Plants in other cities in Myanmar, thereby realizing Myanmar's nationwide sustainable development through the reduction of environmental impact and fossil fuel consumption.

6) Toward project realization (planned schedule and possible obstacles to be overcome)

The Project planning will be construed considering the Project to start from September 2015 subject to the obtention of the relevant JCM subsidy. Toward project materialization, there are mainly two issues to be settled:

The first issue is the progress of JCM Agreement between Myanmar and Japan.
YCDC and MOECAF (Ministry of Environment Conservation and Forestry) have acknowledged that this Project will have the highest priority under the JCM scheme. However, there is no detailed information about the actual progress of the signing of the JCM agreement.
Currently, unofficial information expects the agreement to be finalized in the first half of 2015 fiscal year.

The second issue is the provision of the capacity building for operation and maintenance of the Plant, including MRV.
The training program is currently planned for both of the manager class and workers class. However, it is expected that the period of the program will be long and the cost will be high due to the relative inexperience of the participants in Waste to Energy Plant management.

(2) JCM methodology development

1) Eligibility criteria

This methodology sets the following eligibility criteria. Justifications for each criterion are explained below.

Table: draft eligibility criteria and their justification

	Criterion	Justification
Criterion 1	The project newly installs an incinerator, waste heat recovery boiler, exhaust gas treatment equipment and turbine generator.	As the methodology calculates emission reductions resulting from installation of a Waste to Energy Plant, the following provisions were introduced: installation of an incinerator, waste heat recovery boiler and turbine generator. The methodology is only applicable to greenfield projects because it assumes the BaU case as open dumping of waste. In

	Criterion	Justification
		addition, in view of environmental integrity, to prevent negative impacts to the atmosphere, installation of exhaust gas treatment equipment is required.
Criterion 2	The project incinerates fresh municipal solid waste and generates electricity from steam produced in a boiler which uses heat of incineration.	Since the methodology is targeted at Methane (CH4) emission reductions, the project is required to directly incinerate waste. Further, as the methodology also deals with Carbon Dioxide (CO2) emission reductions from the replacement of electricity, a provision was set for the project to utilize heat from waste incineration to generate electricity.
Criterion 3	The project facility is constructed within the municipality where waste to be incinerated by the project is generated.	This criterion was set because the methodology does not cover the change in GHG emissions resulting from changes in distance of incinerated ash transportation due to the installation of waste incineration plants.
Criterion 4	The fraction of energy generated by auxiliary fossil fuels in a construction design document is planned to be not more than 50 % of the total energy generated in the incinerator during normal operation.	If electricity generation due to fossil fuel firing surpasses that of waste incineration, such electricity generation should be regarded as fossil fuel fired generation.
Criterion 5	Electricity generated is exported to a grid or used for displacing captive fossil fuel fired power generator.	This criterion was introduced to ensure the replacement of grid or fossil fuel fired captive power generation.
Criterion 6*	Emissions of NO2 and CO at the stack of incinerator are designed to be less than or equal to the following levels: NO2 (230mg/m^3@11%Oxgen(O2)) and CO (42mg/m^3@11%O2)	This criterion was set to confirm a proper control of incineration of the plant through the concentration of Nitrous Oxide (NO2) and Carbon Oxygen (CO) at the tail-end of the stack of the facility.

2) Calculation of GHG emissions (including reference and project emissions)

a) Establishment of reference emissions

Projects assumed under this methodology incinerate waste and utilize its heat from incineration to generate electricity. In Myanmar, waste is open dumped in dump sites. In recent years, land available for dump sites is decreasing which led to consideration of volume reduction of waste, however, since the cost of installing plants is expensive, without financial assistance, waste incinerators would not be installed, thus in the BaU, waste is open dumped. At the same time, in the BaU case, the same amount of electricity generated by the project would have been produced using fossil fuels.

Reference emissions mainly consist of CH4 emissions from open dumping of waste and CO2 emissions from fossil fuels which would have been fired to generate the same amount of net electricity generated by the project. To estimate reference emissions conservatively in the methodology, two methods are considered: a certain discount factor is multiplied to CH4 emissions and CO2 emissions and set conservative values for parameters to calculate CH4. As a result of the consideration, a discount factor was applied to estimate reference emissions conservatively. As another option for assuring conservativeness, to set the model correction factor for CH4 emissions at a conservative value is proposed in addition to application of the discount factor.

b) Calculation of reference emissions

Calculation method of reference emissions is developed taking into consideration the baseline emission calculation method of the approved methodology of the CDM, ACM0022 "Alternative waste treatment processes". As shown in the below equation, a discount factor (DF_{RATE}) is multiplied to the sum of CH4 emissions ($RE_{CH4,p}$) from open dumped waste and CO2 emissions ($RE_{elec,p}$) from fossil fuels which would have been fired to generate the same amount of net electricity generated by the project. The discount factor is derived by subtracting ratio of the amount of intermediately treated waste to the amount of all waste generated in the municipality where waste to be incinerated by the project is generated from 1.

$$\mathbf{RE_p = \left(RE_{CH4,p} + RE_{elec,p}\right) \times DF_{RATE}}$$

$$\mathbf{DF_{RATE} = 1 - RATE}$$

The equation for calculating CH4 emissions from open dump sites is based on the monthly calculation option used in the methodological tool of the CDM, "Emissions from solid waste disposal sites". As shown in the below equation, the amount of degradable organic carbon in waste is multiplied by respective factors such as degree of decomposition.

$$\mathbf{RE_{CH4,p} = \sum_{m=p\_start}^{p\_end} \left\{ \varphi \times (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{i=1}^{m} \sum_{j} W_{j,i} \cdot DOC_j \cdot e^{-\frac{k_j}{12}(m-i)} \cdot \left(1 - e^{-\frac{k_j}{12}}\right) \right\}}$$

As shown in the below equation, CO2 emissions from fossil fuels which would have been fired to generate the same amount of net electricity generated by the project is calculated from multiplying the amount of electricity generated and sold by the project and the emission factor of electricity.

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

c) Calculation of project emissions

Calculation method of project emissions is developed taking into consideration the project emission calculation method of the approved methodology of the CDM, ACM0022 "Alternative waste treatment processes". As shown in the below equation, project emissions are the sum of CO2 emissions from combustion of fossil waste ($PE_{COM\_CO2,p}$), N2O emissions from combustion of waste ($PE_{COM\_N2O,p}$), CO2 emissions from electricity consumption ($PE_{EC,p}$) and fossil fuel consumption ($PE_{FC,p}$). Furthermore, CH4 emissions associated with waste incineration are negligibly small in terms of quantity and excluded from the project emission calculation. Moreover, emissions associated with waste water treatment are not included as the project assumed under this methodology does not discharge waste water.

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

3) Data and parameters fixed *ex ante*

Project specific values fixed ex ante or parameters which were fixed with default values are listed below. For each parameter, consideration was made on its content and possibility of setting conservative values. As a result, the discount factor is applied in the proposed methodology for assuring conservativeness. As another option for assuring conservativeness, the model correction factor φ was set conservatively taking into consideration the situation of Myanmar.

Table: Project specific values fixed ex ante

Parameter	Description	Justification
RATE	Ratio of the amount of intermediately treated waste to the amount of all waste generated in the municipality where waste to be incinerated by the project is generated	The parameter is for calculating the discount rate of the situation of waste treatment in the project site. The parameter is fixed ex ante. The parameter is decided based on the ratio of the amount of intermediately treated waste to the amount of all waste generated in the municipality where waste to be incinerated by the project. It is estimated at the time of validation or the start of operation, whichever comes earlier, using data or information provided from the municipality.
MCF	Methane correction factor	Select one of the followings taking into consideration the situation of the project. In Yangon City: Default value of 0.8 In other places in Myanmar: Estimate using the equation in the methodology or select the applicable value from the following: 1.0, 0.5, 0.8 or 0.4.
EF_{elec}	Emission factor for electricity generation	Select one of the followings taking into consideration the situation of the project. For grid electricity: The value available from PDD of the most recently registered CDM project hosted in Myanmar or the calculated value using the latest version of the "Tool to calculate the emission factor for an electricity system" under the CDM at the time of validation. For captive electricity: The most recent value available from CDM approved small scale methodology AMS-I.A.
WC	Water content of waste	Decided based on sampling survey conducted on waste intended to be treated by the project.
EF_{N2O}	Emission factor for N2O associated with incineration	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} (tN2O/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	Decided based on invoice or other commercial evidence / contracts of fossil fuel.

Table: Default values

Parameter	Description	Justification
φ	Model correction factor	Decided from CDM Methodological Tool "Emissions from solid waste disposal sites" taking into consideration the situation of Myanmar. If the option for ensuring conservativeness is employed, the conservative value is selected from the default values in the tool.
f	Fraction of methane captured at the SWDS	Set as zero taking into consideration the situation of Myanmar. Based on current situation of Myanmar, options such as monitoring, project specific value fixed ex ante, or higher default value may be selected.
GWP_{CH4}	Global Warming Potential of CH4	Set from IPCC AR4. It is appropriate.
OX	Oxidation factor	The default value from the CDM methodological tool. Use of this value is appropriate.
F	Fraction of methane	The default value from the CDM methodological tool. A conservative value

	in the SWDS gas	may be selected taking into consideration a range of uncertainty described in 2006 IPCC guidelines.
DOC_f	Fraction of degradable organic carbon (DOC) that decomposes in the SWDS	The default value from the CDM methodological tool. A conservative value may be selected taking into consideration a range of uncertainty described in 2006 IPCC guidelines.
DOC_j	Fraction of degradable organic carbon in waste	The default value from the CDM methodological tool. A conservative value may be selected taking into consideration a range of uncertainty described in 2006 IPCC guidelines.
k_j	Decay rate	The default value from the CDM methodological tool. A conservative value may be selected taking into consideration a range of uncertainty described in 2006 IPCC guidelines.
EFF_{COM}	Combustion efficiency of incinerator	The default value from 2006 IPCC guidelines. The value is already the most conservative one.
FCC_j	Fraction of carbon content in waste	The default value from ACM0022 “Alternative waste treatment processes”. It is difficult to make it more conservative.
FFC_j	Fraction of fossil carbon in total carbon content of waste	The default value from ACM0022 “Alternative waste treatment processes”. It is difficult to make it more conservative.
GWP_{N2O}	Global Warming Potential of N2O	Set from IPCC AR4. It is appropriate.
$EF_{CO2,fuel}$	CO2 emission factor of fuel	The default value from 2006 IPCC guidelines. Use of this value is appropriate.