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

"JCM Feasibility studies「Environment Improvement through Utilization of Biogas from POME Fermentation System」"

(Implementing Entity: Nikken Sekkei Civil Engineering Ltd. The Japan Research Institute, Ltd.)

1. Overview of the Proposed JCM Project

Study partners	Cooperation；Kubota Corporation			
Project site	Tanintharyi District in the south of Republic of the union of Myanmar* (* Hereinafter Myanmar)			
Category of project	Renewable Energy			
Description of project	We conducted a survey to aim introduction of biomass utilization business to a palm oil mill in Tanintharyi District in the southern part of Myanmar by using a Japanese biogas technology which has been applied to Palm Oil Mill Effluent (*POME) in Malaysia and Indonesia.The survey includes high profitability biogas utilization measures to promote an investment to the palm oil mill and a brief report related to business practices and local contractors to enhance feasibility of the business.			
Expected project implementer	Japan	Kubota Corporation or some Japanese trading company, etc.		
	Host country	Yuzana Co., Ltd. (*Company Y)		
Initial investment	413.1（mill yen）Biogas generation equipment 420.2（mill yen）Gas utilization equipment 833.3（mill yen）Total (Utility plan is CNG for working vehicles)		**Date of groundbreaking**	2016 year
Annual maintenance cost	52.9（million yen） ※Including gas utilization equipment		**Construction period**	18 months
Willingness to investment	The local company has been seeking for some profitable biomass utilization measures on their own, their implementation motivation is high.		**Date of project commencement**	2018 year
Financial plan of project	Regarding policy on financing plan, funds owned in the group of the companies is a first, then the local company procure necessary funds by local financing, etc.			
GHG emission reductions	About 38,971 (t-CO2/year) 1)Avoidance of Methane emissions; About 30,849 (t-CO2/year) 2)Replacement of fossil fuel like light oil, etc.; About 8,122 (tCO2/year) *The above is calculated from the facilities planning, so it is different from the JCM methodology.			

2. Study Contents

(1) Project development and implementation

1) Project planning

a) Implementation system for project

<Construction implementation plan>

Since Company Y has recently made a decision to proceed the project with one of biogas utilization alternatives, we are still considering a proper way accordingly. The figure below is an example currently considered.

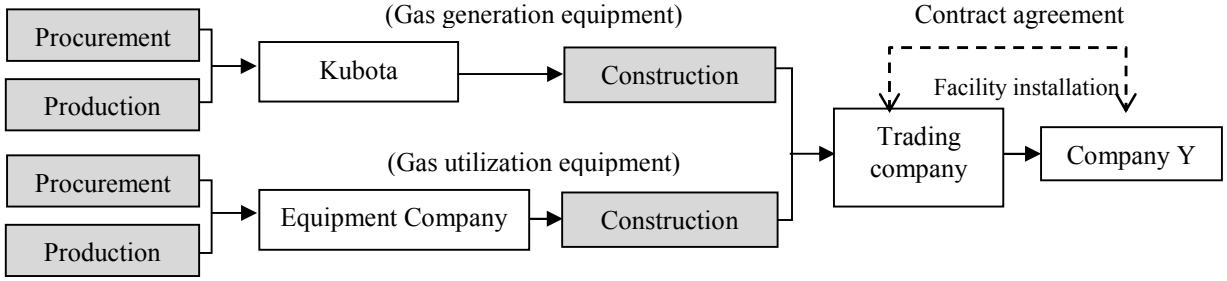


Fig 2.1 Implementation system of project (An example)

<Operation plan>

The following operation modes are considered.

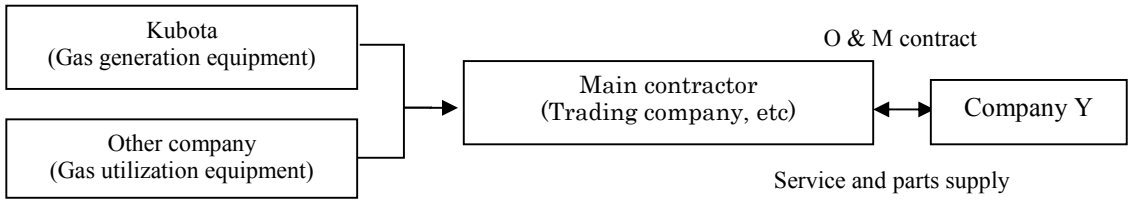


Fig 2.2 Management structure of the project (An example)

b) Management structure of the project implementing body and Performance

Table 2.1 JCM Implementing body and equipment introduction of the project

Item	Detail	Name	Location
JCM project proponents	Head Office	YUZANA Co., Ltd.	No130, Shwe Gon Dine Road, Bahan Township, Yangon, Myanmar
	Local plant Palm mill	Kawthaung Mill	38mile Khamauk Gyi Township Tanintharyi Division, Kawthaung District, Myanmar
Candidate of the equipment introduction		Kubota Corporation or Japanese trading company, etc.	2-47, Shikitsuhigashi 1-chome, Naniwa-ku, Osaka Japan

c) Summary of the project

The proposed project is divided into two parts of the "methane fermentation equipment" and the "methane gas utilization equipment". The "methane fermentation equipment" is the "Anaerobic membrane-type high-temperature methane fermentation (AnMBR)" method that Kubota developed. An overview of the project is described hereafter.

<Methane fermentation equipment>

The methane fermentation equipment using the thermophilic anaerobic digestion method produces biogas from most of organic matter in POME. The equipment consists of a methane fermentation tank and its relevant equipment.

Table 2.2 Planning conditions of biogas generation facilities from POME

Item	Detail	Planning content	Remarks
FFB processing capacity of mill	Maximum capacity per hour	120 (t/hr)	Ability of equipment
Yield of FFB	Maximum yield per date in peak	1,800 (t/d)	About 3 months
	Year total	408,000(t/ｙ)	Annual variation was considered
POME amount of processed	Maximum peak date	1,080 (t/hr)	About 3 months
	Year total	244,800 (m^3/y)	Consider the annual variation
POME water quality (COD Cr)	Average	60,000 (mg/L)	Determined by research and literature
Methane generation method		AnMBR*	By Kubota Corporation

* Anaerobic membrane-type high-temperature methane fermentation

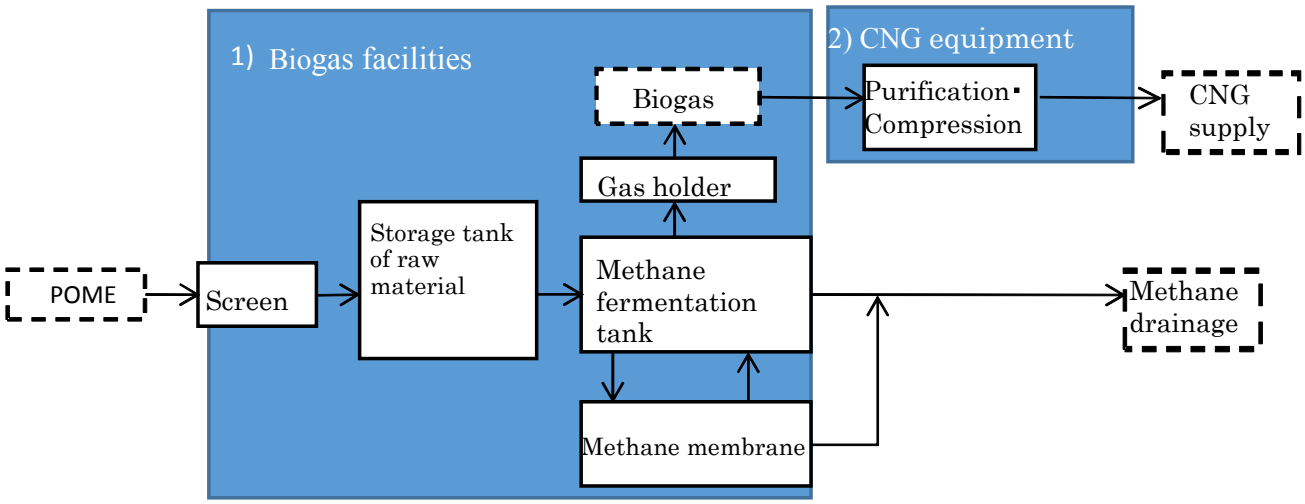


Fig. 2.3 Basic flow of utilization and biogas generation (Case of CNG use)

<Biogas utilization equipment>

We considered a plural biogas utilization measures corresponding to situation of the counter party. The most economical measure was to utilize biogas to produce EFB pellet as drying fuel. This business included sale of the EFB pellet. In the final meeting, however, the counter party chose utilizing biogas as vehicle fuel despite of less economical advantage than the EFB pellet. The reason was that the business characteristics of the EFB pellet were quite difference the palm oil business which is a main business of the counter party. Moreover, uncertainty of the EFB pellet business such as selling price and its market size seemed to affect their decision making.

To utilize biogas as vehicle fuel, it is necessary of both equipment of gas refinery and injection. The vehicle improvement to enable use of the gas fuel is also necessary. Through hearings in the local, we found that a local company could do the vehicle improvement on the price level of about 2000 USD per a truck. We have estimated that the amount of the biogas production on this project is enough to supply fuel to 262 trucks (out of total 400 trucks) which the counter party owns.

Table 2.3 Object of study for biogas utilization

Biogas utilization measures		Summary
In the Company Y	1) Fuel for working vehicle used in the plantation (CNG)	To utilize biogas as fuel of working vehicle owned by Y Corporation.
	2) Fuel for the EFB pellet production	In an EFB pellet production facilities, the biogas is used for drying EFB and pelletizing.
	3) Power supply Workers' households and others	For workers' households in the Palm plantation and schools, etc. the electric power, generated from the biogas, is supplied.
	4) Sale of gas fuel to such as Kawthaung City	As general fuel, to sell the gas filled into cylinder.
For external	5) Power supply to the surrounding area	To sell the power generated by using the biogas to the neighboring town (Kawthaung).

d) Benefits

Table 2.4 Effect of biogas utilization for POME processing and working vehicle

Item	Detail	Planned figures	Remarks
Amount of gas generation	maximum amount of gas per year	6,680,000 (Nm3/y)	Conversion ratio 78%
	maximum amount of methane gas per year	4,010,000 (Nm3/y)	
GHG emission reduction *Non-Energy source	(1)Released methane from the ponds	1,469 (t/y)	Conversion ratio 40%
	(2)Reductions	30,849 (t-CO2/y)	=(1)×21(Methane coefficient) *Different from the value methodology
The reduction by fuel alternative (CNG car) ※Energy source	(3)Reduction of Diesel consumption	3,100 (kL/y)	Study results
	(4)CO2 reduction	8,122(t-CO2/y)	=(3)×2.62 (Light oil)
CO_2 reduction	Non-Energy source and Energy source	38,971(t-CO2/y)	=(2)+ (4)
Water quality improvement (COD Cr)	Current condition	≒60,000 (mg/L)	Set from research and literature
	After the introduction of the equipment	About 6,600(mg/L)	78% conversion of COD ×50% reduction by sedimentation

e) Evaluation of business profitability

Table 2.5 Prerequisites of financial analysis

Item	Content	Setting basis
Project period	The upper limit for 10 years	By study team
Depreciation	Concrete building（Factory）: Declining balance depreciation at 3%	By Myanmar government laws and regulations
	Machinery and equipment・ Machinery and equipment: Declining balance depreciation at 6.25%	Ditto
Corporate tax	25%	Ditto
Commercial tax	5% and some exception	Ditto
Working capital	Working capital is assumed to be fixed.	-
Exchange rate	1 kyat＝0.12 yen	Trade statistics by Ministry of Finance "foreign exchange rates"（2015.1.4～1.10）
	1 US dollar＝115 yen	Set by the study team from document published by Myanmar central bank.

In case of in CNG vehicle, intended for 10 years, IRR is 23% if there is no equipment assistance by JCM, IRR when equipment cost is assumed to be half price by JCM has been estimated to be 47%. In addition, Payout time with JCM support is estimated 2years and 11months. In the last meeting of this research, an executive officer of the counter party, being in charge of the palm business, commented to start to realize the CNG project in this proposal.

Table 2.6 Investment efficiency of projects, including the gas utilization measures

Utilization measures of methane gas	Payout time (year)		IRR（%） （10years）	
	With JCM	Without JCM	With JCM	Without JCM
1. CNG Fuel for working vehicle	2years and 11months	3 years	47%	23%
2. Pelletizing of EFB (Palm shell)	Less than 1 year	1year and 4months	59%	120%

f) Financial planning

Regarding financial planning, fund of the partner's company group is the first, the next policy is to be raised financing by the partner company.（For not determined the evaluation of Myanmar and its companies by financial institutions of Japan, private and public financing of Japan is difficult.）

g) Risk Analysis

As risks associated with business, there are country risk, credit risk on the partner company, various risks due to lack of agreement, risk of damage or delay or the like in the procurement and risk by defects in the contract work. Because those that can be quantified are small, other credit investigation, to take full advantage of the hedge measures such as trade insurance. Since the description contents of essentially agreement is internationally effective, to reduce as much as possible the risk by contract.

2) Permits and Licenses for the project development and implementation

(As contractor of construction)

Because it does not progressed consultation to contract, details are not yet determined. Even if the Japanese companies undertake a set of construction, the owner of the equipment should take construction approval, etc. For Japanese companies, it is necessary to take the permission of the construction industry from Myanmar government.

(Environmental impact assessment)

In Myanmar, the enforcement bylaws of the new Foreign Investment Law of January 2013, in response to that EIA is defined investment areas becomes a condition of approval, the rules on environmental impact assessment is currently under consideration. In this draft, the business corresponding to the current content, such as the following, be submitted materials surveyed considered the environmental impact on the related organizations are described. These contents are common, in a state where not specified the business or the scale of additional circumstance unable definite decision.

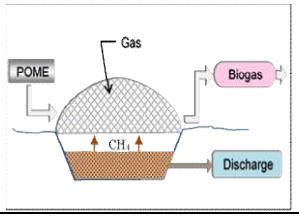
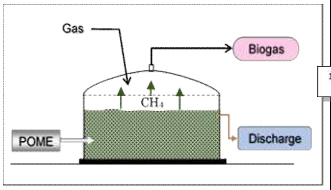
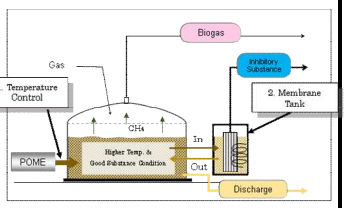
(a) Modification of terrain, natural ecosystems and natural landscape
(b) Development of renewable energy and non-renewable energy resources
(c) Activities and actions with the potential to give the emissions and damage, deterioration against benefits of ecosystem
(d) Activities and actions that can affect against social and cultural environment
(e) Activities and actions that can affect to conservation of natural resources protection area, history and culture
(f) Introduction of new plant and animal species and life forms, including the genetically modified
(g) Application techniques that can be expected to considerably affect the environment
(h) Activities that may affect a high probability to national security
(i) Use and production of biologic al and non-biological material
(j) Those corresponding to other criteria such as defined by the National Environmental Protection Committee

Source) Rules of the environmental impact assessment (Draft) Myanmar environmental protection Ministry of Forestry

3) Advantage of Japanese technology

A covered lagoon is currently a common system for biogas capture from the POME at palm oil mills in the Southeast Asia, but has some issues such as the low productivity of biogas caused by uncontrollable temperature and insufficient mixing in the lagoon digester. On the contrary, the proposed system (Kubota's system) has an advantage on the high biogas productivity by employing a thermophilic digester having an aerobic membrane, which has already been used at palm oil mills in Malaysia and Indonesia.

Table2.7 Comparison of the proposed method and the conventional method for this project

Item	A method Cover Dragoon	B method Conventional tank system	C method The proposed scheme
1. Appearance			
2. System image			
3. Fermentation temperature zone	Mesophilic fermentation (34～37℃)	Mesophilic fermentation (34～37℃)	High temperature fermentation (50～55℃)
4. Conversion ratio of from COD of POME to biogas	≒40% Poor	≒50～60% Good	72*～82% Superior
5. The amount of energy obtained from biogas (Model case; COD 60,000mg / L in POME 1080m3 / d)	36,000 kWh/day (Ave 1,500 kW)	50,000 kWh/day (Ave 2,100 kW)	65,000 kWh/day (Ave 2,700 kW)
6. Initial cost (Including also generator)	≒4.9 million USD	≒6.1 million USD	3.5～7 million USD**
7. Advantage	・Initial cost is the cheapest ・Simple introduction	・It is more effective than the left	・It is the most effective ・Drainage water quality is the best
8. Shortcoming	・Unstable fermentation ・Danger, such as in a storm ・Sheet is aging	・Relatively complex mechanism	・Most complex mechanism

4) MRV structure

Kubota, when it has been introduced through facilities directly or contractor is likely that connects a maintenance contract with some kind of ways. Therefore, directly or indirectly, Kubota it is possible to improve the responsibility and technical support for the MRV such technology by also implementing monitoring. In addition, when the Japanese trading company, etc. to participate as prime contractor also, Japanese companies have a policy that mainly performs MRV.

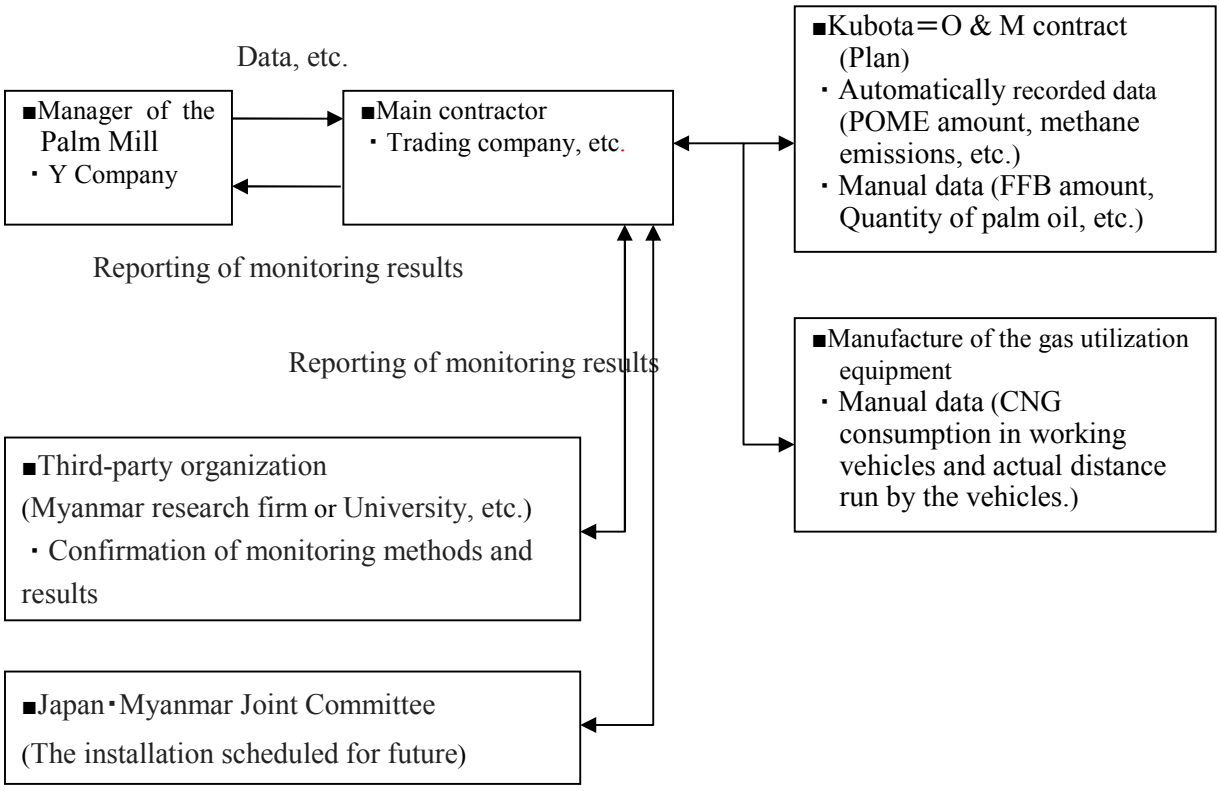


Fig. 2.4 Conceptual diagram of MRV system (An example)

Depending on the potential of the measured potential and the COD concentration of the direct measurement of the amount of POME flow meter, monitoring items is determined.

Table 2.8 Monitoring items

Item		COD concentration	
		Measurable	Not measured
POME amount	Actual measurement・Estimation Possible	【Option 1】 ・COD Concentration ・POME Amount of emission ・Power, the amount of gas	【Option 2】 ・POME Amount of emission ・Power, the amount of gas
	Actual measurement・Estimation Not possible	【Option 3】 ・FFB input amount ・Power, the amount of gas	【Option 4】 ・FFB input amount ・Power, the amount of gas

5) Environmental integrity and Sustainable development in host country

POME from the palm mills is currently released into the field at the still high COD from precipitation ponds. The proposed project, because it intends to extract the organic matter from the waste water as biogas containing methane, can obtain the following effects such as environmental improvement, then it is considered that the environmental integrity at the host country will be enough guaranteed.

Table 2.9 Environmental impact of before and after the project introduction (Excerpt)

Classification	Environmental element	Impact・2(Equipment introduction)	Evaluation of business
Air quality	(1) Air	・Hydrogen sulfide and ammonia generated in the biogas extraction process, is removed in the process. ＊Biological desulfurization, etc.	・Impact of air pollution is reduced. (Improve)
	(2) Noise	・Noise does not occur in the biogas extraction equipment. ・Mechanical noise is generated in the power generation use of methane gas. 60db (A) degree in the package type.	・Noise of the generator occurs. （Deteriorate）
	(3) Stench	・Odor in EFB yard is reduced by stopping the application of POME to EFB. ・Odor, POME pounds are eliminated, not generated by being processed in a closed tank.	・Occurrence of bad smell can be prevented, employee environment improvement （Improve）
Water environment	(1) Water quality	・CODcr removal rate is estimated as 90% such as by organic extraction and precipitation effects biogas.	・Improve organic matter concentration, etc. of drainage. （Improve）
	(2)Groundwater	・Effects of osmosis water from the EFB yard and POME pound of ground is eliminated.	・Groundwater contamination is prevented from. （Improve）
Soil environment other	・Soil	・Effects of osmosis water from the EFB yard and POME pound of ground is eliminated.	・Soil contamination is prevented from. （Improve）
Friendship	・Landscape	・POME pounds are eliminated ・Equipment is installed such as reaction tank of φ about 33m H about 15m.	・Improvement in the lead. （Improve）
Environmental load	(1)Solid waste	・Waste generated from bio-gas tank, but the composting and the like, it is possible to reduce the influence by the farmland to Palm Garden.	・At present, it is not possible to evaluate the difference. （Null）
	(2) Greenhouse gas	・Greenhouse gases, are reduced by the fuel alternative in the case of emissions and biogas utilization from POME ponds.	・Lead to a significant reduction. （Improve）

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

a） To enhance the accuracy of emissions and water quality values trough a year, such as in P / S survey.

→By using the measured values of the loss GHG reductions by the correction coefficient due to MRV methodology, it can be prevented.

b） The officials of the other companies, and invited to visit to Kubota plant in Malaysia

→To show the sites to the partner company to enhance the persuasiveness of negotiations.

c） Continuation of quotient negotiations toward the project contract

（2）JCM methodology development

①Eligibility criteria

This methodology can be applied to the project that meets all of the criteria as follows.

Table 2.10 Eligibility criteria

	Content
Criteria 1	Anaerobic digesters and system that is fuelled by the biogas are to be installed.
Criteria 2	The materials to be fed into the anaerobic digesters are organic waste including septage that would have been disposed at a landfill site in the absence of the project activity.
Criteria 3	Anaerobic digester for wet thermophilic fermentation (50 to 55 degree Celsius) is to be installed.
Criteria 4	Anaerobic digester which has anaerobic membrane is to be installed.
Criteria 5	The project secures organic waste as the materials of the project activity and has a proper maintenance system that outlines a maintenance plan and equipment for monitoring activities.

Source：Study Team

The policy for establishing the above eligibility criteria is described as follows.

Table 2.11 Policy for establishing eligibility criteria

	Grounds for establishment
Criteria 1	To identify the target technology covered by this methodology.
Criteria 2	In this methodology, the word “reference emissions” is defined as “emissions from organic effluent which is treated in an open ended system, when the project is not conducted”. Thus, materials put into the anaerobic digesters need to be limited as organic effluent, which are treated in an open ended system when project is not conducted.
Criteria 3	To give an advantage for Japanese technologies in the GHG emission reduction.
Criteria 4	Same as above.
Criteria 5	To make the GHG emission reduction effective by realizing continuous management.

Source：Study Team

The project which will be covered by this study plans to introduce Japanese anaerobic digester system with wet thermophilic fermentation and meets all the criteria above.

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

In this study, we developed methodologies with reference to small-scale methodologies, AMS-III.H (Version 16.0).

In the mill targeted by this project, organic wastewater drained in the process of producing palm oil (Palm Oil Mill Effluent; POME) is finally discharged in the river after the pond (or utilized for watering in the palm garden in the dry season). In Myanmar, there is no rule or standards to regulate the quality of industrial wastewater as of January 2015. Unless otherwise Myanmar government introduces rule or standards to regulate the quality of industrial wastewater or operators of factories starts introducing technologies of effluent treatment by themselves, it is expected that the amount of organic effluent with high concentration will increase, with expanding of economic activities in the country. Thus, in this methodology, we developed the calculation method with setting reference scenario as "organic effluent from the factory is treated in an open ended system, when the project is not conducted".

① Calculations of reference emissions

$$RE_y = RE_{treatment,y} + RE_{discharge,y} + RE_{power}$$

RE_y	Reference emissions in year y (tCO_2e)
$RE_{treatment,y}$	CH4 emissions from wastewater treatment systems in the reference scenario (tCO_2e) (R1)
$RE_{discharge,y}$	CH4 emissions from treated wastewater discharged into sea, river or lake in the reference scenario (tCO_2e) (R2)
$RE_{power,y}$	CO2 emissions on account of electricity or fossil fuel used in the reference scenario (tCO_2e) (R3)

② Calculations of the project emissions

Project emissions are calculated by totaling 1. project CH_4 emissions from effluent treatment system without biogas plant, which is affected by the project, 2. project CH_4 emissions from effluent discharged into the sea, river or lake, and 3. CO_2 emissions from electricity and fuel used by the project facilities.

$$PE_y = PE_{treatment,y} + PE_{discharge,y} + PE_{power,y}$$

PE_y	Project emissions during the period of year y (tCO_2e)
$PE_{treatment,y}$	Project CH_4 emissions from effluent treatment system without biogas plant, which is affected by the project (tCO_2e) (P1)
$PE_{discharge,y}$	Project CH_4 emissions from effluent discharged into sea, river or lake (tCO_2e) (P2)
$PE_{power,y}$	CO_2 emissions from electricity and fuel used by the project facilities (tCO_2e) (P3)

③ Calculations of emission reductions

Emission reductions in year are calculated by deducting project emissions from reference emissions.

$$ER_y = RE_y - PE_y$$

ER_y	Emission reductions in year y (tCO_2)
RE_y	Reference emissions in year y (tCO_2)
PE_y	Project emissions in year y (tCO_2)

③Data and parameters fixed ex ante

Table 2.12 Parameters fixed prior to project implementation as a default value(1)

No.	Parameter	Description of data	Value	Source
1	$COD_{inflow,i,RS}$	Concentration of COD in POME flows in to the treatment system in the reference scenario (mg/L)	60,000mg/mL	monitored data
2	$COD_{outflow,i,RS}$	Concentration of COD in POME flows out from the treatment system in the reference scenario (mg/L)	(To be obtained)	monitored data
3	$MCF_{treatment,RS,i}$	Methane correction factor for reference wastewater	Refer to the Table 5.4 in the report	IPCC2006 Guideline
4	$B_{o,ww}$	CH4 producing capacity of the wastewater (t-CH_4/t–COD)	0.25t-CH_4/t-COD	IPCC2006 Guideline
5	UF_{RS}	Model correction factor to account for model	0.89	SBSTA 2003
6	GWP_{CH4}	Global Warming Potential for CH_4	21	IPCC Fourth Assessment Report: Climate Change 2007
7	f_Q	Model correction factor to account for model	0.5	Set based on "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories"
8	Q_{RS}	Amount of POME in the reference scenario	97,920 m^3/month	monitored data
9	P_{RS}	Amount of FFB used in the reference scenario	34,000t/month	monitored data

Table 2.13 Parameters fixed prior to project implementation as a default value(2)

No.	Parameter	Description of data	Value	Source
10	CODdischarge,RS	Concentration of COD in POME discharged into the river in the reference scenario (mg/L)	13,300mg/mL	monitored data
11	MCFdischarge,RS	Methane correction factor for reference wastewater	Refer to the Table 5.4 in the report	IPCC2006 Guideline
12	EFelectricity	CO2 emissions factor of electricity (tCO2/MWh)	-	Each of regulatory value set by the government of Myanmar, result of the calculation in the project conducted in the past, or result of original calculation
13	EFFF,RS	CO2 emissions factor of diesel (tCO2/TJ)	0.0686	Regulatory value set by the government of Myanmar
14	MCFtreatment,RS,i	Methane correction factor for reference wastewater	Refer to the Table 5.4 in the report	IPCC2006 Guideline
15	UFPJ	Model correction factor to account for model	1.12	SBSTA 2003
16	*f*COD	Model correction factor to account for model	2	Set based on "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories"

As mentioned above, in this methodology, parameters are set to calculate GHG emission with conservative way, when amount of POME or concentration of COD in POME could not be measured.

Specifically, in calculation of reference emissions, calculation formula is set to halve the amount of POME, which is calculated from α_{RS} (factor of amount of POME per FFB) by multiplying 0.5 which is a model correction factor set by IPCC guideline, when the amount of POME could not be measured.

In the same way, in calculation of project emissions, calculation formula is set to double the concentration of COD, which is calculated with designed value, by multiplying 2 which is a model correction factor by IPCC guideline, when concentration of COD in POME could not be measured.

With these calculation formulas, conservativeness of the result of the calculation is fully secured.