CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

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Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Title: Methane Recovery in Wastewater Treatment and Utilization for Electricity Generation at Saremas 1 Palm Oil Mill, Sarawak, Malaysia

Version: 2

Date: 03/08/2012

A.2. Description of the small-scale project activity:

Purpose of the Project Activity
The Saremas 1 Palm Oil Mill in Miri (Sarawak, Malaysia) processes fresh fruit bunches to produce palm oil while discharging raw palm oil mill effluent (POME). The raw POME must be treated in the POME treatment plant before discharging it to surface water bodies and for mill area washings or plantation in order to comply with the Environment Quality (Prescribed Premises Crude Palm Oil) Regulations 1977 of Malaysia.[1]

Prior to the project activity, the raw POME from Saremas 1 Palm Oil Mill is treated in the existing POME treatment system which involves an open ponds system. The open ponds system comprises a cooling and acidification pond, two (2) anaerobic ponds, three (3) aerobic ponds and seven (7) downstream oxidation ponds to treat the raw POME before discharging the final effluent to the waterways. This treatment scheme is the most common system utilised in the region. The mill effluent which includes treated POME is then discharged to waterways. The series of treatment ponds are generally not de-sludged for disposal of accumulated sludge. The anaerobic processes in the existing open anaerobic ponds generate methane that is currently emitted to the atmosphere.

The purpose of the project activity is to recover the biogas generated during the anaerobic processes in the treatment of POME, through the introduction of a sequential stage of wastewater treatment which comprises three (3) units of anaerobic digesters, coupled with two (2) units of clarifiers and biogas recovery, to the existing open anaerobic ponds without methane recovery.

How the Proposed Project Activity Reduces Greenhouse Gas Emissions
In the project scenario, the recovered biogas will subsequently be flared in a controlled manner or combusted in a biogas engine to generate electricity for captive consumption. The treated POME from the anaerobic digester system will be further treated in the subsequent existing treatment system (aerobic and oxidation ponds) before being discharged to surface water streams as per local environmental requirements. The sludge generated will be used in land application within plantation under aerobic condition.

[1] http://palmoilis.mpob.gov.my/publications/TOT/TS-67.pdf

For the project activity, it is expected to be implemented in two phases as per the following:

- Phase I (from expected commissioning) – The installation of a sequential stage of wastewater treatment, which comprises three (3) units of anaerobic digesters, coupled with two (2) units of clarifiers, where biogas will be captured and flared in a controlled way. These anaerobic digesters will treat up to 600 m^3/day of POME from the mill, with any excess flowing to the two existing anaerobic pond system.

- Phase II (expected to be implemented in one year after Phase I) – The installation of biogas engine using the captured and recovered biogas from anaerobic digesters. Any excess of biogas will be flared in a controlled way.

The following Table 1 provides the rated capacity of the existing electricity generation units.

Table 1. Rated capacity of existing connected electricity generation units

Electricity generation units	Nameplate capacity	Rated capacity in kW
Biomass based steam turbine 1	1,600 kW	1,600
Biomass based steam turbine 2 (back-up)	*1,600 kW*	*1,600*
Biomass based steam turbine 3(back-up)	*900 kW*	*900*
Diesel generator 1	400 kVA	320
Diesel generator 2	400 kVA	320

The breakdown of electricity demand and production in Saremas 1 palm oil mill is provided in Table 2.

Table 2. Electricity supply and demand before and after CDM implementation

Timeline	Rated capacity (kW)	Electricity demand (kW)	Capacity balance (kW)
Before CDM	2,240	1,250	990
With CDM - Phase I	2,240	1,350	890
With CDM - Phase II	2,740	1,350	1,390

The operating configurations of the biomass based turbines are as follows:

1. The biomass boiler on-site supplies steam to the turbine first (to reduce the pressure and temperature to process requirements) before going to the palm oil processes. There is no branch-out lines along the main steam line from boilers so to supply process steam, it has to pass through the turbine.

2. All turbines (main 1600kW and backups of 1600kW & 900kW) are back-pressure steam turbines manufactured by SHINKO IND. LTD. The two boilers are never run together simultaneously at any one time.

3. The biomass based boilers do not operate when the mill is not in operation and the diesel generators are needed to supply electricity to the entire complex. Of the total electricity demand for the entire

palm oil mill complex, the major demand is from the palm oil mill. The biomass based steam turbine operates when the palm oil mill operates (8 hours – 24 hours). The diesel generators will be operating at all other times when the palm oil mill is not operating. This means that when the palm oil mill and the biomass based boiler are operating for 8 hours in a day, the diesel generators will be operating for 14 hours. Annex 3 summarises the operating history for diesel and biomass boilers.

Thus, in the baseline scenario, the combination of the diesel generator sets and the biomass based steam turbine 1 were used to meet the daily electricity demands. The project activity is intended to reduce the use of diesel generators.

In Phase I of this project activity, the electricity supply to the site remains the same as that before project implementation (i.e. 2,240 kW) as the biogas engine is not in operation. However, additional power requirement of 100 kW will be required to operate the anaerobic digesters system in this phase.

In Phase II, biogas engine will be installed and is expected to replace the existing diesel generators by generating additional power of 500 kW. The electricity from this biogas engine will be connected to the captive grid and then distributed to all facilities on site.

The project activity will, therefore, reduce greenhouse gases (GHG) emissions due to the recovery of methane in the anaerobic digesters and potential avoidance of CO_2 emissions through displacing the combustion of fossil fuel (i.e. diesel) in diesel generators with a renewable fuel based (i.e. biogas) engine in a later phase.

Project Activity's Contributions to Sustainable Development

Environmental Sustainability:

1. The project activity involves the use of anaerobic digesters with methane recovery. The project thus avoids the emission of methane gas into the atmosphere and therefore contributes to the reduction of GHG emissions.
2. The final treated effluent from the POME wastewater treatment, which includes the project activity (i.e. anaerobic digesters), meets the Malaysian's environmental regulations.
3. The recovered methane from project activity will be used for electricity generation for captive use in the facilities. The project will displace the electricity which is generated by combustion of diesel in generators and reduce the GHG emission.
4. The avoidance of methane emission and use of sludge for plantation in aerobic conditions will therefore reduce the unpleasant odour associated with the existing POME treatment system.

Economic Sustainability:

1. The project activity involves displacing the use of diesel in power generation with indigenous renewable source and thus contributes to resource conservation.
2. More manpower will be required in operation therefore more employment opportunities as a results of this project.

Social Sustainability:

1. The project activity involves the use of new technology in the treatment system. In addition, more skills are required to maintain the system. This will help to improve the local workforce quality.
2. The implementation of the innovative configuration of the wastewater treatment would also require involvement of professionals from various fields of specialization including engineering, finance and management thus leads to overall skill improvements.

A.3. Project participants:

Name of the party involved ((host) indicates a host party)	Private and/or public entity(ies) Project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (host)	Saremas Sdn Bhd (Private Entity)	No
Denmark (Annex I)	Nordjysk Elhandel A/S (Private Entity)	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Malaysia.

A.4.1.2. Region/State/Province etc.:

Sarawak.

A.4.1.3. City/Town/Community etc:

Miri.

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The project activity will be located at Saremas 1 Palm Oil Mill, Batu 65, Jalan Miri-Bintulu, Miri, Sarawak and the coordinates for the biogas plant site is approximately 3°31’29.561”N, 113°44’50.147”E. Project site is about 100km from Miri to the south in the state of Sarawak. The new anaerobic digester plant will be located adjacent to the existing wastewater treatment system.

Sarawak

Figure 1: The location of Sarawak Malaysia

Project site: Miri – Sarawak

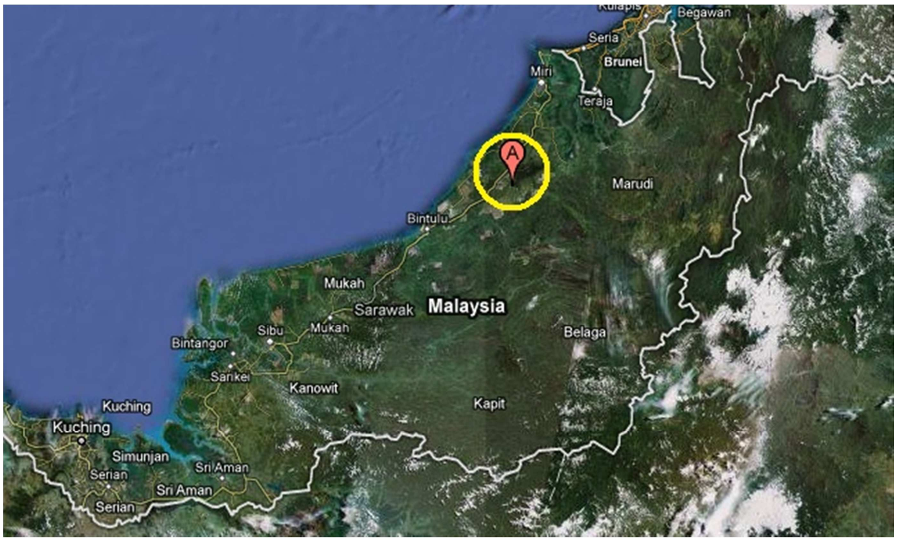

Figure 2: The Saremas POME project site (Source: Google Map 2010)

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

In accordance with Appendix B of the simplified modalities and procedures for small-scale CDM project activities (SSC M&P), the proposed project falls under the following categories[2]:

Type III: Other project activity
Category M: AMS III.H Methane recovery in wastewater treatment (version 16)
The project activity involves the installation of three (3) units of anaerobic digesters and recovery of the produced biogas.

Type I: Renewable energy projects
Category C: AMS I.C Thermal energy production with or without electricity (version 19)
The project activity involves a renewable energy technology, with a maximum thermal energy potential of less than 45 $MW_{thermal}$ (i.e., 15 $MW_{electrical}$) based on design quantity of the biogas recovered by the project activity.

Existing wastewater treatment system
Prior to the project activity, raw POME will flow to the open ponds treatment system at 867m^3/day[3]. The dimension of the open anaerobic ponds is 137m x 76m x 4.5m depth (i.e. capacity 46,854m^3) and 122m x 76m x 4.5 m depth (i.e. capacity 41,724m^3), respectively. The COD removal efficiency of the anaerobic ponds is 77.53%[4].

Technology used in the project activity
Adequate cooling and hydrolysis/acidification of the raw POME are required prior to anaerobic digesting. In the project activity, sufficient buffering and storage capacity will be provided in a mixing pond to facilitate a more uniform and controllable biogas output.

The POME anaerobic digestion process in this project activity comprises of two (2) stages.

Stage 1: Upon pre-treatment, 600m^3/day of raw POME will be distributed into two (2) anaerobic digesters from a common feeding tank located subsequent to the mixing pond, while any excess raw POME will flow to the two existing anaerobic ponds which will not be part of the project activity. The two digester tanks provide approximately 689 m^3 of gas storage and balancing capacity each. Internal and external piping and mixing systems are provided in each of the reactor. The capacity and residence time for each of the two digesters is 3,488 m^3 and 11.63 days, respectively. The two anaerobic digesters in stage 1 are expected to result in 80% COD removal in the untreated POME entering stage 1. From these two digesters, the wastewater is fed into first clarifier with a capacity of 1,045.58 m^3.

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[2] http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

[3] Based on the average of the POME inflow rates from the 10-day measurement campaign (Annex 3 in this PDD).

[4] Based on the average values of the COD_{in} and COD_{out} from the 10-day measurement campaign (Annex 3 in this PDD).

Stage 2: The clarified wastewater from the first clarifier is then further treated in the third anaerobic digester with a capacity and residence time of 3,488 m^3 and 6.46 days, respectively. This anaerobic digester in stage 2 is expected to result in 50% COD removal in the partially treated wastewater from stage 1. The discharged wastewater from this digester is transferred to the second clarifier where the clarified wastewater will be further treated in the existing aerobic pond downstream.

All three anaerobic digesters (both stage 1 and 2) will be made of mild steel and have fixed roofs and are expected to have an overall COD removal efficiency of 90%[5].

The slurry separated by the two clarifiers will be collected in a sludge holding tank before being further dewatered for sludge concentration. The dried sludge from the sludge holding tank will be disposed to plantation in aerobic condition while the wastewater will be fed into the second clarifier.

The produced biogas generated in the anaerobic digesters is led up to the boundary of the anaerobic tank farm through the Biogas Piping System to a biogas tank of 51.5m^3 capacity. In Phase I, this system is connected to a gas flaring system for flaring of the recovered biogas. In Phase II, part of the recovered biogas from the biogas tank will be combusted in a biogas engine and converted to electricity, thus, substituting current use of diesel generators. Any unused biogas will be flared in a controlled way. Flame and lightning arrestors, shut-off valves and other safety equipment are provided in the system (refer to Figure 4 and Figure 5 of this PDD for the delineation of project configuration).

Operation and Control of the Anaerobic Digester

For the purpose of process control and monitoring, the system is equipped with flow monitoring equipment, digester liquor sampling ports, and biogas extraction ports.

The pre-conditioned (after cooling, hydrolysis, and acidification processes) raw POME is stored temporarily in a feeding tank and then fed to the anaerobic digesters under continuous and controlled maintenance as far as possible. The dual function of the digesters (complete-mixing mechanism and anaerobic digestion activity) will be maintained at minimum desirable level all year round. The Chemical Oxygen Demand (COD) and other process parameters will be monitored at inlet prior to the anaerobic digesters system and at outlet of second stage clarifier (i.e. prior to aerobic pond system).

List of the Equipment Used Prior to Project and in the Project and the Operational Lifetime

No.	Equipment	Operational lifetime
Prior to Project		
1.	Open anaerobic ponds (unlined open ponds)	More than 25 years (due to the nature of these open ponds, it is not practicably possible to assess the lifetime which could go for ever with de-sludging)
Project Scenario[6]		
2.	Wastewater feed-in tank	25 years
3.	Anaerobic digesters	25 years
4.	Clarifiers	25 years
5.	Sludge holding tank	25 years

[5] 80% in stage 1 followed by further 50% in stage 2

[6] Technical statement from the equipment supplier, Rekanan Jurutera Perunding Sdn. Bhd., dated on 19/04/2011.

No.	Equipment	Operational lifetime
6.	Sludge concentrator	25 years
7.	Biogas tank	25 years
8.	Biogas engine system	10 years

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The estimated amount of emission reductions during the first crediting period is as follows.

Years	Annual estimation of emission reductions in tonnes of CO_2 equivalent (tCO_{2e})
2012 – 2013	23,101
2013 – 2014	24,419
2014 – 2015	24,419
2015 – 2016	24,419
2016 – 2017	24,419
2017 – 2018	24,419
2018 – 2019	24,419
Total estimated reductions (tonnes of CO_{2e})	**169,613**
Total number of crediting years	7
Annual average of the estimated reductions over the crediting period (tCO_{2e})	24,230

A.4.4. Public funding of the small-scale project activity:

There is no available public funding for this project activity.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

In accordance to the Appendix C of the simplified modalities and procedures for the small scale CDM project activities (also in EB54 Report, Annex 13), a small scale project activity shall be deemed to be a de-bundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants
- In the same project category and technology/measure
- Registered within the previous 2 years
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

This is the first CDM project activity with the PP and there is no large-scale project activity existing at the project site. Hence, this project activity is not a de-bundled component of a large scale project activity as it does not satisfy any of the above provisions.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

The baseline and monitoring of this project activity is based on the following approved methodologies:

1. **AMS III-H (version 16)**: "Methane recovery in wastewater treatment"
2. **AMS I-C (version 19)**: "Thermal energy production with or without electricity"

B.2 Justification of the choice of the project category:

Table 3: Justification of the choice of the project category AMS III.H (version 16)

Para	AMS III.H Applicability Requirements	Project activity
1.	This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options: a. Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion; b. Introduction of anaerobic sludge treatment system with biogas recovery and combustion to a wastewater treatment plant without sludge treatment; c. Introduction of biogas recovery and combustion to a sludge treatment system; d. Introduction of biogas recovery and combustion to an anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on-site industrial plant e. Introduction of anaerobic wastewater treatment with biogas recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream; f. Introduction of a sequential stage of wastewater	This project activity involves the introduction of a sequential stage of anaerobic wastewater treatment with biogas recovery and combustion to anaerobic wastewater treatment system without biogas recovery (i.e. open anaerobic lagoons). This is in compliance with Option 1(f).

Para	AMS III.H Applicability Requirements	Project activity
	treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery (e.g. introduction of treatment in an anaerobic reactor with biogas recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).	
2.	In cases where baseline system is anaerobic lagoon the methodology is applicable if: a. The lagoons are ponds with a depth greater than two meters, without aeration. b. Ambient temperature above 15°C, at least during part of the year, on a monthly average basis; c. The minimum interval between two consecutive sludge removal events shall be 30 days.	The baseline system is anaerobic lagoon with following characteristics: a. The two existing anaerobic ponds have depth of 4.5 meters each (also refer section A.4.2 in the PDD). b. On a monthly average basis[7], the ambient temperature in the area around the project site is above 15°C. c. The existing two anaerobic ponds have not been de-sludged consecutively within intervals of 30 days.
3.	The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring: a. Thermal or mechanical, electrical energy generation directly; b. Thermal or mechanical, electrical energy generation after bottling of upgraded biogas; or c. Thermal or mechanical, electrical energy generation after upgrading and distribution, in this case additional guidance provided in Annex 1 shall be followed: i. Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; ii. Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or	The recovered biogas will partially be used in Phase II for electricity generation via generation of heat in biogas engine system. Any excess quantity will be flared. This in compliance with only paragraph 3(a) and not the others.

[7] http://www.world-climates.com/city-climate-miri-malaysia-asia/

Para	AMS III.H Applicability Requirements	Project activity
	iii. Upgrading and transportation of biogas (e.g. by trucks) to distribution points for end users. d. Hydrogen production. e. Use as fuel in transportation applications after upgrading.	
4.	If the recovered biogas is used for project activities covered under paragraph 3 (a), that component of the project activity can use a corresponding methodology under Type I	Part of the recovered biogas is planned for potential use for electricity generation in Phase II of the project activity. The approved baseline and monitoring methodology AMS I.C (version 19) is used for the electricity generation component of the project activity.
5.	For project activities under paragraph 3(b), if bottles with upgraded biogas are sold outside the project boundary, the end-use of the biogas shall be ensured via a contract between the bottled biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas in such situations. If however the end use of the bottled biogas is included in the project boundary and is monitored during the crediting period CO_2 emissions avoided by the displacement of fossil fuel can be claimed under the corresponding Type I methodology, e.g. AMS I-C “Thermal energy production with or without electricity”.	Applicability requirement under paragraph 3(b) is not applicable to this project activity, this applicability requirement is therefore also not applicable to this project activity.
6.	For project activities covered under paragraph 3(c) (i), emission reductions from the displacement of the use of natural gas are reliable under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries.	Applicability requirement under paragraph 3 (c) (i) is not applicable to this project activity. This applicability requirement is therefore also not applicable to this project activity.
7.	For project activities covered under paragraph 3 (c) (ii), emission reductions for the displacement of the use of fuels can be claimed following the provision in the corresponding Type I methodology, e.g. AMS-I.C.	Applicability requirement under paragraph 3 (c) (ii) is not applicable to this project activity. This applicability requirement is therefore also not applicable to this project activity.
8.	In particular, for the case of 3 (b) and (c) (iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles for transporting biogas shall be considered. Relevant procedures in paragraph 11 of	Applicability requirements under paragraph 3 (b) and (c) (iii) are not applicable to this project activity. This applicability requirement is therefore also not applicable to this project activity.

Para	AMS III.H Applicability Requirements	Project activity
	Annex 1 of AMS-III.H “Methane recovery in wastewater treatment” shall be followed in this regard.	
9.	For project activities covered under paragraph 3 (b) and (c), this methodology is applicable if the upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum 96% (by volume).	Applicability requirement under paragraph 3 (b) and (c) are not applicable to this project activity. This applicability requirement is therefore also not applicable.
10.	If the recovered biogas is utilized for the production of hydrogen (project activities covered under paragraph 3(b)), that component of the project activity shall use the corresponding methodology AMS-III.) “Hydrogen production using methane extracted from biogas”.	The recovered biogas of this project activity is not utilized for the production of hydrogen. This is therefore not applicable.
11.	If the recovered biogas is used for project activities covered under paragraph 3(e), that component of the project activity shall use corresponding methodology AMS-III.AQ “Introduction of Bio-CNG in road transportation”.	The recovered biogas of this project activity is not used for project activities under paragraph 3(e). This is therefore not applicable.
12.	New facilities (Greenfield projects) and project activities involving a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible to apply this methodology if they comply with the relevant requirement in the “General guidelines to SSC CDM methodologies”. In addition the requirements for demonstrating the remaining lifetime of the equipment replaced, as described in the general guidelines shall be followed.	This project activity is neither a Greenfield project nor involves any change of equipment resulting in capacity addition of the wastewater treatment system. This is therefore not applicable.
13.	The location of the wastewater treatment plant as well as the source generating the wastewater shall be uniquely defined and described in the PDD.	The location of the project activity is defined under section A.4.1.
14.	Measures are limited to those that result in aggregate emissions reductions of less than or equal to 60,000 tCO_{2e} annually from all Type III components of the project activity.	The project activity is expected to generate annual emission reduction of 23,101 tCO_{2e} (Phase I) and 23,251 tCO_{2e} (Phase II) from all Type III components of the project activity only during the crediting period which is below the eligibility limit of 60,000 tCO_{2e}.

Table 4: Justification of the choice of project category AMS I.C (version 19)

Para	AMS I.C Applicability Requirements	Project activity
1.	This methodology comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.	In Phase II, this project activity involves the utilisation of the generated biogas from the anaerobic digesters for electricity generation via generation of thermal energy through combustion in a biogas engine.
2.	Biomass-based cogeneration systems are included in this category. For the purpose of this methodology "cogeneration" shall mean the simultaneous generation of thermal energy and electrical energy in one process. Project activities that produce heat and power in separate element process (for example heat from a boiler and electricity from a biogas engine) do not fit under the definition of cogeneration project.	The recovered biogas is used for only electricity generation. This is therefore not a cogeneration project. This is not applicable.
3.	Emission reductions from a biomass cogeneration system can accrue from one of the following activities: (a) Electricity supply to the grid; (b) Electricity and/or thermal energy (steam or heat) production for on-site consumption or for consumption by other facilities; (c) Combination of (a) and (b).	This is not a cogeneration project activity. This is not applicable.
4.	The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal	The biogas-based energy generation system in the project activity will have a maximum installed capacity of 0.5 MW (also refer section A.4) which is less than the eligibility limit of 45 MW thermal which is equivalent to 15 MW electrical.
5.	For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel, shall not exceed 45 MW thermal.	This is not co-fired systems project activity. This is not applicable.
6.	The following capacity limits apply for biomass cogeneration units: (a) If the project activity includes emission reductions from both the thermal and electrical energy components, the total installed energy	This is not cogeneration project activity. This is not applicable.

Para	AMS I.C Applicability Requirements	Project activity
	generation capacity (thermal and electrical) of the project component shall not exceed 45 MW thermal. For the purpose of calculating this capacity limit, the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy (i.e. for renewable energy project activities, the maximal limit of 15 MW(e) is equivalent to 45 MW thermal output of the equipment or the plant); (b) If the emission reduction of the cogeneration project activity are solely on account of thermal energy production (i.e. no emissions accrue from the electricity component), the total installed thermal energy production capacity of the project equipment of the cogeneration unit shall not exceed 45 MW thermal. (c) If the emission reductions of the cogeneration project activity are solely on account of electrical energy production (i.e. no emission reductions accrue from the thermal energy component), the total installed electrical energy generation capacity of the project equipment of the cogeneration unit shall nto exceed 15 MW.	
7.	The capacity limits specified in the above paragraphs apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should comply with capacity limits in paragraph 4 to 7 and should be physically distinct from the existing units.	This project activity does not involve addition of renewable energy units at existing renewable energy facility. This is not applicable.
8.	Project activities that seek to retrofit or modify an existing facility for renewable energy generation included in this category.	This project activity does not seek to retrofit or modify an existing facility. This is not applicable.
9.	New facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirement in the “General	This is not a Greenfield project activity. This is not applicable.

Para	AMS I.C Applicability Requirements	Project activity
	Guidelines to SSC CDM methodologies".	
10.	If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in the emissions reduction calculation.	This project activity does not involve solid biomass fuel. This is not applicable.
11.	Where the project participant is not the producer of the processed solid biomass fuel, the project participant and the producer are bound by a contract that shall enable the project participant to monitor the source of the renewable biomass to account for any emissions associated with solid biomass fuel production. Such a contract shall also ensure that there is no double-counting of emission reductions.	The project participant of this project activity is the producer and consumer of the generated electricity. This is therefore not applicable.
12.	If electricity and/or steam/heat produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the suppler and consumer(s) of the energy have to be entered into that ensures there is no double-counting of emission reductions.	The electricity is for captive consumption. This is therefore not applicable.
13.	If the project activity recovers and utilizes biogas for power/heat production and applies this methodology on a stand-alone basis i.e. without using a Type III component of a SSC methodology, any incremental emissions occurring due to the implementation of the project activity (e.g. physical leakage of the anaerobic digester, emissions due to inefficiency of the flaring), shall be taken into account either as project or leakage emissions.	This project activity does not use AMS I.C on a stand-alone basis. AMS III.H is used to cover the methane recovery component of this project activity.
14.	Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources provided: (a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or (b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emissions from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the	This project activity does not use charcoal based biomass. This is therefore not applicable.

Para	AMS I.C Applicability Requirements	Project activity
	approved methodology AMS III.K. Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g. source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln , operating conditions such as ambient temperature.	

B.3. Description of the project boundary:

In accordance with paragraph 15 of AMS III.H (version 16), a project activity boundary is the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project situations. It covers all facilities affected by the project activity including sites where processing, transportation and application or disposal of waste products as well as biogas takes place.

The spatial extent of the project boundary encompasses the description in (a) and (c) of paragraph 15 of AMS I.C (version 19):

(a) All plants generating power and/or heat located at the project site, whether fired with biomass, fossil fuels or a combination of both; and

(c) Industrial, commercial or residential facility, or facilities, consuming energy generated by the system and the processes or equipment by the project activity.

Based on the above, the boundaries in baseline and project scenarios are delineated in Figure 3 and Figures 4 and 5, respectively, in this PDD.

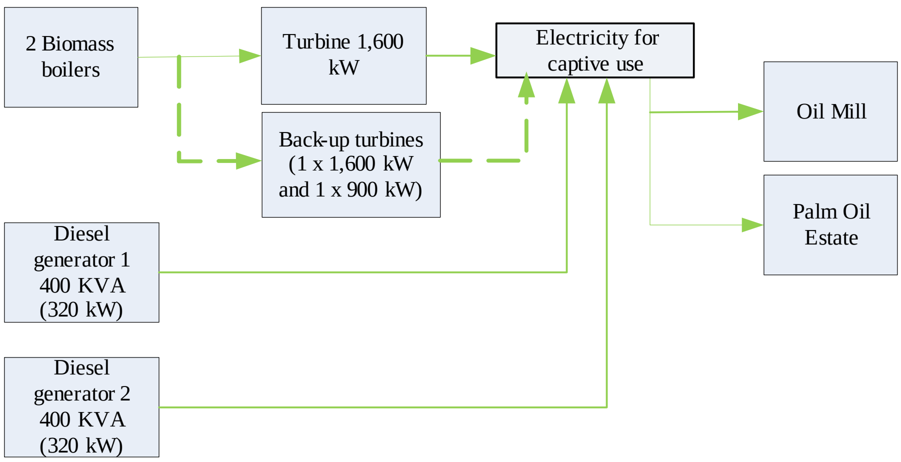
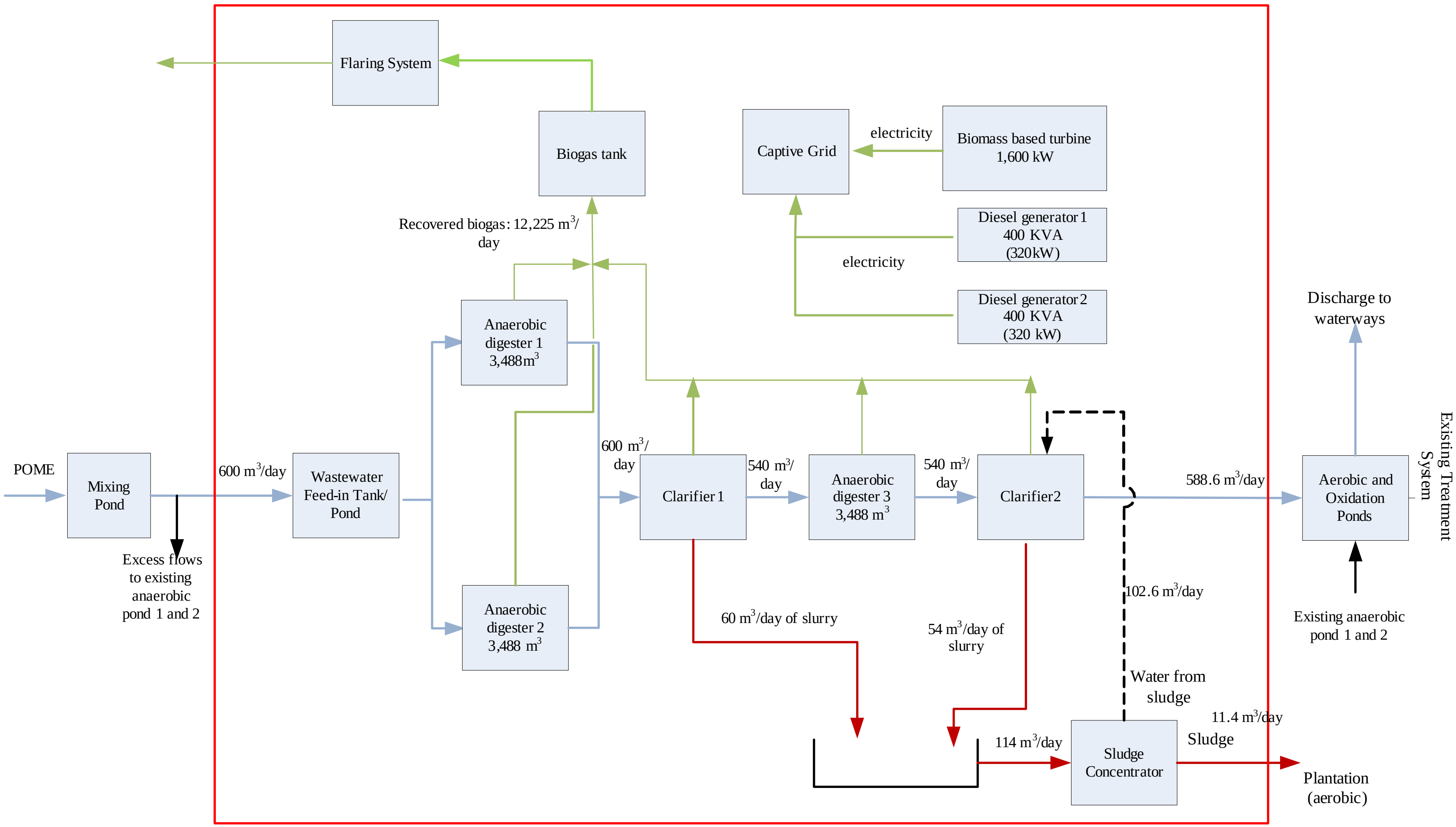
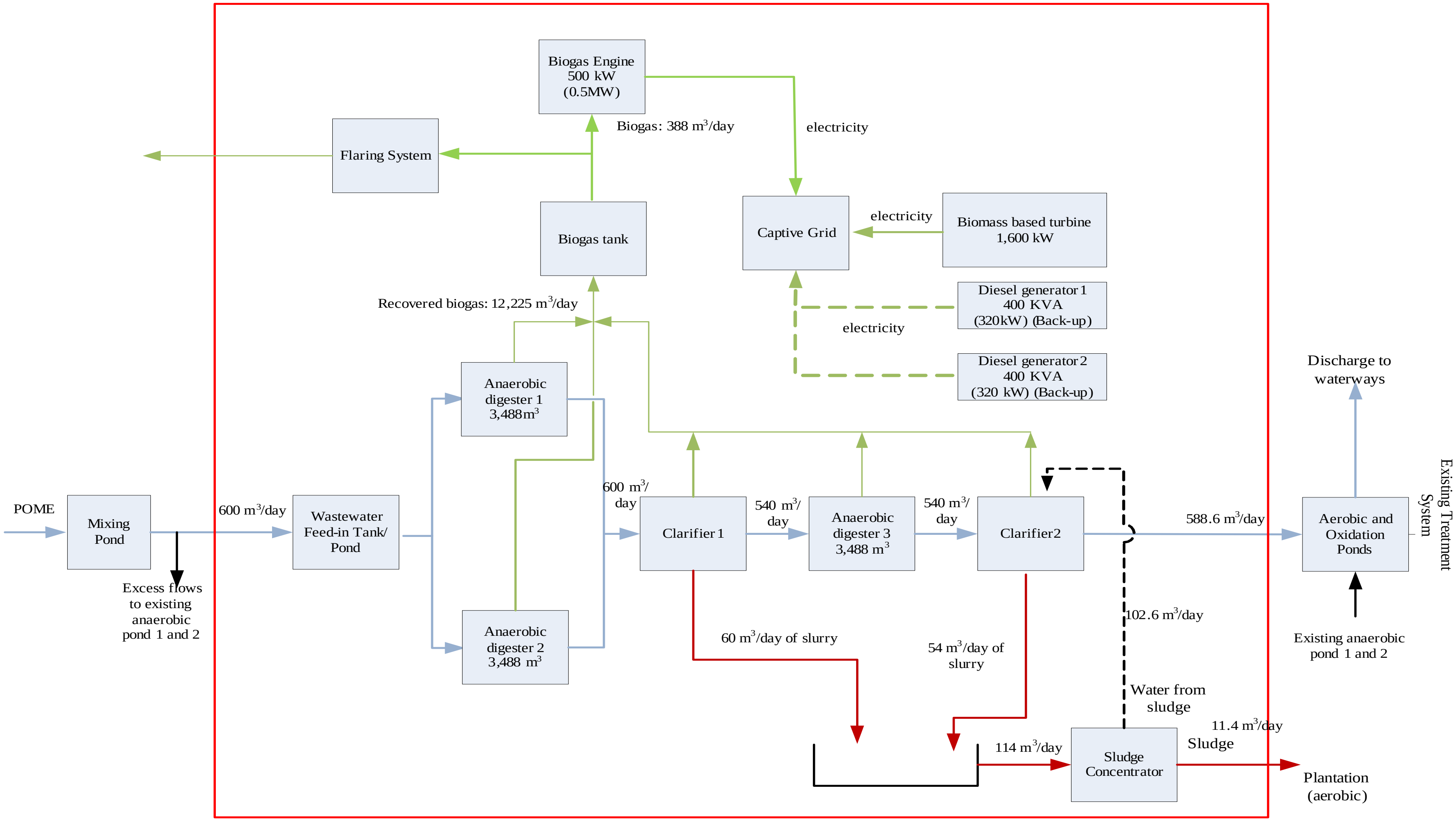


Figure 3: Delineation of Baseline Scenario



Note: For safety purposes associated with any potential biogas accumulation in Clarifiers 1 and 2, outlets are connected to biogas line.

Figure 4. Delineation of Project Activity (Phase I)



Note: For safety purposes associated with any potential biogas accumulation in Clarifiers 1 and 2, outlets are connected to biogas line.

Figure 5. Delineation of Project Activity (Phase II)

Table 5: Possible Greenhouse gas produced in the baseline and project activity

	Source	Gas	Inclusion	Justification
Baseline	Emissions from the wastewater treatment in the two anaerobic ponds.	CO_2	No	CO_2 emission is not accounted because this is generated from the decomposition of organic matter.
		CH_4	Yes	CH_4 is the major component in the biogas produced from decomposition of organic matter in the anaerobic treatment of POME.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from the treatment of sludge in the two anaerobic ponds.	CO_2	No	There is no baseline sludge treatment system which will be affected by the project activity.
		CH_4	No	
		N_2O	No	
	Emissions from the discharge of the effluent of the anaerobic ponds	CO_2	No	CO_2 emission is not accounted because this is generated from the decomposition of organic matter.
		CH_4	Yes	CH_4 is the major component in emissions produced from decomposition of residual organic matter in discharged effluent to the downstream poorly managed and overloaded aerobic pond.
		N_2O	No	Excluded for simplification. This is conservative.
	Diesel as a baseline fuel for electricity generation in diesel generation (applicable for Phase II)	CO_2	Yes	CO_2 is emitted from the combustion of diesel (fossil fuel) in the baseline diesel generator
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project activity	Fugitive emissions from biogas recovery system at the anaerobic digesters	CO_2	No	CO_2 emission is not accounted because this is generated from the decomposition of organic matter.
		CH_4	Yes	Inefficiency in methane capture in the anaerobic digesters will contribute to methane emission to atmosphere.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	Emissions from the discharge of the effluent of the anaerobic digesters	CO_2	No	CO_2 emission is not accounted because this is generated from the decomposition of organic matter.
		CH_4	Yes	CH_4 is the major component in emissions produced from decomposition of residual organic matter in discharged effluent to the downstream poorly managed and overloaded aerobic pond.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.
	On-site electricity consumption	CO_2	Yes	In Phase I of project activity, electricity required by the anaerobic digesters system will be supplied by both the existing biomass based turbine and

	Source	Gas	Inclusion	Justification
				diesel generators. In Phase II, the diesel generators are used as back up. Any use of electricity generated by diesel generators will be monitored *ex-post*.
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible
	Emission from incomplete flaring of excess biogas in standby flaring system	CO_2	No	It is assumed that CO_2 emissions from recovered biogas do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Yes	Incomplete combustion of biogas due to inefficiency of flaring system leads to fugitive emission of methane.
		N_2O	No	Not applicable
	Combustion of biogas in energy generation system	CO_2	No	It is assumed that CO_2 emissions from recovered biogas (i.e. methane) do not lead to changes of carbon pools in the LULUCF sector
		CH_4	No	Excluded for simplification. This emission source is assumed to be negligible.
		N_2O	No	Excluded for simplification. This emission source is assumed to be negligible.

B.4. **Description of baseline and its development:**

In accordance to "General Guidelines to SSC CDM methodologies (version 18)", EB 66 Report, Annex 23, the baseline of this project activity is the most plausible scenario, which is the continuation of the existing systems (i.e. anaerobic ponds for wastewater treatment with no biogas recovery and electricity generation using diesel generators) and is not a Greenfield project. The baseline scenario for each component is described as follows:

1. POME wastewater treatment system in the form of anaerobic ponds without methane recovery, in which the project activity (i.e. anaerobic digesters system) will be introduced. This is accordance to paragraph 1 f of AMS III.H (version 16)

2. According to paragraph 16 AMS I.C (version 19), for the renewable energy technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times the emission factor for the fossil fuel displaced. For this project activity, the baseline scenario is the generation of electricity to the captive grid[8]. The captive grid is fed with electricity from the existing diesel generator sets and

[8] Table 2 in the PDD provides the maximum electricity demand expected at the project site. It was explained during the DOE's site visit for validation that the captive electricity grid provides electricity to the project activity, the palm oil mill operations and the colony and other infrastructure in the plantation. As provided in Table 1 in this PDD, the biomass boiler and the diesel generators are the main sources for electricity supply to the captive grid. In the project,

existing biomass boilers with turbine. The project activity will result in replacement of electricity generation from the diesel generator sets. Since, the captive grid in the baseline comprises biomass and diesel based electricity generation, equation 1 in paragraph 20 of AMS I.C (version 19) is taken to estimate the baseline emissions (refer sections B.6.1 and B.6.3 in this PDD).

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

Prior consideration of CDM

Prior to the decision to implement this project activity, project developer considered CDM necessarily for establishing the project. The following sequence of events below is the main milestone showing that CDM is an integral part of the decision leading to the project implementation.

Table 6: Chronological events leading to the CDM activity

Date	Event
14 May 2008	Interactions with IFC that resulted in awareness on CDM.
12 November 2008	Internal study on anaerobic digester system with CDM consideration.
22 January 2009	Completion of internal evaluation of the project.
15 October 2009	UNFCCC and DNA notification on prior consideration.
19 November 2009	Local stakeholder meeting.
11 February 2010	Financial approval to start Phase I. Subsequent approval for additional budget will be provided during implementation of the project activity until Phase II.
12 February 2010	EPC contract award of the anaerobic digester.
4 March 2010	Start date of project construction.
11 April 2011	Project commissioning and start-up (Phase I) for biogas recovery from anaerobic digester.

Demonstration of additionality

In accordance with Attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities, project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

(a) **Investment barrier**: a financially more viable alternative to the project activity would have led to higher emissions;

(b) **Technological barrier**: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;

(c) **Barrier due to prevailing practice**: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;

(d) **Other barriers**: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational

while the biomass based electricity generation will be continied, the biogas engine will take over the role of the diesel generator sets.

capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

Using the above mentioned provisions, additionality in this project activity is demonstrated through the following three barriers to its implementation.

Investment barriers

The investment barrier has been analyzed by extending this to an 'investment analysis' method.

Within the various approaches available, the 'simple cost analysis' approach cannot be used since the project activity generated other revenues (viz., diesel savings).

Within the 'investment comparison' approach, IRR analysis cannot be used because the cash flows across the project lifetime vary between positive and negative. However, even with such variations, within the 'investment comparison' approach, NPV analysis could be completed. Therefore, the PP has used the NPV approach.

High capital investment is required to implement the project activity. The estimated investment for the project in Phase I is US$1,800,733 and additional for Phase II is US$780,938 of which US$ 659,764 will be incurred every 10th year in the project life-time. The biogas engine installation will result in estimated diesel cost saving of US$146,310 per year. Apart from the expected CERs, this diesel cost saving is the only source of revenue that the project proponent can expect from the implementation of the project. Benchmark analysis using a relevant financial indicator (i.e. Net Present Value) is used to determine that the proposed project activity is less financially viable to the baseline scenario (i.e. continuation of existing open anaerobic lagoons system). The following analysis below also shows how CERs revenue from successful registration of this project activity as CDM project can alleviate such investment barrier.

Due to the nature of the cash flow trend over the 25-year timeframe (i.e. positive and negative cash flows), IRR of the project could not be defined and hence is not used as financial indicator. The project proponent has thus chosen to use Net Present Value (NPV) as the financial indicator, using a default expected return of equity of 10.9% (as per the table in Appendix of the *UNFCCC Guidelines on the Assessment of Investment Analysis Version 5* for Malaysia)[9] as the discount factor. This default value is selected because the project activity is based on equity investments only and there is no other similar project activity with the PP from which any other value of 'expected return on equity' could be adopted. As a result, the UNFCCC provided value for the country is considered to be the most suitable benchmark for the project activity.

Without the revenue from the CERs (i.e. in the absence of the CDM project activity registration), the NPV of this project activity would have been **negative (i.e. US$2,472,820)**. However, with CERs revenue (i.e. if the project activity is successfully registered for CDM), the NPV would be **positive (i.e. US$1,128,917)** to make the project financially viable. The table included below summarises the basic data on cost and revenue items used in the NPV calculations.

[9] http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf

Capital expenditure	Value	Unit	Source/Remarks
Total investment Cost for Phase I	6,674,000	MYR	Proposal for the anaerobic digester project
Total Investment Cost for Phase I	1,880,733	USD	
Total investment cost for Phase II (Biogas engine)	2,771,250	MYR	For first 10 years: As per item B1, B2, B3 and 2.1 of 'Phase II investment breakdown' work sheet
Total investment cost for Phase II (Biogas engine)	780,938	USD	
Total investment cost for Phase II (Biogas engine)	2,341,250	MYR	For 11th year onwards: New equipment every 10 years and excluding costs related to civil work and building
Total investment cost for Phase II (Biogas engine)	659,764	USD	
Total Investment Cost for Phase I and Phase II	**2,661,671**	**USD**	
Operational and Maintenance Costs	**Value**	**Unit**	**Source/Remarks**
Annual salary per mill operator	12,138	MYR	Based on salary slip for plant operators in the existing operations
Number of operators	5	persons	PP's estimate
Salaries	17,102	USD/yr	PP's estimate
Maintenance and repair cost	69,594	USD/yr	As per 'Maintenance and Repair Cost' work sheet
Operating and Maintenance Costs	**86,696**	**USD/yr**	
Revenue	**Value**	**Unit**	**Source/Remarks**
Diesel saving	264,897	litre/yr	One year historical record
Diesel price	1.96	RM/litre	PPBOP Average monthly diesel price
Diesel Purchase Savings	519,198	MYR/yr	
Diesel Purchase Savings	**146,310**	**USD/yr**	
Estimated Average Project CERs (Phase 1)	23,101	CER/yr	PDD
Estimated Average Project CERs (Phase 2)	24,419	CER/yr	PDD - for the lifetime of the 1st biogas engine

Estimated CER Price	19	USD/CER	"Understanding CER Price Volatility", JPMorgan 2008, http://www.latincarbon.com/2009/docs/presentations/UnderstandingCERpriceVolatility_Steinacker.pdf
CER Revenue (Phase 1)	**438,919**	**USD/yr**	Phase 1 is the operation of biodigesters system with biogas being flared
CER Revenue (Phase 2)	**463,956**	**USD/yr**	Phase 2 is the operation of biodigesters system with biogas utilised in engine and excess flared
Discount rate for NPV calculation	**10.9%**		http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf
Currency Conversion	0.2818	USD/MYR	http://www.oanda.com/currency/historical-rates, dated 12 November 2008

Therefore, the project proponent would likely to have continued with the most financially viable technology, which is the continuation of the existing open anaerobic lagoons without methane recovery (i.e. no additional capital investment is required). The continuation of such practice, however, will continue to emit GHG (i.e. methane) to the atmosphere.

Sensitivity analysis

Sensitivity analysis is done to demonstrate how variations of the above parameters affect the Net Present Value (NPV) of the project activity with a ±10% variation of the fuel savings, operating cost and capital expenditure. The results of the NPV of the project both without CDM consideration and with CDM consideration are provided in the following tables.

NPV of project activity without CDM consideration (without CERs revenue - in US$)

Parameters	-10%	-5%	0%	5%	10%
Fuel savings	(2,583,751)	(2,528,286)	(2,472,820)	(2,417,355)	(2,361,889)
Operating cost	(2,399,270)	(2,436,045)	(2,472,820)	(2,509,595)	(2,546,370)
Capital expenditure	(2,214,329)	(2,343,574)	(2,472,820)	(2,602,066)	(2,731,312)

NPV of project activity with CDM consideration (with CERs revenue - in US$)

Parameters	-10%	-5%	0%	5%	10%
Fuel savings	1,117,986	1,173,452	1,128,917	1,284,383	1,339,848
Operating cost	1,302,467	1,265,692	1,128,917	1,192,142	1,155,367
Capital expenditure	1,513,580	1,371,249	1,128,917	1,086,586	944,254

It is, therefore, evident that with ± 10% variation in the fuel savings, operating cost and capital expenditure, the NPV values of the project activity without the potential CDM revenues are negative, while these values with potential CDM revenues are positive within the range of variation. This, therefore, indicates that the NPV estimates are not sensitive for major reasonable variations in major investment parameters and are robust representation of alleviation of the investment barrier if CDM revenues could be provided to the project activity.

Technological barriers
The project activity involves anaerobic digesters which require higher quality skills and expertise in the operations. The reactors require sufficient time for start up before reaching equilibrium condition and maintaining the equilibrium condition is very important so as to allow the bacteria to work in optimum treatment conditions.

In addition, the handling of the biogas (i.e. methane) produced from these digesters carries a plausible risk. Unexpected leakage from the biogas piping and distribution system must be avoided as methane is explosive (methane has an explosion limit of 5%-15% volume[10]) and is highly hazardous. As such, well trained and technically skilled manpower is thus required for operating the anaerobic treatment system so as to avoid any unexpected leakage and hazardous occurrences.

However, at the existing POME wastewater treatment plant, which does not require dedicated manpower and resources to maintain the system, the workers are not equipped with the expertise and skills to operate the anaerobic digesters as well as the new energy generation system in the project activity. Also, the use of such configuration as per the project activity is not common in Malaysia, thus trained and highly skilled labour is not readily available in the region. Therefore, this project activity faces technological barriers in the implementation due to the requirement to train the local manpower to install, operate and maintain the project activity.

The PDD provides for objective demonstration of the barriers using publicly available statistics relevant to the project activity in Malaysia (also refer to footnotes 9 and 10 in the PDD). This is in accordance with the requirements on Annex 13 of EB50.

The justification of technological barrier has been substantiated with evidences to demonstrate that there are some technological risks in the implementation of the project activity. How CDM can alleviate this barrier has also been described under "the benefits of implementing the CDM project activity".

Barriers due to prevailing practice
The baseline anaerobic treatment system, open ponds technology, is the prevailing practice in treating POME in Malaysia. More than 85% [11] of the POME treatment system in the region uses the anaerobic open ponds technology due to its technology simplicity and low operational cost.

In Malaysia, the generated POME is required to meet the standards of Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulation, 1977 by the Department of Environment before being discharged to the waterways or for land application. The existing open ponds POME treatment system is sufficient in

[10] http://cartwright.chem.ox.ac.uk/hsci/chemicals/methane.html

[11] Baharuddin. A. S. (2010) *Effects of palm oil mill effluent (POME) anaerobic sludge from 500 m^3 of closed anaerobic methane digested tank on pressed-shredded empty fruit bunch (EFB) composting process*, African Journal of Biotechnology Vol. 9(16), pp 2427-2436.

meeting the aforesaid standards and the available results on final discharge confirm this. Therefore, there is no requirement for further efforts in employing new technology for the treatment of raw POME.

In addition, there is no requirement for methane emission control in wastewater treatment, under the "Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977" set by the Department of Environment, Malaysia. Thus, project owners are not required to recover the methane generated from the anaerobic wastewater treatment system. As such, project owners of Palm Oil Mills generally will not put in big investment to employ technology with methane recovery. Using wastewater treatment with no methane recovery would have been an easier and lower cost option, however, it results in GHG emissions into the environment. Therefore, this project activity faces prevailing practice barrier.

Furthermore, from the UNFCCC website database on registered CDM project activities, it is evident that since June 2008, only 29 project activities (as per table below) have been registered for implementing biogas/methane recovery technologies. Such projects were possible to be implemented due to potential CDM revenues to alleviate barriers.

Registered	Title	Host Parties	Other Parties	Methodology	Reductions	Ref
14 Sep 11	Biogas Plant at United Plantations Berhad, ULU BASIR Palm Oil Mill	Malaysia	Denmark	AMS-III.H. ver. 16	23973	5150
31 Aug 11	Biogas Project at Prolific Yield Palm Oil Mill	Malaysia	Denmark	AMS-III.H. ver. 16 AMS-I.F.	38883	4285
05 Mar 11	MY08-WWP-30, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Netherlands	AMS-III.H. ver. 13	26983	4216
26 Jan 11	Biogas Plant at United Plantations Berhad, UIE Palm Oil Mill	Malaysia	Denmark	AMS-III.H. ver. 13	14848	3622
25 Jan 11	Biogas Recovery at Ulu Kanchong Palm Oil Mill	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-III.H. ver. 14	33503	3125
29 Dec 10	KDC MILL 1 AND MILL 2 BIOGAS PROJECT	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-III.H. ver. 13 AMS-I.A. ver. 13	39806	3639
21 Dec 09	AMA08-W-10, Methane Recovery in Wastewater Treatment, Kedah, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	45392	2623
25 Nov 09	MY08-WWP-34, Methane Recovery in Wastewater Treatment, Pahang and Negeri Sembila, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	30472	1756

Registered	Title	Host Parties	Other Parties	Methodology	Reductions	Ref
16 Nov 09	MY08-WWP-36, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	22092	1738
13 Nov 09	Methane Recovery in Wastewater Treatment, Project AMA07-W-07, Kedah, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	44248	2665
13 Nov 09	AMA08-W-08, Methane Recovery in Wastewater Treatment, Sabah, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	19634	2656
13 Nov 09	Methane Recovery in Wastewater Treatment, Project AMA07-W-05, Pahang, Malaysia	Malaysia	Netherlands	AMS-III.H. ver. 9	35174	2655
13 Nov 09	AMA08-W-23, Methane Recovery in Wastewater Treatment, Sarawak, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	20002	2635
13 Nov 09	MY08-WWP-26, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	30692	2657
12 Nov 09	AMA08-W-25, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	35472	2602
12 Nov 09	AMA08-W-24, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	26568	2642
12 Nov 09	AMA08-W-21, Methane Recovery in Wastewater Treatment, Johor, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	21671	2632
12 Nov 09	AMA08-W-22, Methane Recovery in Wastewater Treatment, Johor, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 9	17646	2641
15 Oct 09	Felda Maokil and Kemahang POME Biogas Project	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 9	42759	2653
19 Sep 09	Felda Chalok and Jerangau Barat Biogas Project	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 9	32666	2651

Registered	Title	Host Parties	Other Parties	Methodology	Reductions	Ref
04 Sep 09	Felda Pancing and Pasoh Biogas Project	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 9	34290	2603
18 Jul 09	FELDA Besout POME Biogas Project	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 9	22764	2542
20 Mar 09	Methane recovery and utilisation project at TSH Lahad Datu Palm Oil Mill, Sabah, Malaysia	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 8	33356	2330
19 Mar 09	Methane recovery and utilisation project at TSH Sabahan Palm Oil Mill, Sabah, Malaysia	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.A. ver. 12 AMS-III.H. ver. 8	53439	2332
15 Mar 09	FELDA Serting Hilir Biogas Power Plant Project	Malaysia	United Kingdom of Great Britain and Northern Ireland	AMS-I.D. ver. 13 AMS-III.H. ver. 8	37251	2336
14 Feb 09	Methane recovery and utilization through organic wastewater treatment in Malaysia	Malaysia	Japan Sweden	AMS-III.H. ver. 8	43152	2313
24 Oct 08	Methane capture from POME for electricity generation in Batu Pahat.	Malaysia	Japan	AMS-I.D. ver. 11 AMS-III.H. ver. 5	48234	1783
27 Sep 08	KKSL Lekir Biogas Project, Project BCM07_SLK_14	Malaysia	Netherlands	AMS-III.H. ver. 6	33955	1888
17 Jun 08	Methane Recovery in Wastewater Treatment, Project AMA07-W-01, Perak, Malaysia	Malaysia	Switzerland Netherlands	AMS-III.H. ver. 5	57094	1616

The operation of open anaerobic ponds is the prevailing practice in the country. Moreover the national regulation on wastewater discharge does not regulate or mandate the use of recovery system in anaerobic processes. This will have allowed the PP to continue with existing treatment system which emits more GHG emissions.

This is in line with the latest guidelines on barrier analysis as per Attachment A of Appendix B (version 8) of EB 63 Annex 24 which provides the definition of the barrier due to prevailing practice as follows:

"Prevailing practice or existing regulatory or policy requirement would have led to implementation of a technology with higher emission".

The benefits of implementing the CDM project activity
The approval and registration of the project activity will alleviate the above three identified barriers and enable the project activity to be undertaken and contribute to emission reductions. Without the expected additional CER revenue, there will be no incentive for the project owner to move away from the existing practice (i.e. anaerobic pond systems), and implement the high-investment project activity.

The expected additional CER revenue will also mitigate the risk (e.g. unexpected downtime) resulting from lack of skilled and qualified workers. By alleviating the barriers and allowing the implementation of the project activity, it will thus promote the gradual transition of prevailing practices to methane recovery projects in the region.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Methane recovery by anaerobic digesters

Baseline emission
As explained in Section B.4, the baseline scenario for the methane avoidance component of the project is the continuation of the existing anaerobic ponds without methane recovery. As per Paragraph 18 of AMS III.H (Version 16), baseline emissions are calculated as follows:

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\}$$

Table 7: Summary of baseline emission for methane recovery

No.	Emissions	Description	Remarks
1.	$BE_{power,y}$	Emissions on account of electricity or fossil fuel used	Not applicable. The operations of the existing anaerobic ponds do not require electricity.
2.	$BE_{ww,treatment,y}$	Methane emissions from baseline wastewater treatment systems	Applicable. Methane is the major component in the biogas produced during anaerobic wastewater treatment.
3.	$BE_{s,treatment,y}$	Methane emissions from baseline sludge treatment system	Not applicable. There is no baseline sludge treatment systems affected by the project activity. Thus, this emission is accounted as zero as per paragraph 22 of AMS III.H version 16.
4.	$BE_{ww,discharge,y}$	Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of biodegradable organic carbon in untreated wastewater discharged to sea /	Applicable. Methane is the major component in the biogas produced during discharge of the effluent to the downstream poorly managed and overloaded aerobic pond.

No.	Emissions	Description	Remarks
		river / lake	
5.	$BE_{s,final,y}$	Methane emissions from the decay of the final sludge generated by baseline treatment system	Not applicable. No sludge is removed from the existing anaerobic ponds.

Therefore, the baseline emission is simplified as follow:

$$BE_y = BE_{ww,treatment,y} + BE_{ww,discharge,y}$$

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,BL,\ discharge}$$

Where:

$Q_{ww,i,y}$	Volume of wastewater treated in baseline wastewater treatment system *i* in year *y* which is affected by the project activity (m^3/year)
$Q_{ww,y}$	Volume of wastewater discharged from anaerobic pond system to aerobic pond 1 in baseline situation which is affected by the project activity in year *y* (m^3/year)
$COD_{inflow,i,y}$[12]	Chemical Oxygen Demand of the wastewater inflow to the baseline treatment system *i* in year *y* (tonnes/m^3)
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline treatment system *i*, determined as per the paragraphs 26, 27 or 28 of AMS III.H version 16
$COD_{ww,discharge,BL,y}$	Chemical Oxygen Demand of the treated wastewater discharged into aerobic pond 1 in the baseline situation in year *y* (t/m^3)
$MCF_{ww,treatment,BL,i}$	Methane correction factor for the baseline wastewater treatment system *i* (MCF value can be obtained from Table III.H.1 in AMS III.H version 16)
$MCF_{ww,BL,\ discharge}$	Methane correction factor based on discharge pathway in the baseline situation of the wastewater (fraction) (MCF values can obtained from Table III.H.1 in AMS III.H version 16)
$B_{o,ww}$	Methane producing capacity of the wastewater (kg CH_4/kg COD)
UF_{BL}	Model correction factor to account for model uncertainties
GWP_{CH4}	Global warming potential for methane

As per paragraph 26 of AMS III.H (version 16), in determining baseline emissions using the above equation, historical records of at least one year prior to the project implementation shall be used. This shall include for example the COD removal efficiency of the wastewater treatment systems. However, one year historical data of the affected two anaerobic ponds in Saremas 1 palm oil mill is not available. Therefore, as per paragraph 27 of AMS III.H (version 16), if the plant has been operating at least three years, an *ex-ante* measurement campaign is implemented to determine the required parameters (i.e. COD removal efficiency). The measurement campaign was implemented in the baseline wastewater treatment system (i.e. the two anaerobic ponds) for 10 days. The measurement was undertaken during the period that was representative for the typical operation conditions of the systems and ambient conditions of the

[12] This COD_{inflow} is equivalent to $COD_{untreated}$ in the list of monitored parameters (Section B.7.1)

site (temperature, etc). Average values from the 10-day measurement campaign are used and the result is multiplied by 0.89 to account for the uncertainty range (30% to 50%).

Table 8: Value of parameters used in baseline emissions calculation due to methane recovery

Parameters	Value	Source
$B_{o,ww}$	0.25 kg CH_4/kgCOD	IPCC value.
$COD_{inflow,i,y}$ (or $COD_{untreated,i,y}$)	0.05285 tCOD/m^3	Measurement by project proponent(s) in the 10 days measurement campaign on the existing site. This is as per paragraph 27 (b) of AMS III.H version 16.
$\eta_{COD,BL,i}$	77.53 %	COD removal efficiency obtained from the 10 days measurement campaign on the existing site. This is as per paragraph 27 (b) of AMS III.H version 16.
$COD_{discharge,y}$	0.011876 tCOD/m^3	Measurement by project proponent(s) in the 10 days measurement campaign on the existing site. This is as per paragraph 27 (b) of AMS III.H version 16.
$Q_{ww,i,y}$	219,000 m^3/year	Part of the POME wastewater (600 m^3/day) from the mill (taken to be same volume at the mixing pond) will be treated by the project activity. Hence the volume of wastewater to be treated in the baseline system which is affected by the project activity is 600 m^3/day, i.e. 219,000 m^3/year.
$Q_{ww,y}$	214,839 m^3/year	The wastewater flowrate discharged to aerobic pond 1 which is affected by the project activity is equal to the design discharged flowrate in the project activity.
$MCF_{ww,treatment,BL,i}$	0.8	IPCC value as per Table III.H.1 in AMS III.H version 16. The anaerobic ponds have depth of 4.5 m (> 2m).
$MCF_{ww,BL,discharge}$	0.3	IPCC value as per Table III.H.1 in AMS III.H version 16. The wastewater is discharged to aerobic pond which can be classified as poorly managed or overloaded.
UF_{BL}	0.89[13]	Value as per AMS III.H (version 16) paragraph 22.
GWP_{CH4}	21	IPCC 2006 value.

Project emission

As per paragraph 29 of AMS III.H (version 16), the project activity emissions from the systems affected by the project activity is calculated as follow:

$$PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y}$$

Table 9: Summary of project activity emission for methane recovery

No.	Project emissions	Descriptions	Remarks
1	PE_{power}	Emissions from electricity or fuel consumption in the year *y*	Applicable. In Phase I, the anaerobic digesters will consume electricity generated from the existing diesel generators, hence

[13] Reference: FCCC/SBSTA/2003/10/Add.2, page 25

No.	Project emissions	Descriptions	Remarks
			resulting in CO_2 emission. However, in Phase II, the biogas engines will replace the diesel generators. Hence, emission associated to electricity consumption is excluded in Phase II. In the case where the diesel generators are used as back up or additional electricity supply, the emission associated to diesel combustion will be calculated *ex-post*.
2	$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y*	Not applicable. All the anaerobic digesters will be equipped with biogas capture and recovery.
3	$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y*	Not applicable. Project activity does not involve sludge treatment.
4	$PE_{y,ww,discharge}$	Methane emissions from degradable organic in treated wastewater in year *y*	Applicable. As the partially treated wastewater from the project activity will be discharged to downstream aerobic treatment ponds which are not well managed, methane could be generated and emitted.
5	$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year *y*	Not applicable. In the project activity, the generated sludge will be used for soil application in the plantation under aerobic condition.
6	$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year *y*	Applicable. The emission due to inefficiency of capture system in anaerobic digesters will contribute to methane emission to atmosphere.
7	$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year *y*	Applicable. The inefficiencies of the flaring system may result in fugitive emission of methane.
8	$PE_{biomass,y}$	Methane emissions from biomass storage under anaerobic conditions	Not applicable. This project activity does not involve biomass storage under anaerobic condition.

Therefore, for *ex-ante* calculation the project activity emissions (PE_y) are simplified as follow:

$$PE_y = PE_{power} + PE_{y,ww,discharge} + PE_{fugitive,y} + PE_{flaring,y}$$

<u>Project emissions from electricity consumption</u>

$$PE_{power} = P_{anaerobic\ digester} * N_{digesters} * EF_{CO2\ captive\ grid,y}$$

Where

$P_{anaerobic\ digester}$	Power requirement for anaerobic digesters system in project activity (MW)
$EF_{CO2\ captive\ grid,y}$	Emission factor of the captive grid in year *y* (tCO_2/MWh)
$N_{digesters}$	Number of operating hours of the anaerobic digesters (hours)

As per Paragraph 12 of AMS I.D (version 17) "Grid connected renewable electricity generation", the Emission Factor for captive grid ($EF_{CO2\ captive\ grid,y}$) can be calculated in a transparent and conservative manner as follows:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the Emission Factor for an electricity system".

OR

(b) The weighted average emissions (in tCO_2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

For calculation of the emission factor for the project's captive grid, option (b) is used.

The emission factor of the captive grid is calculated by the following equation:

$$EF_{captive\ grid} = (\sum FC_{i,y} * NCV_i * EF_{CO2,i}) / EG_y$$
$$= (Q_{biomass,y} * NCV_{biomass} * 0 + FC_{diesel,y} * NCV_{diesel} * EF_{diesel}) / EG_y$$

$$FC_{diesel,y} = (\rho_{diesel} * Q_{diesel,y}) / 1,000$$

For *ex-ante* estimation, the EG_y is determined using the design capacity of each unit as follow:

For Phase I:

$$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,} + P_{diesel} * N_{diesel\ generators,}$$

For Phase II:

$$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,y} + P_{diesel} * N_{diesel\ generators,y} + EG_{captelec,PJ,y}$$

$Q_{biomass}$	Amount of biomass used for power generation in year *y* (tonnes)
$NCV_{biomass}$	Net calorific value of biomass used for power generation in year *y* (GJ/tonne)
FC_{diesel}	Fuel consumption (i.e. diesel) used in the diesel generators in year *y* (tonnes)
ρ_{diesel}	Density of diesel used in the diesel generators (g/ml)
$Q_{diesel,y}$	Volume of diesel used in the diesel generators in year *y* (litre)
NCV_{diesel}	Net calorific value of diesel used in the diesel generators in year *y* (GJ/tonne)
EF_{diesel}	Emission factor of diesel used in the diesel generators (tCO_{2e} / GJ)

EG_y Total electrical energy produced in year *y* (MWh)
$P_{biomass\ based\ turbine}$ Power generating capacity of biomass based turbine (MW)
P_{diesel} Power generating capacity of diesel generators (MW)
$N_{biomass\ based\ turbine,y}$ Number of operating hours of biomass based turbine (hours)
$N_{diesel\ generators,y}$ Number of operating hours of diesel generators(hours)
$EG_{captelec,PJ,y}$ Electricity generated from the biogas engine to the captive grid in year *y* (MWh)

Project emissions from treated wastewater discharge

$PE_{y,ww,discharge} = Q_{ww,y\ discharge} * GWP_{CH4} * B_{o,ww} * UF_{PJ} * COD_{ww,discharge,PJ,y} * MCF_{ww,PJ,\ discharge}$

Where

$Q_{ww,y\ discharge}$ Volume of treated wastewater discharged from anaerobic digesters (m^3/year)

$COD_{ww,discharge,PJ,y}$ Chemical Oxygen Demand of discharged wastewater from anaerobic digesters (t/m^3)

$MCF_{ww,PJ,\ discharge}$ Methane correction factor of the discharged pathway (as per Table III.H.1 in AMS III.H version 16)

Project emissions from fugitive emissions

$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y}$

$PE_{fugitive,ww,y}$ Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year *y* (tCO_{2e})

$PE_{fugitive,s,y}$ Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year *y* (tCO_{2e})

$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4}$

CFE_{ww} capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a value of 0.9 is used, as per AMS III.H version 16)

$MEP_{ww,treatment,y}$ Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year *y* (tonne)

$$MEP_{ww,treatment,y} = Q_{ww,y,treated} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}$$

$Q_{ww,y,treated}$ Amount of wastewater to be treated in the wastewater treatment system equipped with biogas recovery (m^3/year)

$COD_{removed,PJ,k,y}$ The Chemical Oxygen Demand removed by the treatment system *k* of the project activity equipped with biogas recovery in the year *y* (t/m^3)

$MCF_{ww,treatment,PJ,k}$ Methane correction factor for the project wastewater treatment system *k* equipped with biogas recovery equipment

UF_{PJ} Model correction factor to account for model uncertainties

Fugitive emission due to inefficiency in capture system in sludge treatment system ($PE_{fugitive,s,y}$) is zero (not accounted) as there will be no sludge treatment in the project activity (i.e. anaerobic digesters system). Therefore the fugitive emission is simplified as:

$$PE_{fugitive,y} = PE_{fugitive,ww,y}$$

Project emissions from flaring of biogas

Based on Annex 13 of EB Report 28 "Methodological tool to determine project emissions from flaring gases containing methane", in the case where it is necessary to include fugitive emissions due to incomplete flaring, the emission ($PE_{flaring,y}$) is determined by the following steps:

The flaring system chosen by project proponent is enclosed flaring with default flaring efficiency of 90% (as per methodological tool to determine project emissions from flaring gases containing methane). As a simplified approach, project proponent will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2) (As per section III of tool to determine project emissions from flaring gases containing methane).

STEP 1. Determination of the mass flow rate of the residual gas that is flared
This step is not applicable for this project activity, since it is expected to use default flaring efficiency.

STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
This step is not applicable for this project activity, since it is expected to use default flaring efficiency.

STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis
This step is not applicable for this project activity, since it is expected to use default flaring efficiency.

STEP 4. Determination of methane mass flow rate in the exhaust gas on a dry basis
This step is not applicable for this project activity, since it is expected to use default flaring efficiency.

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60ºC), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis).

$$TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH4,n}$$

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (m^3/h)

$fv_{CH4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane).
$\rho_{CH4,n,h}$	Density of methane at normal conditions (0.716 kg/m^3)

STEP 6. Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project proponents to determine the flare efficiency (default value or continuous monitoring).

The project activity involves the use of enclosed flare and chooses a default efficiency of 90%. The choice of this default flare efficiency ($\eta_{flare,h}$) is based on the following:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500^{o}C for more than 20 minutes during hour h.
- 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500^{o}C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h.
- 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500^{o}C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.

STEP 7. Calculation of annual project emissions from flaring

As per paragraph 29 of AMS III.H version 16, project emissions from flaring are calculated based on "Tool to determine project emissions from flaring gases containing methane" which is the sum of emissions from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$). The equation used as per the tool, section II, equation 15 is as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1,000$$

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year *y* (tCO_{2e})
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,h}$	Flare efficiency in hour *h* (default efficiency value of 90%)
GWP_{CH4}	Global Warming Potential of methane valid for commitment period (IPCC default value of 21).

<u>**For *ex-ante* calculations**, the following equations are used:</u>

For Phase I (i.e. when biogas engine is not implemented yet):

According to AMS III.H version 16, for *ex-ante* estimation of the project emissions from flaring, baseline calculation for wastewater treatment ($BE_{ww,treatment,y}$) can be used without the consideration of GWP for CH_4 therefore, for the purpose to calculate the flaring emissions for this project activity, this approach will be taken. The equation in step 7 above will then be simplified as follow:

$$PE_{flare,y} = BE_{ww,treatment,y} / GWP_{CH4} * (1 - \eta_{flare,h}) * GWP_{CH4}$$

$= BE_{ww,treatment,y} * (1 - \eta_{flare,h})$

For the remaining crediting period (i.e. when biogas engine is implemented):

$PE_{flare,y} = TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1,000$

Where $TM_{RG,h}$ is the balance of the methane in the biogas which is not delivered to the biogas engine for electricity generation. For *ex-ante* estimation, $TM_{RG,h}$ is calculated as follow:

$TM_{RG,h} = (BE_{ww,treatment,y} / GWP_{CH4}) – BG_{recovered,y} * w_{CH4,y} * \rho_{CH4,n}$

$BG_{recovered,y} = (EG_{captelec,PJ,y} * 0.0036\ TJ/MWh) / ((NCV_{biogas} * \rho_{biogas}) / 1,000,000\ kg/Gg)$

For *ex-post* calculation of the projection emission from flaring, the actual flow rate of biogas and volume fraction of methane of the biogas in the residual gas entering the flaring system will be monitored and used to calculate the project emission due to flaring (i.e. equation 15 of "Tool to determine project emissions from flaring gases containing methane").

Table 10: Value of parameters used in project emissions calculation due to methane recovery

Parameter	Value	Source
$P_{anaerobic\ digester}$	0.1 MW	Measurement by project proponent(s).
$P_{biomass\ based\ turbine}$	1,600 kW (1.6 MW)	Rated generating capacity.
P_{diesel}	640 kW (0.64 MW)	Total rated generating capacity for two diesel generators.
$Q_{diesel,y}$	264,897 litres	For *ex-ante* calculation, one year historical record of fuel consumption is used.
$EG_{captelec,PJ,y}$	4,380 MW	For *ex-ante* calculation, the design capacity of the biogas engine is used (500 kW = 0.5 MW; 0.5 MW * 24 hours/day * 365 days / year)
ρ_{diesel}	0.841 g/ml	Default value[14]
$N_{digesters}$	8,760 hours	Measurement by project proponent(s).
NCV_{diesel}	43.3 GJ/tonne	Upper-limit value of IPCC 2006 value as per Table 1.2 volume 2 chapter 1.
EF_{diesel}	0.0748 tCO_{2e}/GJ	Upper-limit value of IPCC 2006 value as per Table 1.4 volume 2 chapter1.
$N_{biomass\ based\ turbine,}$	7,300 hours	Expected operational hours of biomass based turbine.
$N_{diesel\ generators,}$	2,920 hours	Expected operational hours of diesel generators.
$Q_{ww,y\ discharge}$	214,839 m^3/year	Design value provided by the equipment manufacturer.
$Q_{ww,y,treated}$	219,000 m^3/year	Design value provided by the equipment manufacturer.
GWP_{CH4}	21	IPCC value
$B_{o,ww}$	0.25 kg CH_4/kg COD	IPCC value
UF_{PJ}	1.12	Value as per AMS III.H version 16 paragraph 29.

[14] http://www.iea.org/work/2004/eswg/SIP9.pdf

Parameter	Value	Source
$COD_{ww,discharge,PJ,y}$	0.005285[15] tonnes COD/m³	For *ex-ante* estimation, this value is calculated based on baseline COD_{inflow} from 10 days measurement campaign (0.05285 tonnes COD/m³) and project designed overall COD removal efficiency. (90%). For *ex-post* estimation, the actual measured COD of the discharged wastewater to the subsequent aerobic pond will be used.
$COD_{ww,removed,PJ,y}$	0.04757[16] tonnes COD/m³	This value is calculated based on baseline COD_{inflow} from 10 days measurement campaign (0.05285 tonnes COD/m³) and project designed overall COD removal efficiency (90%).
$MCF_{ww,PJ,\ discharge}$	0.3	IPCC value as per Table III.H.1 in AMS III.H version 16. The wastewater is discharged to poorly managed and overloaded aerobic pond.
$MCF_{ww,treatment,PJ,k}$	0.8	IPCC value as per Table 6.8 Volume 5 Chapter 6 of IPCC 2006 Guideline for anaerobic reactor.
CFE_{ww}	0.9	Default value as per paragraph 30 AMS III.H version 16.
$\eta_{flare,h}$	0.9	Default value for enclosed flaring system as per “Tool to determine project emissions from flaring gases containing methane”
NCV_{biogas}	100 TJ/Gg	Upper-limit value of IPCC 2006 default value as per Table 1.2. Volume 2 Chapter 1.
$w_{CH4,y}$	0.65	Value from literature[17]. For *ex-post* calculation, actual monitored volume fraction of methane in the biogas will be used.
ρ_{biogas}	1.112 kg/m³	http://biomass.ucdavis.edu/materials/calculator/EconCalculator_Biogas.xls.
$\rho_{CH4,n}$	0.716 kg/m³	Default value as per “Tool to determine project emissions from flaring gases containing methane”

Power generation

Baseline emissions

The baseline emission from electricity generation is calculated using equation 1 in paragraph 20 of AMS I.C (version 19) as follow:

$BE_{captelec,y} = (EG_{captelec,PJ,y}\ /\ □_{BL,captive\ plant}) * EF_{BL,FF,CO2}$

As mentioned in Section B.4 of this PDD, the electricity to be generated from the biogas engine in Phase II displaces the electricity which would have been generated from a captive grid system comprising of biomass based turbine and diesel generator sets. The recipients of the electricity in this project activity are not connected to the regional or national grid. Hence, the emission factor of fossil fuel in the equation above ($EF_{BL,FF,CO2}$) is adjusted to account for the captive grid emission factor that is more conservative

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[15] $COD_{ww,discharge,PJ,y} = COD_{inflow} * (1-□_{COD})$ = 0.05285 tonnes COD/m³ * (1-0.9) = 0.005285 tonnes COD/m³.

[16] $COD_{ww,removed,PJ,y} = COD_{inflow} * □_{COD}$ = 0.05285 tonnes COD/m³ * 0.9 = 0.04757 tonnes COD/m³.

[17] Yacob. S, et al (2006) *Baseline study of methane emission from open digesting tanks of palm oil effluent treatment.* Chemosphere 59 pp. 1575-1581

than using emission factor for only diesel. As the electricity from the biogas engine in Phase II will displace the captive grid electricity on-site, hence the above equation is adjusted as follow:

$BE_{captelec,y} = (EG_{captelec,PJ,y} / \square_{BL,captive\ plant}) * EF_{captive\ grid,phaseII,y}$

where:

$BE_{captelec,y}$	The baseline emissions from electricity displaced by the project activity during the year *y* (tCO_2)
$EG_{captelec,y}$	The amount of electricity produced by the project activity during the year *y* (MWh)
$\square_{BL,captive\ plant}$	The efficiency of the captive grid.
$EF_{captive\ grid,phaseII,y}$	Captive grid emission factor of Phase II in year *y* (tCO_2/MWh)

For *ex-ante* estimation, the quantity of electricity generated by the biogas engine is estimated based on the design capacity and its operational hours as follow:

$EG_{captelec,PJ,y} = P_{biogas,} * N_{biogas,y}$

Hence for *ex-ante* estimation, the above equation will be:

$BE_{captelec,y} = (P_{biogas} * N_{biogas} / 100\%) * EF_{captive\ grid,phaseII,y}$

where:

P_{biogas}	Power generating capacity of biogas engine (MW)
N_{biogas}	Number of operating hours of biogas engine in a year (hour)

Table 11. Value of parameters used in calculation of baseline emissions from power generation

Parameter	Value	Source
$P_{biogas,}$	0.5 MW	Design power generation capacity by project proponent(s).
$N_{biogas,}$	8,760 hours	Estimated operational hours of the biogas engine
$EF_{captive\ grid,phaseII,y}$	0.0402 tCO_2/MWh	Based on the calculation of captive grid emission factor of Phase II (Please refer to calculation in Section B.6.3)

Project emissions

As per paragraph 45 of AMS I.C (version 19), the following source of emissions are to be accounted:

- CO2 emissions from on-site consumption of fossil fuel to the project activity.
- CO2 emissions from electricity consumption by the project activity.
- Any other significant emissions associated with project activity within the project boundary.
- For geothermal project activities, project participants shall account for the fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam and

carbon dioxide emissions resulting from combustion of fossil fuels related to the operation of geothermal plant.

The biogas engine of this project activity does not require fossil fuel in the operation and the generated electricity measured and used for baseline estimation has already accounted the net generation. Moreover, this is not geothermal project activity. Therefore, there are no project emissions applicable to this project activity.

Emission reductions

For methane recovery (AMS III.H version 16)

As per paragraph 32 of AMS III.H version 16, the emission reduction *ex-ante* is calculated as per the following:

$$ER_{y,ex\ ante} = BE_{y,\ ex\ ante} - (PE_{y,\ ex\ ante} + LE_{y\ ex\ ante})$$

where:

$ER_{y,ex\ ante}$	*Ex ante* emission reduction in year *y* (tCO_{2e})
$LE_{y\ ex\ ante}$	*Ex ante* leakage emissions in year *y* (tCO_{2e})
$PE_{y,\ ex\ ante}$	*Ex ante* project emissions in year *y* (tCO_{2e})
$BE_{y,\ ex\ ante}$	*Ex ante* baseline emissions in year *y* (tCO_{2e})

According to paragraph 33 of AMS III.H version 16, for case 1(f), *ex-post* emission reductions shall be based on the lowest value as per the following equation (paragraph 34 of AMS III.H version 16):

$$ER_{y,\ ex\ post} = min\ ((BE_{y,\ ex\ post} - PE_{y,\ ex\ post} - LE_{y,ex\ post}), (MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,ex\ post}))$$

where:

$ER_{y,\ ex\ post}$	Emission reductions achieved by the project activity based on monitored values for year *y* (tCO_{2e})
$BE_{y,\ ex\ post}$	Baseline emissions calculated using *ex post* monitored values
$PE_{y,\ ex\ post}$	Project emissions calculated using *ex post* monitored values
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year *y* (tCO_{2e})

In the case of flaring/combustion, MD_y will be measured using the conditions of the flaring process as per the following equation in paragraph 35 of AMS III.H version 16:

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}$$

where:

$BG_{burnt,y}$	Biogas volume flared/combusted in year *y* (m^3)
$w_{CH4,y}$	Methane content of the biogas in the year *y* (volume fraction)
D_{CH4}	Density of methane at the temperature and pressure of the biogas in the year *y* (t/m^3)
FE	Flare efficiency in year *y* (fraction).

<u>For power generation (AMS I.C)</u>

As per paragraph 49 of AMS I.C version 19, the emission reduction is calculated as per following equation:

$ER_y = BE_y - PE_y - LE_y$

where:

ER_y	Emission reductions in year y (tCO_{2e})
BE_y	Baseline emissions in year y (tCO_{2e})
PE_y	Project emissions in year y (tCO_{2e})
LE_y	Leakage emissions in year y (tCO_{2e})

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**$MCF_{ww,treatment,BL}$**
Data unit:	Factor
Description:	Methane correction factor for anaerobic pond (with depth greater than 2 m) in the baseline condition.
Source of data used:	Table III.H.1 in AMS III.H (version 16).
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	The baseline situation is anaerobic deep pond (lagoon) with depth of 4.5m (greater than 2 m).
Any comment:	-

Data / Parameter:	**$MCF_{ww,discharge,BL}$**
Data unit:	Factor
Description:	Methane correction factor for aerobic pond to which the treated wastewater from the existing anaerobic ponds is discharged.
Source of data used:	Table III.H.1 in AMS III.H (version 16).
Value applied:	0.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The subsequent aerobic pond is considered poorly managed and overloaded.
Any comment:	-

Data / Parameter:	**$MCF_{ww,treatment\ PJ}$**
Data unit:	Factor
Description:	Methane correction factor for wastewater treatment (i.e. anaerobic digesters) in project activity.
Source of data used:	Table 6.8 of Volume 5 Chapter 6 IPCC 2006 guideline.
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project activity wastewater treatment system is anaerobic digesters.
Any comment:	-

Data / Parameter:	**$MCF_{ww,discharge,PJ}$**
Data unit:	Factor
Description:	Methane correction factor of aerobic pond 1 to which the wastewater from the anaerobic digesters system will be discharged in the project activity.
Source of data used:	Table III.H.1 in AMS III.H (version 16).
Value applied:	0.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The aerobic pond 1 is poorly managed and overloaded.
Any comment:	-

Data / Parameter:	**$B_{o,ww}$**
Data unit:	kg CH_4/kgCOD
Description:	Methane producing capacity of the wastewater treated in the anaerobic digesters.
Source of data used:	AMS III.H (version 16).
Value applied:	0.25
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC value, as per AMS III.H (version 16).
Any comment:	-

Data / Parameter:	**UF_{BL}**
Data unit:	-
Description:	Model correction uncertainty factor to account for model uncertainties in calculating baseline emissions.
Source of data used:	AMS III.H (version 16).
Value applied:	0.89
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per AMS III.H.
Any comment:	-

Data / Parameter:	**UF_{PJ}**
Data unit:	-
Description:	Model correction uncertainty factor to account for model uncertainties in calculating project emissions.
Source of data used:	AMS III.H (version 16).
Value applied:	1.12
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per AMS III.H.
Any comment:	-

Data / Parameter:	**GWP_{CH4}**
Data unit:	Factor
Description:	Global warming potential of methane.
Source of data used:	IPCC value as in AMS III.H (version 16).
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per IPCC 2006.
Any comment:	-

Data / Parameter:	**$Eff_{flaring}$**
Data unit:	%
Description:	Flaring efficiency
Source of data to be used:	Default flare efficiency
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied	As per the procedure in the "Tool to determine project emissions from flaring gases containing methane". For enclosed flare, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h* then a default flare efficiency of 90% can be used.
QA/QC procedures to be applied:	Regular maintenance shall be carried out to ensure optimal operation of flares.
Any comment:	

Data / Parameter:	$\eta_{BL,captive\ plant}$
Data unit:	%
Description:	The efficiency of the captive grid on-site.
Source of data to be used:	An efficiency of 100% as a conservative default value (refer: paragraph 30(c) in AMS I.C (version 19).
Value applied:	100
Justification of the choice of data or description of measurement methods and procedures actually applied	There are no available efficiency test results (using national/international standards) of units with similar specifications.Information on efficiency of units with similar specifications, using baseline fuel from two or more manufacturers is also not available. Hence, the conservative default value has been used.
QA/QC procedures to be applied:	Not relevant
Any comment:	-

Data / Parameter:	**$P_{biomass\ based\ turbine}$**
Data unit:	MW
Description:	Power generating capacity of biomass based turbine
Source of data to be used:	Name plate capacity of the biomass based turbine.
Value applied	1.6 (1,600 kW)
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the biomass based turbine.
QA/QC procedures to	-

be applied:	
Any comment:	-

Data / Parameter:	$\mathbf{P}_{\mathbf{diesel\ generator1}}$
Data unit:	MW
Description:	Power generating capacity of diesel generator 1
Source of data to be used:	Name plate capacity of the diesel generator 1.
Value applied	0.32 (320 kW)
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the diesel generator 1.
QA/QC procedures to be applied:	-
Any comment:	This parameter is only applicable in Phase I of project activity

Data / Parameter:	$\mathbf{P}_{\mathbf{diesel\ generator,2}}$
Data unit:	MW
Description:	Power generating capacity of diesel generator 2
Source of data to be used:	Name plate capacity of the diesel generator 2.
Value applied	0.32 (320 kW)
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the diesel generator.
QA/QC procedures to be applied:	-
Any comment:	This parameter is only applicable in Phase I of project activity.

Data / Parameter:	$\mathbf{P}_{\mathbf{anaerobic\ digester}}$
Data unit:	MW
Description:	Power requirement for anaerobic digester system in project activity.
Source of data to be used:	Name plate wattage of the anaerobic digester system, manufacturer's specifications or catalogue references.
Value applied	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity consumed by the anaerobic digester system.
QA/QC procedures to	-

be applied:	
Any comment:	This parameter is only applicable in Phase I of project activity.

Data / Parameter:	$\mathbf{N_{digesters}}$
Data unit:	Hours
Description:	Number of operating hours of anaerobic digesters.
Source of data to be used:	Design operational hours of the digesters
Value applied	8,760
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity consumed by the anaerobic digester system.
QA/QC procedures to be applied:	-
Any comment:	

Data / Parameter:	$\mathbf{N_{biomass\ based\ turbine}}$
Data unit:	Hours
Description:	Number of operating hours of biomass based turbine.
Source of data to be used:	Expected operational hours of the biomass based turbine.
Value applied	7,300
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the biomass based turbine.
QA/QC procedures to be applied:	-
Any comment:	

Data / Parameter:	$\mathbf{N_{diesel\ generator1,y}}$
Data unit:	Hours
Description:	Number of operating hours of diesel generator 1
Source of data to be used:	Expected operational hours of diesel generators.
Value applied	2,920
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the diesel generator.
QA/QC procedures to	-

be applied:	
Any comment:	

Data / Parameter:	**$N_{diesel\ generator2,}$**
Data unit:	Hours
Description:	Number of operating hours of diesel generator 2.
Source of data to be used:	Expected operational hours of diesel generators.
Value applied	2,920
Justification of the choice of data or description of measurement methods and procedures actually applied:	The data is used in the *ex-ante* calculation of total electricity generated by the diesel generator.
QA/QC procedures to be applied:	-
Any comment:	

Data / Parameter:	***NCV_{biogas}***
Data unit:	TJ/Gg
Description:	Net calorific value of the biogas generated from the anaerobic digesters.
Source of data to be used:	IPCC 2006 default value as per Table 1.2. Volume 2 Chapter 1.
Value applied	100
Justification of the choice of data or description of measurement methods and procedures actually applied:	Since no on-site measurement of the NCV of biogas is available, upper-limit of IPCC 2006 value is used for conservativeness.
QA/QC procedures to be applied:	-
Any comment:	The upper-limit of IPCC 2006 value is used for conservativeness. This is used only in the *ex-ante* estimation of the project emissions from flaring in 2nd to 21st year (i.e. Phase II, when biogas engine is implemented).

Data / Parameter:	***ρ_{biogas}***
Data unit:	kg/m^3
Description:	Density of biogas
Source of data to be used:	Data from the following source is used: http://biomass.ucdavis.edu/materials/calculator/EconCalculator_Biogas.xls
Value applied	1.112
Justification of the choice of data or description of measurement methods	Since there is no available measurement available for the density of the biogas on-site and there is no default value available from the IPCC 2006 guideline, the default value from the above source is used.

and procedures actually applied:	
QA/QC procedures to be applied:	-
Any comment:	This is used only in the *ex-ante* estimation of the project emissions from flaring in 2nd to 21st year (i.e. Phase II, when biogas engine is implemented).

Data / Parameter:	$\rho_{CH4,n}$
Data unit:	kg/m^3
Description:	Density of methane at normal condition.
Source of data to be used:	Default value from "Tool to determine project emissions from flaring gases containing methane"
Value applied	0.716
Justification of the choice of data or description of measurement methods and procedures actually applied:	Default value as per "Tool to determine project emissions from flaring gases containing methane" (Annex13- EB 28)
QA/QC procedures to be applied:	For *ex-post* calculation, any changes in the default value from the tool will be monitored and applied accordingly.
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

Baseline emissions

AMS III.H (version 16): Methane recovery by anaerobic digesters

As mentioned in section B.6.1., the baseline emission for the methane recovery is calculated as follow:

$$BE_y = BE_{ww,treatment,y} + BE_{ww,discharge,y}$$

$$BE_{ww,treatment,y} = (Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * DF * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * (COD_{ww,discharge,BL,y} * DF) * MCF_{ww,BL,discharge}$$

Discount factor (DF) of 0.89 is accounted since the baseline parameters were collected from 10 days measurement campaign in the baseline treatment system (i.e. open anaerobic ponds system).

$BE_{ww,treatment,y}$ = 219,000 m^3 * (0.05285 tonnes COD/m^3 * 77.53% * 0.89 * 0.8) * 0.25 tonnes CH_4/tonnes COD * 0.89 * 21
= 29,853 tCO_{2e}

$BE_{ww,discharge,y}$ = 214,839 m^3 * 21 * 0.25 tonnes CH_4/tonnes COD * 0.89 * (0.011876 tonnes COD/m^3 * 0.89) * 0.3
= 3,183 tCO_{2e}

Total baseline emission from methane recovery (*BE)*:

$BE_{methane\ recovery,y}$ = 29,853 tCO_{2e} + 3,183 tCO_{2e} = 33,036 tCO_{2e}

<u>AMS I.C (version 19): Power generation by biogas engine</u>

$BE_{captelec,y}$ = (P_{biogas} * N_{biogas} / 100%) * 3.6 GJ/MWh * $EF_{BL,diesel,CO2}$
= (0.5 MW * 8,760 hours / 100%) * 3.6 GJ/MWh * 0.0741 tCO_2/GJ
= 1,168 tCO_2

Baseline emission for power generation ($BE_{power\ generation}$) = 1,168 tCO_2 = 1,168 $tCO_{2e.}$

Project emissions

<u>AMS III.H (version 16): Methane recovery by anaerobic digesters</u>

As explained in section B.6.1, the emission from project activity is as follow:

<u>Emission from power consumption (applies in the Phase I of project activity)</u>

$PE_{power} = P_{anaerobic\ digester} * N_{digesters} * EF_{CO2\ captive\ grid,y}$

$EF_{CO2\ captive\ grid,y} = \sum(FC_{i,y} * NCV_i * EF_{CO2,i}) / EG_y$
$= (Q_{biomass,y} * NCV_{biomass} * 0 + FC_{diesel,y} * NCV_{diesel} * EF_{diesel}) / EG_y$

$FC_{diesel,y} = (\rho_{diesel} * Q_{diesel,y})$ / 1,000
= (0.841 g/ml * 264,897 litres * 1,000 ml/litres) / (10^6 tonnes/g)
= 222.78 tonnes

In Phase I :
$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,y} + P_{diesel} * N_{diesel\ generators,y}$
= 1.6 MW * 7,300 hours + 0.64 MW * 2,920 hours
= 13,548.8 MWh

$EF_{CO2\ captive\ grid,y}$ = (222.78 tonnes * 43.3 GJ/tonne * 0.0748 tCO_{2e}/GJ) / 13,548.8MWh
= 0.0533 tCO_2/MWh

PE_{power} = 0.1 MW * 8,760 hours * 0.0533 tCO_2/MWh = 47 tCO_{2e}

<u>In Phase II:</u>

$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,y} + P_{diesel} * N_{diesel\ generators,y} + EG_{captelec,PJ,y}$
= 1.6 MW * 7,300 hours + 0.64 MW * 2,920 hours + 4,380 MWh
= 17,928.8 MWh

$EF_{CO2\ captive\ grid,y}$ = (222.78 tonnes * 43.3 GJ/tonne * 0.0748 tCO_{2e}/GJ) / 17,928.8 MWh
= 0.0402 tCO_2/MWh

PE_{power} = 0.1 MW * 8,760 hours * 0.0402 tCO_2/MWh = 35 tCO_{2e}

Emission from discharge of wastewater to aerobic pond 1

$PE_{y,ww,discharge} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{PJ} * COD_{ww,discharge,PJ,y} * MCF_{ww,PJ, discharge}$
= 214,839 m^3 * 21 * 0.25 tonnes CH_4 / tonnes COD * 1.12 * 0.005285 tonnes COD/m^3 * 0.3
= 2,003 tCO_{2e}

Fugitive emission

$MEP_{ww,treatment,y} = Q_{ww,y,treated} * B_{o,ww} * UF_{PJ} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}$
= 219,000 m^3 * 0.25 tonnes CH_4/tones COD * 1.12 * 0.04757 tonnes COD/m^3 * 0.8
= 2,333.593 tonnes CH_4

$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4}$
= (1 - 0.9) * 2,333.593 * 21 = 4,900 tCO_{2e}

$PE_{fugitive,y} = PE_{fugitive,ww,y}$ = 4,900 tCO_{2e}

Flaring emission

For year 1 of the crediting period (i.e. when biogas engine is not implemented yet):

$PE_{flare,y} = BE_{ww,treatment,y} / GWP_{CH4} * (1-\eta_{flare,h}) * GWP_{CH4}$
$= BE_{ww,treatment,y} * (1-\eta_{flare,h})$ = 29,853 * (1-0.9) = 2,985 tCO_{2e}

For year 2 – year 21 of the crediting period (i.e. when biogas engine is implemented) :

$BG_{combusted\ in\ biogas\ engine,,y} = (EG_{captelec,PJ,y} * 0.0036\ TJ/MWh) / ((NCV_{biogas} * \rho_{biogas}) / 1,000,000\ kg/Gg)$
= (4,380 MWh * 0.0036 TJ/MWh) / ((100 TJ/Gg * 1.112 kg/m^3) / 1,000,000 kg/Gg)
= 141,798.56 m^3

$TM_{RG,h} = BE_{ww,treatment,y} / GWP_{CH4} – (BG_{recovered,y} * w_{CH4,y} * \rho_{CH4,n}) / 1,000$
= 29,853 tCO_{2e} / 21 – ((141,798.56 m^3 * 0.65 * 0.716 kg/m^3) / 1,000 kg/tonne)
= 1,421.57 – 65.993 = 1,355.577 tonnes CH_4

$PE_{flare,y} = TM_{RG,h} * (1-\eta_{flare,h}) * GWP_{CH4}$ = 1,355.577 * (1-0.9) * 21 = 2,847 tCO_{2e}

AMS I.C (version 19): Power generation by biogas engine

As mentioned in Section B.6.1, during the phase when the biogas engine is in operational, the electricity consumed (by the biogas engine) from the captive grid will be generated from biogas and biomass. In addition, any required quantity of diesel to be combusted to meet the electricity demand of the on-site facilities (in addition to the electricity supplied by the biomass based turbine) is assumed zero for *ex-ante* calculations. Hence, there is no project emission for this component.

$PE_{power\ generation}$ = 0 tCO_{2e}

Leakage

According to paragraph 31 AMS III.H (version 16) if the technology is using equipment from another activity, leakage effects at the site of the other activity are to be considered and estimated. However, in this project activity new power generation equipment is to be installed. Therefore there will be no leakage to be considered.

According to paragraphs 47 and 48 of AMS I.C (version 19), leakage will be considered in the following conditions:

1. If the energy generating equipment currently being utilised is transferred from outside the boundary to the project activity
2. In case collection/processing/transportation of biomass residues is outside the project boundary.

The project activity does not involve transferring energy generating equipment and biomass residues from outside the project boundary. Thus, there is no leakage to be considered.

Emission reduction

Emission reduction (ER) of the project activity follows the following equation:

For the first year (Phase I):

ER $= (BE_{power\ generation,y} + BE_{methane\ \mathrm{recovery},y}) - (PE_{power\ generation,y} + PE_{wastewater\ discharge,y} + PE_{fugitive,y} + PE_{power,y} + PE_{flaring,y}) - \text{Leakage}$

$= (0 + 33{,}036) - (0 + 2{,}003 + 4{,}900 + 47 + 2{,}985) - 0$

$= 23{,}101\ tCO_{2e}$

From the second year onwards (Phase II):

ER $= (BE_{power\ generation,y} + BE_{methane\ \mathrm{recovery},y}) - (PE_{power\ generation,y} + PE_{wastewater\ discharge,y} + PE_{fugitive,y} + PE_{power,y} + PE_{flaring,y}) - \text{Leakage}$

$= (1{,}168 + 33{,}036) - (0 + 2{,}003 + 4{,}900 + 35 + 2{,}847) - 0$

$= 24{,}419\ tCO_{2e}$.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO2e)
2012-2013	9,935	33,036	0	23,101
2013-2014	9,785	34,204	0	24,419
2014-2015	9,785	34,204	0	24,419
2015-2016	9,785	34,204	0	24,419
2016-2017	9,785	34,204	0	24,419
2017-2018	9,785	34,204	0	24,419
2018-2019	9,785	34,204	0	24,419
	68,645	238,260	0	169,615

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$EF_{CO2\ captive\ grid,y}$
Data unit:	tCO_2/MWh
Description:	Emission factor of the captive grid in year *y*.
Source of data to be used:	Calculated based on others monitored parameters.
Value applied:	Phase I: 0.0533 Phase II: 0.0402
Justification of the choice of data or description of measurement methods and procedures actually applied	As per paragraph 12 b) of AMS I.D version 17, the emission factor of the captive grid is calculated as weighted average emissions of the power generation mix during crediting period (i.e. electricity generated by biomass based turbine, diesel generators and biogas engine). The emission factor of the captive grid will be calculated based on the actual power generation of the biomass based turbine, diesel generators and biogas engine (in Phase II) which are also monitored *ex-post*.
QA/QC procedures to be applied:	Power generation of the biomass based turbine,diesel generators and biogas engine will be monitored during the crediting period.
Any comment:	The detail information on how captive grid emission factor had been calculated is provided in Annex 4 of this PDD.

Data / Parameter:	$EG_{biomass\ based\ turbine}$
Data unit:	MWh
Description:	Annual electricity generated by the biomass based turbine and supplied to the on-site facilities.
Source of data to be used:	Daily operations log book.
Value applied	11,680

Description of measurement methods and procedures to be applied:	The total net electricity generated by the biomass based turbine will be measured using sophisticated electricity meters. The data will be measured continuously and aggregated monthly. The measured data will be recorded on the log book and archived electronically.
QA/QC procedures to be applied:	Calibration: The electricity meter will be calibrated at least/not less than once in three years. Accuracy/class: the accuracy class of the electricity meter will be verified during the first verification.
Any comment:	If the unit of electrical energy generated and recorded in the log book is not in MWh (i.e. kWh), unit conversion will be applied. The meter is located at the mill MCCB panel. The location of the meter is labelled as number one (1) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**$EG_{diesel\ generator1}$**
Data unit:	MWh
Description:	Annual electricity generated by diesel generator 1 and supplied to the on-site facilities.
Source of data to be used:	Daily operations log book.
Value applied	934.4
Description of measurement methods and procedures to be applied:	The total net electricity generated by diesel generator 1 will be measured using sophisticated electricity meters. The data will be measured continuously and aggregated monthly. The measured data will be recorded on the log book and archived electronically.
QA/QC procedures to be applied:	Calibration: The electricity meter will be calibrated at least/not less than once in three years. Accuracy/class: the accuracy class of the electricity meters will be verified during the first verification.
Any comment:	If the unit of electrical energy generated and recorded in the log book is not in MWh (i.e. kWh), unit conversion will be applied. The meter is located at mill MCCB panel. The location of the meter is labelled as number two (2) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**$EG_{diesel\ generator\ 2}$**
Data unit:	MWh
Description:	Annual electricity generated by diesel generator 2 and supplied to the on-site facilities.
Source of data to be used:	Daily operations log book.
Value applied	934.4
Description of measurement methods	The total net electricity generated by diesel generator 2 will be measured using sophisticated electricity meters. The data will be measured continuously and

and procedures to be applied:	aggregated monthly. The measured data will be recorded on the log book and archived electronically.
QA/QC procedures to be applied:	Calibration: The electricity meter will be calibrated at least/not less than once in three years. Accuracy/class: the accuracy class of the electricity meter will be verified during the first verification.
Any comment:	If the unit of electrical energy generated and recorded in the log book is not in MWh (i.e. kWh), unit conversion will be applied. The meter is located at mill MCCB panel. The location of the meter is labelled as number three (3) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**$EC_{captive\ grid}$**
Data unit:	MWh
Description:	Annual electricity supplied from the captive grid to the project.
Source of data to be used:	Daily operations log book.
Value applied	876
Description of measurement methods and procedures to be applied:	The total net electricity supplied from the captive grid to the project will be measured using current transformer (CT) meter. The data will be measured continuously and aggregated monthly. The measured data will be recorded on the log book and archived electronically.
QA/QC procedures to be applied:	Calibration: The electricity meter will be calibrated at least/not less than once in three years. Accuracy/class: the class of the electricity meter used is 1.00 A / 0.00 R.
Any comment:	If the unit of electrical energy generated recorded in the log book is not in MWh (i.e. kWh), unit conversion will be applied. The meter will be located at the composting plant MCCB panel. The location of the meter is labelled as number four (4) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**$Q_{diesel,y}$**
Data unit:	Litres
Description:	Volume of diesel fuel used in diesel generators in year *y*.
Source of data to be used:	Measurement by project proponent(s).
Value of data	264,897
Description of measurement methods and procedures to be applied:	The volume of diesel fuel will be measured and recorded daily using a diesel flow meter.
QA/QC procedures to	The consistency of metered diesel consumption quantities will be cross-checked

be applied:	by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased diesel invoices can be identified for the CDM project, the metered diesel consumption quantities will also be cross-checked with available purchase invoices from the financial records. Calibration: the diesel flow meter will be calibrated at least / not less than once in three years. Accuracy/class: the accuracy of the diesel flow meter will be verified during the verification.
Any comment:	The diesel flow meter is located after diesel storage tank. The location of the hose is labelled as number five (5) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$\rho_{,y}$
Data unit:	Mass unit / volume unit (e.g. g/ml).
Description:	Weighted average density of diesel used in year *y*.
Source of data to be used:	Default international value provided by IEA is used.
Value of data	0.841 g/ml
Description of measurement methods and procedures to be applied:	Since no value from supplier is available and default value has been used, this measurement method is not applicable.
QA/QC procedures to be applied:	Any revision from the default value by IEA will be taken into account.
Any comment:	This is applicable when quantity of fuel is measured in volume unit (i.e. $Q_{diesel,y}$).

Data / Parameter:	$NCV_{i,y}$
Data unit:	GJ/tone
Description:	Weighted average net calorific value of diesel in year *y*.
Source of data to be used:	Table 1.2. of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value of data	43.3
Description of measurement methods and procedures to be applied:	Since no value from supplier is available and default value has been used, this measurement method is not applicable.
QA/QC procedures to be applied:	Any revision from the IPCC guidelines will be taken into account.
Any comment:	In the absence of value provided by supplier of fuel, the upper-limit value of IPCC 2006 is used.

Data / Parameter:	EF_{diesel}
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of the diesel used in year *y*.
Source of data to be used:	Table 1.4. of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value of data	0.0748

Description of measurement methods and procedures to be applied:	Since no value from supplier is available and default value has been used, this measurement method is not applicable.
QA/QC procedures to be applied:	Any revision from the IPCC guidelines will be taken into account.
Any comment:	In the absence of data from supplier of diesel, the upper-limit IPCC value is used.

Data / Parameter:	$\mathbf{EG_{captelec,PJ,y}}$
Data unit:	MWh
Description:	Annual quantity of electricity generated by the biogas energy generation system to the captive grid
Source of data to be used:	Measurement by project proponent(s).
Value of data	4,380
Description of measurement methods and procedures to be applied:	Measured using calibrated electricity meters. Continuous monitoring, integrated hourly and at least monthly recording. The measured data will be recorded on the log book and archived electronically.
QA/QC procedures to be applied:	Calibration: the electricity meter will be calibrated at least / not less than once in three years. Accuracy/class: the accuracy class of the electricity meters will be verified during the first verification.
Any comment:	The location of the meter is labelled as number six (6) in diagram provided in Annex 4 of this PDD.

Data / Parameter	$\mathbf{Q_{ww,in,,y}}$
Data unit:	m^3/month
Description:	Monthly flow of untreated wastewater entering the anaerobic digester in project activity.
Source of data to be used:	Measurement by project proponent(s).
Value of data	18,250
Description of measurement methods and procedures to be applied:	Measurements are undertaken by using two 3" electromagnetic flow meters at inlet to the feeding tank before anaerobic digester. Daily data from the flow meter will be recorded in log book and aggregated monthly.
QA/QC procedures to be applied:	The measurements will be monitored continuously. Calibration: The flow meter will be calibrated at least / not less than once in three years. Accuracy/class: ±0.5%
Any comment:	The flow meters are located at the pipes entering anaerobic digester 1 and 2. The location of the meter is labelled as number seven (7) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$Q_{ww,discharge,y}$
Data unit:	m^3/month
Description:	Monthly flow of treated wastewater discharged from anaerobic digester system which will enter aerobic pond 1 in project activity.
Source of data to be used:	Measurement by project proponent(s).
Value of data	17,903.25
Description of measurement methods and procedures to be applied:	Measurements are undertaken by using a 4” electromagnetic flow meter located after the second clarifier (prior to subsequent aerobic pond). Daily data from the flow meter will be recorded in log book and aggregated monthly.
QA/QC procedures to be applied:	The measurements will be monitored continuously. Calibration: The flow meter will be calibrated at least / not less than once in three years. Accuracy/class: ±0.5%
Any comment:	The flow meter is located after the clarifier 2. The location of the meter is labelled as number eight (8) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$COD_{untreated,y}$
Data unit:	$tCOD/m^3$
Description:	Chemical oxygen demand of the wastewater entering the Anaerobic Digester 1.
Source of data to be used:	Measurement by project proponent(s).
Value of data	0.05285
Description of measurement methods and procedures to be applied:	Measurement of the COD is according to national or international standards and done by external accredited laboratory.
QA/QC procedures to be applied:	The measurement will be monitored to ensure a 90/10 confidence/precision level.
Any comment:	The location of sampling point is labelled as number nine (9) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$COD_{discharge,y}$
Data unit:	$tCOD/m^3$
Description:	Chemical oxygen demand of the wastewater discharged to the subsequent poorly managed aerobic pond.
Source of data to be used:	Measurement by project proponent(s).
Value of data	0.005285
Description of measurement methods and procedures to be applied:	Measurement of the COD is according to national or international standards and done by external accredited laboratory.
QA/QC procedures to be applied:	The measurement will be monitored to ensure a 90/10 confidence/precision level.

Any comment:	The location of the sampling point is labelled as number ten (10) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$\mathbf{BG_{burnt,,y}}$
Data unit:	m^3
Description:	Annual volume of biogas burnt in the flaring system in the dry basis in year *y*.
Source of data to be used:	Measurement by project proponent(s).
Value of data	4,320,342
Description of measurement methods and procedures to be applied:	The amount of biogas burnt in the flaring system will be measured using calibrated flow meter. Daily data from flow meter will be recorded in log book, aggregated monthly and archived electronically.
QA/QC procedures to be applied:	The measurement will be monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 will be attained). Calibration: The flow meter will be calibrated at least / not less than once in three years. Accuracy of the flow meter is to be confirmed during verification.
Any comment:	This parameter is measured by the same flow meter which is also used to measure and monitor $FV_{RG,h.}$ The meter is located after the gas blower shed. The location of the meter is labelled as number eleven (11) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$\mathbf{BG_{recovered,y}}$
Data unit:	m^3
Description:	Annual volume of biogas recovered from the biogas recovery system in the project activity in the dry basis in year *y*.
Source of data to be used:	Measurement by project proponent(s).
Value of data	4,462,141
Description of measurement methods and procedures to be applied:	The total amount of biogas recovered from the biogas recovery system is measured and monitored using a calibrated flow meter continuously. Daily data from flow meter will be recorded in log book, aggregated monthly and archived electronically.
QA/QC procedures to be applied:	The measurement will be monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 will be attained). Accuracy of the flow meter: a.) When the flow is above the limit value (Qt) : accuracy is ±1.5% of the measured value.

	b.) When the flow is below the limit value (Qt): accuracy is ±5% of the measured value. Frequency of calibration: The meter will be calibrated at least / not less than once in three years.
Any comment:	The meter is located after the gas blower shed. The location of the meter is labelled as number twelve (12) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	$\mathbf{w_{CH4,y}}$ **/** $\mathbf{fv_{CH4,h}}$
Data unit:	Fraction
Description:	Volumetric fraction of methane in biogas.
Source of data to be used:	Measurement by project proponent(s).
Value of data	-
Description of measurement methods and procedures to be applied:	The fraction of methane in the biogas will be measured hourly by using gas analyzer at a 90/10 confidence/precision level, recorded daily and archived electronically. The equipment will be able to measure methane directly in the biogas. The measurement will be carried out close to a location in the system where a biogas flow measurement takes place. The same dry basis measurement will be ensured between this parameter and measurement of biogas flow rates (i.e. $BG_{burnt,y}$; $BG_{recovered,y}$ and $FV_{RG,h}$).
QA/QC procedures to be applied:	Calibration: the analyzer will be calibrated at least / not less than once in three years. A zero check and a typical value check will be performed by comparison with a standard certified gas. The accuracy of the analyzer will be verified during verification.
Any comment:	The location of the analyzer is labelled as number thirteen (13) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**T**
Data unit:	^{o}C
Description:	Temperature of the biogas.
Source of data to be used:	Measurement by project proponent(s).
Value of data	-
Description of measurement methods and procedures to be applied:	The temperature of the biogas is required to determine the density of the methane combusted. The temperature will be monitored continuously by temperature meter, recorded on log book and archived electronically.
QA/QC procedures to be applied:	The temperature of the biogas will be measured at the same time when methane content in biogas ($w_{CH4,y}$/$fv_{CH4,h}$) is measured.

	Accuracy class: a.) For temperature span ≤ 250°C: accuracy is <0.25°C. b.) For temperature span > 250°C: accuracy is 0.1% of the span. Frequency of calibration: The temperature meter will be calibrated at least / not less than once in three years.
Any comment:	The location of the meter is labelled as number fourteen (14) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of the biogas.
Source of data to be used:	Measurement by project proponent(s).
Value of data	-
Description of measurement methods and procedures to be applied:	The pressure of the biogas is required to determine the density of the methane combusted. The pressure will be measured continuously by pressure transmitter, recorded on log book and archived electronically.
QA/QC procedures to be applied:	The pressure of the biogas will be measured at the same time when methane content in biogas ($w_{CH4,y}$) is measured. The accuracy class of this meter will be verified during verification. Frequency of calibration: The pressure meter will be calibrated at least / not less than once in three years.
Any comment:	The location of the meter is labelled as number fifteen (15) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*.
Source of data to be used:	Measurement by project proponent(s) by using flow meter.
Value of data	-
Description of measurement methods and procedures to be applied:	The flow will be monitored continuously and values are to be averaged hourly or at a shorter interval. Dry basis measurement will be conducted for this parameter (i.e. the same basis of measurement as for the volumetric fraction of methane in biogas).
QA/QC procedures to be applied:	Accuracy of the flow meter is to be confirmed during verification. Frequency of calibration: The meter will be calibrated at least / not less than once in three years.
Any comment:	This parameter is measured using the same flow meter which is also used to measured and monitored $BG_{burnt,y}$. The meter is located at enclose flare area. The location of the meter is labelled as

	number eleven (11) in diagram provided in Annex 4 of this PDD.

Data / Parameter:	T_{flare}
Data unit:	^oC
Description:	Temperature of the exhaust gas of the flare.
Source of data to be used:	Measurements by project proponent(s).
Value of data	-
Description of measurement methods and procedures to be applied:	AType N thermocouples are used to measure the temperature of the exhaust gas stream. A temperature of above 500^oC indicates that a significant amount of gases are still being burnt and the flare is operating. Temperature will be monitored continuously. Thermocouple N type: Simplex, Ungrounded, Head: Weather proof IP-67. Terminal and ceramic block, cable entry: ½" NPT (F) with cable gland, length: 400mm below head.
QA/QC procedures to be applied:	Calibration: the thermocouple will be calibrated at least / not less than once in three years. Accuracy/class: the accuracy of the thermocouple will be verified during the first verification.
Any comment:	An excessively high temperature at the sampling point (above 700^oC) will be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. Temperature of the exhaust gas from the flare will be monitored and maintained at above 500^oC for more than 40 minutes every hour and the manufacturer's specification on proper operation of the flare will be met continuously in order to comply with the requirement to use default flare efficiency of 90%. The thermocouples are located at the enclosed flare. The location of the thermocouple is labelled as number sixteen (16) in diagram provided in Annex 4 of this PDD.

B.7.2 Description of the monitoring plan:

The monitoring team of this project activity comprises of plant technician, plant manager, and general manager. The plant technician will be in charge in the daily monitoring of the process in accordance to the quality assurance and control of each parameter. In addition, the plant technician will be responsible in recording the monitored data and report any abnormalities to plant manager in daily basis. The monitored and recorded data will be stored electronically and in hard copy format up to 2 years after the end of crediting period or the last issuance of CERs, whichever is later. The monitored and recorded data will be used and presented to DOE.

Plant manager will be responsible in reviewing the monitored data for the completeness and also correcting any data when required. Plant manager will also in charge in the verification of the data and calculation of emission reduction.

The general manager of the project activity will be responsible in the final review of the monitoring plan. As the plant manager, general manager is also responsible in making any required correction in the monitored data. Monitoring report will need to be endorsed by the general manager.

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

The baseline and monitoring study was completed on 10/02/2011 by:

Saremas Sdn Bhd
38 Jalan Sultan Ismail
15th floor, Wisma Jerneh, Kuala Lumpur
Tel: +60-3-2119-9000
Email: joshualim@wilmar.com.sg (responsible person: Mr. Joshua Lim)

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

12/02/2010[18]

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:

The crediting period used for this project activity is renewable.

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

31/10/2012 or the date of CDM registration, whichever is later.

C.2.1.2. Length of the first crediting period:

7 years

[18] As per the Guidelines for Completing the Simplified Project Design Document (version 5), the starting date of a CDM project activity is the earliest date of the (1) implementation; or (2) construction; or (3) real action of a project activity. Using this definition, the start date of the project activity is the date where real action starts, i.e. the award of the EPC contract, which is 12/02/2010.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

The project activity does not require an environmental impact assessment, as per letter from the Department of Environment (locally called "Jabatan Alam Sekitar, Negeri Sarawak"). The letter reference is 000/001.jld.7(26) dated 21 May 2010.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

The project participant invited interested local stakeholders to attend a meeting on 19 November 2009 at Saremas Club House. In all, 43 participants attended this meeting. The meeting was chaired by Mr. Henry Gasah.

The agenda of the meeting was as follows:

1. Opening remark by Mr. Henry Gasah

2. Presentation by mill manager Mr. Alvin Justin with topics as follows:
   - Sources and impacts of global warming in general and how POME treatment plant can be one of the sources of global warming.
   - Introduction to Clean Development Mechanism (CDM) under Kyoto Protocol and its benefits.
   - Biogas generation in Palm Oil Industry and its potential as fuel replacement
   - Methane gas collection and usage

3. Question and answer (Q&A) session

4. Explanation on company's procedure on communication and negotiations

5. Distribution of complaint forms to the local stakeholders

6. Conclusion

E.2. Summary of the comments received:

The local stakeholders did not raise any objections or concerns about the proposed project. The local stakeholders agreed and supported the project activity as it gives positive impact in reducing the impact of global warming. Some of the local stakeholders requested whether the generated electricity can be distributed to the nearby long houses.

E.3. Report on how due account was taken of any comments received:

Query 1 from Tuai Rumah Gundi, Tuai Rumah Tapu, Representative Tuai Rumah Bunsu and Ketua Kampung Sri Jaya: Request the goodwill of the company to distribute the generated electricity to surrounding long houses

PP's response to Query # 1: Company cannot promise anything as this project is still in the early stages

Query 2 from Representative from SK Suai 1(Government School), Mr Siew: whether the same technology can be applied in the domestic waste from school

PP's response to Query #2: The technology cannot be applied to domestic waste from school as it is a mixture of both organic and non-organic waste while the project's wastewater is more to organic waste.

Query 3 from Representative from NREB, Mr Dau: request the detail of cost to implement the project and whether the same project has been done before by other companies in Sarawak. He also suggested that NREB was willing to promote the project to other palm oil mills if the cost is reasonable.

PP's response to Query #3: The cost to implement the project is very high however companies who are willing to embark on this type of project are able to seek financial help as it is a CDM project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Saremas Sdn Bhd
Street/P.O.Box:	38 Jalan Sultan Ismail
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URL:	www.wilmar-international.com
Represented by:	-
Title:	Project Manager
Salutation:	Mr
Last Name:	Lim
Middle Name:	Chian Yieh
First Name:	Joshua
Department:	Project/CSR
Mobile:	-
Direct FAX:	-
Direct tel:	-
Personal E-Mail:	joshualim@wilmar.com.sg

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FAX:	+45 9939 5999
E-Mail:	-
URL:	http://www.neas.dk/
Represented by:	-
Title:	Head of Climate Centre
Salutation:	Mr
Last name:	Andersen
Middle name:	Treumer
First name:	Rene
Department:	-
Mobile:	-
Direct FAX:	-
Direct tel:	-
Personal e-mail:	rta@neas.dk

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is availed in this project.

Annex 3

BASELINE INFORMATION

The result from 10 Days measurement campaign in the baseline wastewater treatment system is presented in the following table.

Chemical Oxygen Demand (COD)

Day	Date	$Q_{ww,in}$ (m^3/day)	$Q_{ww,out}$ (m^3/day)	COD_{in} (mg/L)	COD_{out} (mg/L)
1	12/10/2010	872.966	1,193.890	53,625	10,250
2	13/10/2010	924.423	1,181.790	55,250	10,094
3	14/10/2010	896.487	1,124.220	53,875	8,812
4	15/10/2010	829.612	1,101.080	54,125	9,031
5	16/10/2010	896.975	830.630	51,375	20,000
6	17/10/2010	809.234	1,106.550	52,375	14,219
7	18/10/2010	776.784	1,145.550	55,125	14,406
8	19/10/2010	920.867	1,109.340	50,000	10,312
9	20/10/2010	791.688	1,078.260	50,500	12,750
10	21/10/2010	952.488	997.484	52,250	8,906

From the above table, the average value is as follow:
$Q_{ww,in}$ = 867.152 m^3/day
COD_{in} = 52,850 mg/L = 0.05285 tonnes/m^3
COD_{out} = 11,876 mg/L = 0.011876 tonnes/m^3

η_{BL} = ((0.05285 – 0.011876) / 0.05285) * 100% = 77.53 %

The design flow rate of the anaerobic digesters system is as follow:
$Q_{ww,in}$ = 600 m^3/day = 219,000 m^3/year
$Q_{ww,out}$ = 588.6 m^3/day = 214,839 m^3/year

Since the design flow rate is less than the existing wastewater treatment system's flow rate, therefore the proposed CDM project will only treat part of the total wastewater generated by the palm oil. As a result, the baseline flow rate ($Q_{ww,in}$ and $Q_{ww,out}$) will use the design flow rate.

The electricity generation and diesel consumption data for September 2009 to August 2010 are summarised below.

	Biomass based steam turbine 1	Biomass based steam turbine 2	Diesel generator 1	Diesel generator 2
	(kwh)	**(kwh)**	**(kwh)**	**(kwh)**
September 2009	386,700	-	23,300	10,480
October 2009	557,120	-	13,330	9,990
November 2009	537,680	-	10,160	6,540
December 2009	493,870	11,050	18,570	13,540
January 2010	422,310	-	30,640	18,110
February 2010	313,260	-	22,770	18,350
March 2010	424,850	-	21,500	15,220
April 2010	341,320	480	41,370	23,880
May 2010	299,210	36,760	19,420	23,020
June 2010	342,780	-	35,170	21,030
July 2010	421,050	3,840	35,220	19,050
August 2010	474,080	-	28,330	13,040
Total	**5,014,230**	**52,130**	**299,780**	**192,250**

The others baseline information is included in sections B.6.1, B.6.2 and B.6.3 in this PDD.

Annex 4

MONITORING INFORMATION

The emission factor of the captive grid is calculated as per paragraph 12 of AMS I.D version 17 "Grid connected renewable electricity generation". The calculation is based on the following options:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the Emission Factor for an electricity system".

OR

(b) The weighted average emissions (in t CO_2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

For calculation of the emission factor for the project's captive grid, option (b) is used.

The emission factor of the captive grid is calculated by the following equation:

$$EF_{grid} = (\sum FC_{i,y} * NCV_i * EF_{CO2,i}) / EG_y$$
$$= (Q_{biomass,y} * NCV_{biomass} * 0 + FC_{diesel,y} * NCV_{diesel} * EF_{diesel}) / EG_y$$

$$FC_{diesel,y} = (\rho_{diesel} * Q_{diesel,y}) / 1{,}000$$

In Phase I:

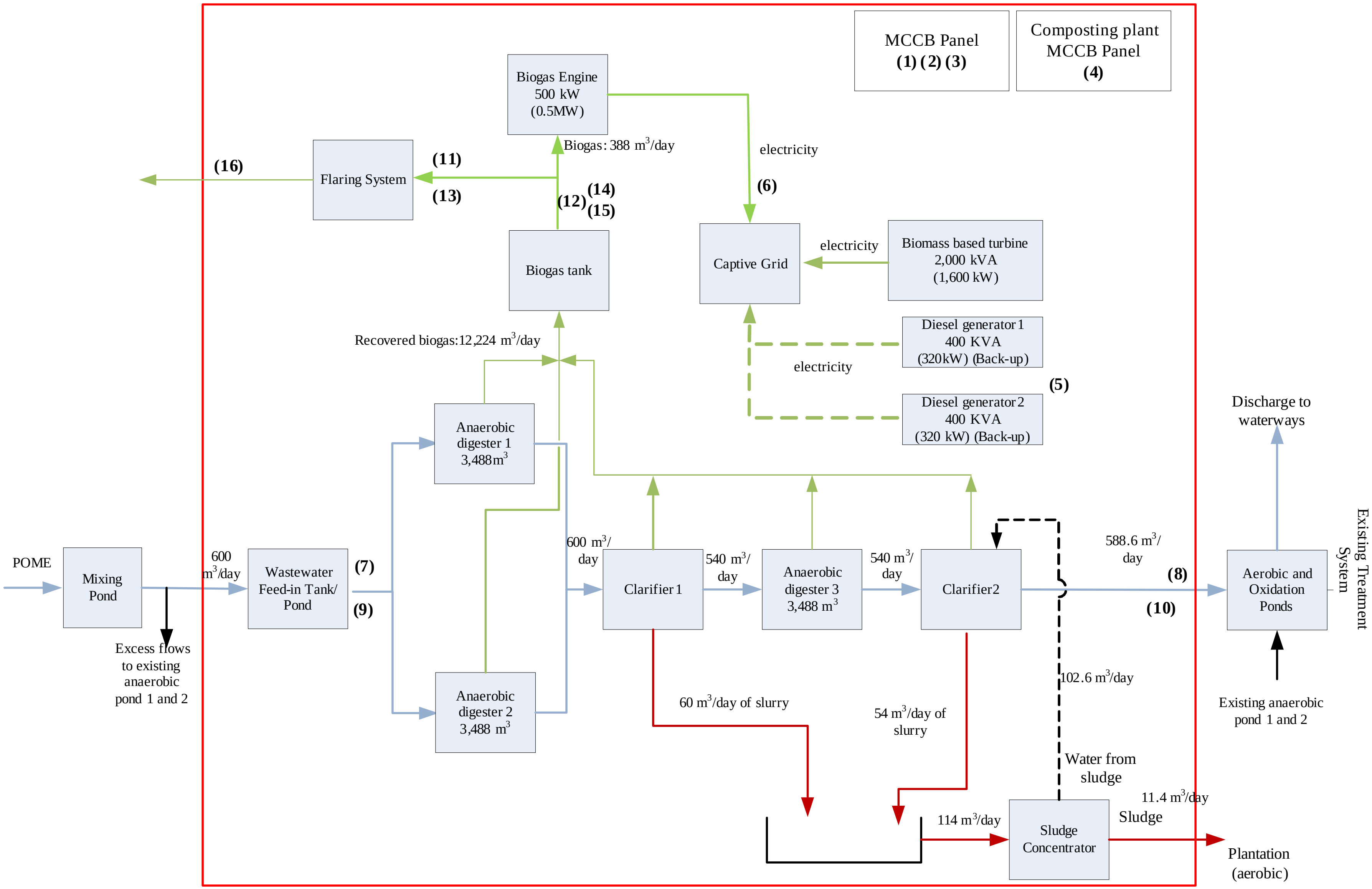
$$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,y} + P_{diesel} * N_{diesel\ generators,y}$$

In Phase II:

$$EG_y = P_{biomass\ based\ turbine} * N_{biomass\ based\ turbine,y} + P_{diesel} * N_{diesel\ generators,y} + EG_{captelec,PJ,y}$$

$Q_{biomass}$	Amount of biomass used for power generation in year *y* (tonnes)
$NCV_{biomass}$	Net calorific value of biomass used for power generation in year *y* (GJ/tonne)
FC_{diesel}	Fuel consumption (i.e. diesel) used in the diesel generators in year *y* (tonnes)
ρ_{diesel}	Density of diesel used in the diesel generators (g/ml)
$Q_{diesel,y}$	Volume of diesel used in the diesel generators in year *y* (litre)
NCV_{diesel}	Net calorific value of diesel used in the diesel generators in year *y* (GJ/tonne)
EF_{diesel}	Emission factor of diesel used in the diesel generators (tCO_{2e} / GJ)
EG_y	Total electrical energy produced in year *y* (MWh)
$P_{biomass\ based\ turbine}$	Power generating capacity of biomass based turbine (MW)
P_{diesel}	Power generating capacity of diesel generators (MW)
$N_{biomass\ based\ turbine,}$	Number of operating hours of biomass boiler (hours)
$N_{diesel\ generators,}$	Number of operating hours of diesel generators (hours)
$EG_{captelec,PJ,y}$	Electricity generated by the biogas engine to the captive grid in year *y* (MWh)

The monitoring information of other parameters is included in section B.7 in this PDD.


MCCB Panel
(1) (2) (3)
Composting plant
MCCB Panel
(4)
Biogas Engine
500 kW
(0.5MW)
Biogas: 388 m3/day
electricity
(6)
(16)
Flaring System
(11)
(13)
(12)
(14)
(15)
Biogas tank
Captive Grid
electricity
Biomass based turbine
2,000 kVA
(1,600 kW)
Diesel generator 1
400 KVA
(320kW) (Back-up)
electricity
(5)
Diesel generator 2
400 KVA
(320 kW) (Back-up)
Recovered biogas:12,224 m3/day
Anaerobic
digester 1
3,488m3
Discharge to
waterways
Existing Treatment
System
POME
Mixing
Pond
600
m3/day
Wastewater
Feed-in Tank/
Pond
(7)
(9)
600 m3/
day
Clarifier 1
540 m3/
day
Anaerobic
digester 3
3,488 m3
540 m3/
day
Clarifier2
588.6 m3/
day
(8)
(10)
Aerobic and
Oxidation
Ponds
Excess flows
to existing
anaerobic
pond 1 and 2
Anaerobic
digester 2
3,488 m3
60 m3/day of slurry
54 m3/day of
slurry
102.6 m3/day
Existing anaerobic
pond 1 and 2
Water from
sludge
11.4 m3/day
Sludge
114 m3/day
Sludge
Concentrator
Plantation
(aerobic)

No.	Measured parameter	Description
1	**$EG_{biomass\ based\ turbine}$**	Power meter to measure annual electricity generated by the biomass based turbine and supplied to the on-site facilities.
2	**$EG_{diesel\ generator1}$**	Power meter to measure annual electricity generated by diesel generator 1 and supplied to the on-site facilities.
3	**$EG_{diesel\ generator\ 2}$**	Power meter to measure annual electricity generated by diesel generator 2 and supplied to the on-site facilities.
4	**$EC_{captive\ grid}$**	Power meter to measure annual electricity supplied from the captive grid to the project.
5	**$Q_{diesel,y}$**	Diesel flow meter to measure volume of diesel fuel used in diesel generators in year *y*.
6	**$EG_{captelec,PJ,y}$**	Power meter to measure annual quantity of electricity generated by the biogas engine system to the captive grid.
7	**$Q_{ww,in,,y}$**	Flow meter to measure volume of untreated wastewater entering the anaerobic digester in project activity.
8	**$Q_{ww,discharge,y}$**	Flow meter to measure volume of treated wastewater discharged from anaerobic digester system which will enter aerobic pond 1 in project activity.
9	**$COD_{untreated,y}$**	Sampling point to measure chemical oxygen demand of the wastewater entering the anaerobic digesters system.
10	**$COD_{discharge,y}$**	Sampling point to measure chemical oxygen demand of the wastewater discharged to the subsequent poorly managed aerobic pond.
11	**$BG_{burnt,y}$ / $FV_{RG,h}$**	Flow meter to measure volume of residual gas burnt in the flaring system.
12	**$BG_{recovered,y}$**	Flow meter to measure volume of recovered biogas by thebiogas recovery system.
13	**$w_{CH4,y}$/ $fv_{CH4,h}$**	Gas analyser to measure the volumetric fraction of methane in biogas.
14	**T**	Temperature meter to measure the temperature of the biogas.
15	**P**	Pressure meter to measure the pressure of the biogas.
16	**T_{flare}**	Temperature meter to measure the temperature of the exhaust gas of the flare.