Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	Biogas recovery from wastewater treatment in PT. Umbul Mas Wisesa Palm Oil Mill	
UNFCCC reference number of the project activity	9197	
Version number of the PDD applicable to this monitoring report	08	
Version number of this monitoring report	06	
Completion date of this monitoring report	04/04/2019	
Monitoring period number	01	
Duration of this monitoring period	16/04/2015 to 30/04/2016	
Monitoring report number for this monitoring report	01	
Project participants	PT Umbul Mas Wisesa	
Host Party	Indonesia	
Sectoral scopes	Sectoral scope 13	
Applied methodologies and standardized baselines	Baseline and monitoring methodology applied: AMS-III.H "Methane recovery in wastewater treatment" (version 16)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO_2e	15553 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	60167 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

>>
The proposed small-scale project activity is the implementation of a sequential stage of anaerobic wastewater treatment system with biogas recovery in a palm oil mill. Both, the palm oil mill as well as the wastewater treatment system with biogas recovery is Greenfield projects. The palm oil mill is located at South Labuhan Batu, North Sumatra, Indonesia. The designed production capacity of the mill is 65 tonnes/hr of fresh fruit bunch ("FFB"). The discharged POME, rich in organic content with Chemical Oxygen Demand (COD) value approximately 65,000 mg/l.

Degradation of organic content in the POME results in the generation of biogas (i.e. methane), which will be emitted into the atmosphere if not recovered. The purpose of the proposed project activity is to treat the discharged POME in an anaerobic digester and to recover the biogas, which would have otherwise been emitted to the atmosphere. The recovered biogas is being combusted together with biomass in a boiler in the palm oil mill and in emergency situation excess biogas being flared. The end use of biogas led to saving of biomass, which would have been used in boiler by the project activity, resulting the saved biomass available to be used by other project activity for steam/power generation displacing fossil fuel, however, the emission reduction due to end use of biogas will not be considered under the proposed project activity.

The construction for project activity started in May 2013, commissioning started in April 2014 and project become operational on 01/04/2015. The project was operational during current monitoring period i.e. from 16/04/2015 to 30/04/2016 the total quantity of POME treated during this verification period is 90691 m^3, which results to a net emission reduction of **15553** tCO_2e.

A.2. Location of project activity

>>
The Project Activity site located at South Labuhan Batu Regency, Kampung Rakyat sub-district, North Sumatra Province, Sumatra Island, Indonesia. The GPS coordinates of the project activity is as follows –

Latitude: 2°12' 50.55"N
Longitude: 100°16' 15.14" E

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Indonesia (host Party)	Private entity - PT Umbul Mas Wisesa	No

A.4. Reference to applied methodologies and standardized baselines

>>
The baseline and monitoring of this project activity is based on the following approved methodology, guidelines and tools:

***Methodology: AMS-III.H (version 16)**: "Methane recovery in wastewater treatment"*

Tools:

- *General guidelines for SSC CDM methodologies (Version 20.0);*
- *Clean development mechanism project standard (Version 07.0);*
- *Guidelines on the Demonstration of Additionality of Small-Scale Project Activities (Version 09.0);*

- *Guidelines for completing the project design document form for small-scale CDM project activities (Version 01.1);*
- *Project emissions from flaring (Version 02.0.0);*
- *Sampling and surveys for CDM project activities and programme of activities (Version 04.1);*
- *Tool to calculate baseline, project and-or leakage emissions from electricity consumption (Version 01);*
- *Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)*

A.5. Crediting period type and duration

>>
This project activity has considered fixed crediting period of 10 years. The start date of the crediting period is from 16/04/2015 to 15/04/2025

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

>>
The technology applied for the project activity is an anaerobic digester system with methane recovery for treatment of POME generated from the palm oil milling operations. The process includes

Up Stream Pre Treatment Systems

The raw wastewater from the process is taken to the effluent treatment plant through closed pipe. Effluent enters into the screen chamber for the removal of floating matter and then enters into the Oil &Grease trap.

Equalization Tank:
The effluent from oil & grease trap enters into the equalization tank for equalization and surge control. Effluent from the equalization tank then pumped into buffer tank through Plate Heat Exchanger (PHE).

Plate Heat Exchanger (PHE):
The raw wastewater from Equalization Tank (EQT) pumped to plate heat exchanger to reduce the temperature.

Dissolve Air Floatation System (DAF)
Effluent from the Plate Heat Exchanger enters in to the Dissolved Air Flotation system. This system is used to remove residual emulsified oil and suspended solids from the effluent to the maximum extent. This DAF is provided as a backup. It is used only when COD of inlet POME is above designed value.

Primary Clarifier:
The effluent from Dissolved Air Flotation then enters into the primary clarifier. The clarifier is a hopper bottom circular tank with centrally driven clarifier mechanism to remove excess solids. It is being used mainly during trouble shooting of process.

Buffer Tank
In buffer tank the complex organics in the wastewater is subjected to hydrolysis. The hydrolyzed effluent pumped from the buffer tank for anaerobic treatment in the reactor.

ANAEROBIC CSTR REACTOR
It is non-media, Continuously Stirrer Tank Reactor. It is mesophillic reactor i.e. it operates best in temp range of 36 – 39 ^{O}C. In reactor the raw waste is introduced from top of the reactor. The recycled sludge is also introduced from the top of the reactor. This mixed liquor travels downward

through the central shaft. In this central shaft, agitator provides adequate mixing of raw waste and recycled sludge. From central shaft liquor enters reactor near bottom of tank.

The solids are separated from the outlet of reactor in Lamella Clarifier and returned to the system by recirculation pumps. This recirculation of settled solids helps to maintain adequate population of active bacteria inside reactor.

The biogas produced by anaerobic digestion inside the reactor is collected from reactor roof. Biogas is then transferred to floating type gas holder. Biogas is then conveyed to blower for further utilization in boiler or biogas engines.

Down Stream Treatment systems

Conventional Aeration Tank:
The overflow from lamella clarifier enters into conventional aeration tank. In Conventional Aeration Tank microorganisms degrade soluble organics aerobically.

Secondary Clarifier-A:
The mixed liquor from Conventional Aeration Tank enters the central well of clarifier–A for separation of sludge and liquid. The clarifier is a hopper bottom circular tank with centrally driven clarifier mechanism.

Extended Aeration Tank:
The overflow of clarifier-A enters into Extended Aeration Tank. In Extended Aeration Tank microorganisms degrade soluble organics aerobically.

Secondary Clarifier-B:
The mixed liquor from Extended Aeration Tank enters the central well of clarifier-B for separation of sludge and liquid. The clarifier is a hopper bottom circular tank with centrally driven clarifier mechanism.

Chlorine Contact Tank
The treated effluent is further subjected to chlorination for disinfection.

De-Chlorine Tank (DCT)
The treated wastewater further subjected to de-chlorination. Sodium Meta Bi Sulphite solution is added to treated wastewater.

Multi Grade Filter (MGF)
De-chlorinated effluent then be pumped to Multi Grade Filter for removal of suspended solids.

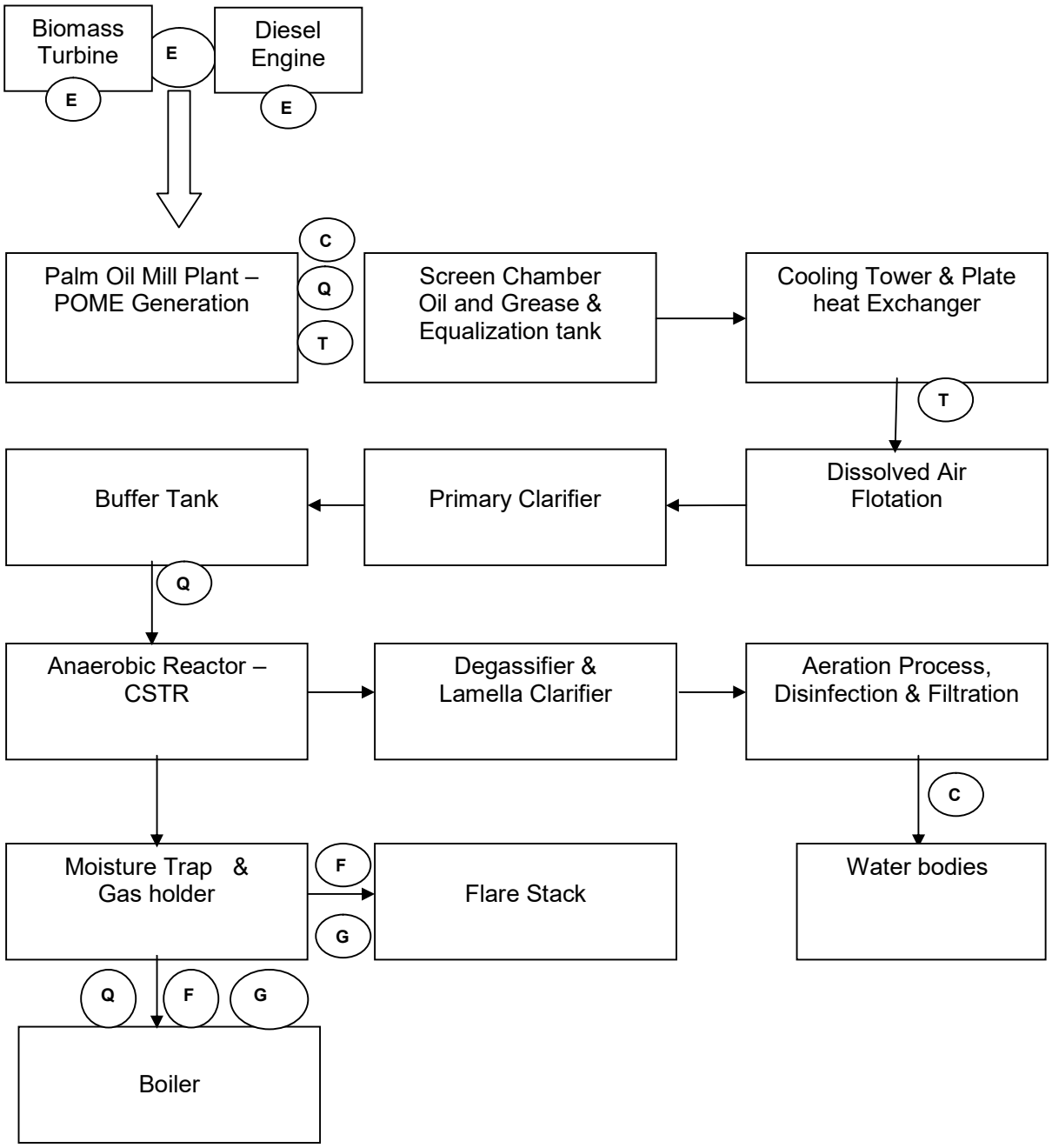
Activated Carbon Filter (ACF)
Effluent will then be pumped from Multi Grade Filter to activated carbon filter for removal of suspended solids, color, odor etc.

The clarified overflow POME from the clarifier will be further treated in the downstream activities. The final treated POME will be discharged to nearby river.

The specification of the anaerobic digester used in the project activity is as follows:

Model	: LESAR reactor
Digester type	: Continuously Stirrer Tank Reactor
Volume	: 8,495 m^3
Hydraulic retention time	: 11 days (=8,495m^3 / 780 m^3/day)
Operating temperature	: 36-39^oC
Volume of biogas	: 0.5 ± 5% m^3/kg COD removed
Expected biogas CH_4 composition	: 60% methane
Design COD removal efficiency	: 85 %
Operational lifetime	: 20 years

The overall process flow diagram applied in the proposed project are shown in the figure below –



Process Flow Diagram

The recovered biogas from the project activity is combusted together with biomass in a boiler. In case there is any excess of biogas, is flared in an open flare system.

The project activity was shut down for 78 days during current monitoring period due to various reasons. Except above the project activity was operational with scheduled operation and maintenance. The construction for project activity started in May 2013, commissioning started in April 2014 and the project activity has been commissioned on 01/04/2015.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

>>
The flare detection system was not installed during current monitoring period, hence flare efficiency has been considered as zero for calculating project emission due to flaring, which is conservative.

B.2.2. Corrections

>>
No corrections are applied in the registered PDD in this monitoring period.

B.2.3. Changes to the start date of the crediting period

>>
No changes to start date of crediting period.

B.2.4. Inclusion of monitoring plan

>>
There is no inclusion of monitoring plan to registered PDD.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>>
There are no permanent changes from registered monitoring plan during current monitoring period.

B.2.6. Changes to project design

>>
There is no change in project design of registered project activity during current monitoring period.

SECTION C. Description of monitoring system

>>
The PP has assigned operational team of the palm oil mill for data monitoring, archiving and analyzing and is reported to the plant's management team.

There is an operational and management team, which is responsible to operate and maintain the wastewater treatment system and implement the monitoring plan.

The team is responsible for daily monitoring of the processes in accordance to the quality assurance and control of each parameter as per the monitoring plan. In addition, a technician responsible in recording the monitored data and report any abnormalities to plant manager on daily basis. The aggregated 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 is used and presented to DOE during CERs verification. The plant manager has reviewed the work performed by the technician and making final reporting to the management of the PP.

The roles and responsibilities performed by the team members are as below:

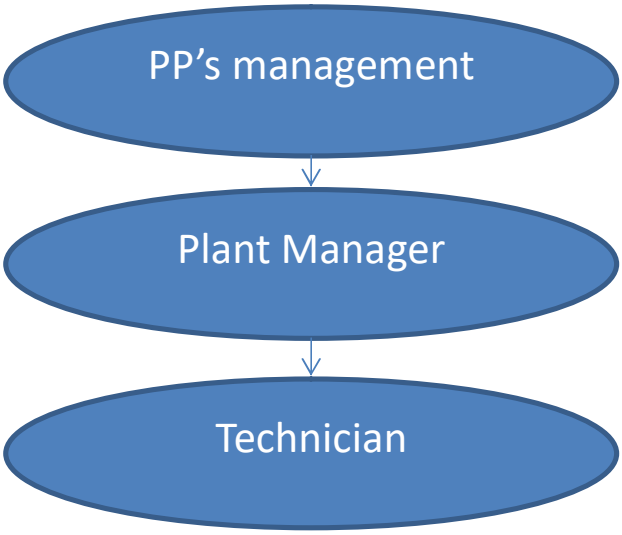


Figure: Organizational Structure

Role	Responsibility description
Technician	• *Data collection* ○ Collect the data on the various monitoring parameters as per the monitoring plan. ○ Report to the plant manager if there any abnormalities • *Data archiving* ○ Well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting will be encouraged to maximize transparency of data archiving • *Data aggregation and emission reduction calculations* ○ Data for various parameters aggregated and used in emission reduction calculations. • *Verification* ○ Coordinate with the DOE during verification.
Plant Manager	• Review and confirm the raw data collected, aggregated and emission reduction calculations done by the technician. • Assist the technician during verification. • Responsible for reporting the following to the management:

Role	Responsibility description
	• Estimated emission reductions during the monitoring period • Outcome of the verification and status of issuance of CERs

Quality assurance and quality control
Calibration has been carried out in accordance with the equipment manufacturer's recommendation as applicable depending upon the nature of the measurement equipment. There are measurement equipment's, which need not be recalibrated during their entire life span. PP will take responsibility for the quality assurance and quality control for recording, maintaining and archiving all the data by appointing consultants and/or technical support team to carry out the system analysis, equipment calibration and overall maintenance on a regular basis throughout the crediting period. PP has provided necessary training on data monitoring and recording to all the staff personnel involved in the monitoring process, in order to improve the efficiency of their work.

Emergency procedure
PP has implemented an Emergency Procedure in the plant, for which a detailed manual being developed. The manual contains instructions on how to handle an emergency situation in the plant, and measures to be taken to ensure that there is no unintended methane leakage from the system. All the plant operators have been familiarized on the procedure.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/parameter:	**$MCF_{ww,treatment,BL,i}$**
Unit	Fraction
Description	Methane correction factor for baseline wastewater treatment system
Source of data	Table III.H.1 in AMS-III.H (version 16)
Value(s) applied)	0.80
Choice of data or measurement methods and procedures	The default value for anaerobic deep lagoons with depth of more than 2 m is specified in AMS-III.H
Purpose of data/parameter	Calculation of baseline emission
Additional comments	None

Data/parameter:	**$B_{o,ww}$**
Unit	kg CH_4/kgCOD
Description	Methane producing capacity of the wastewater
Source of data	Paragraph 20 of AMS-III.H (version 16)
Value(s) applied)	0.25
Choice of data or measurement methods and procedures	IPCC value, as per AMS-III.H (version 16) paragraph 20
Purpose of data/parameter	Calculations of baseline and project emissions
Additional comments	None

Data/parameter:	UF_{BL}
Unit	Fraction
Description	Model correction uncertainty factor to account for model uncertainties
Source of data	Paragraph 22 of AMS-III.H (version 16)
Value(s) applied)	0.89
Choice of data or measurement methods and procedures	As per paragraph 22 of AMS-III.H (version 16)
Purpose of data/parameter	Calculations of baseline emissions
Additional comments	None

Data / Parameter	GWP_{CH4}
Unit	-------
Description	Global warming potential of methane
Source of data	IPCC value as per paragraph 20 of AMS-III.H (version 16)
Value(s) applied	25
Choice of data Or measurement methods and procedures	IPCC default for second commitment period
Purpose of data/parameter	Calculations of baseline and project emissions
Additional comment	None

Data / Parameter	$\eta_{COD,BL,i}$
Unit	%
Description	COD removal efficiency of the baseline treatment system i
Source of data	The value as per manufacturer specification
Value(s) applied	85
Choice of data Or measurement methods and procedures	The data has been determined (please refer to Appendix-4) in line with the requirements of paragraph 28 (2) (b) of the baseline and monitoring methodology AMS-III.H (version 16).
Purpose of data/parameter	Calculations of baseline emissions
Additional comment	None

Data / Parameter	$MCF_{ww,treatment\ PJ,k}$
Unit	Fraction
Description	Methane correction factor for project wastewater treatment system k
Source of data	Table III.H.1 in AMS-III.H (version 16)
Value(s) applied	0.8
Choice of data Or measurement methods and procedures	The project activity wastewater treatment system is an anaerobic digester
Purpose of data/parameter	Calculations of project emissions
Additional comment	None

Data / Parameter	UF_{PJ}
Unit	Fraction
Description	Model correction to account for model uncertainties

Source of data	Paragraph 30(a) Eq 11 of AMS-III.H (version 16)
Value(s) applied	1.12
Choice of data Or measurement methods and procedures	As per paragraph 30 of AMS-III.H (version 16)
Purpose of data/parameter	Calculations of project emissions
Additional comment	None

Data / Parameter	$\eta_{COD,PJ,j}$
Unit	%
Description	COD removal efficiency of the project treatment system j.
Source of data	The COD removal efficiency is obtained from the supplier of the anaerobic digester.
Value(s) applied	85%
Choice of data Or measurement methods and procedures	The value is used from manufacturer specification.
Purpose of data/parameter	Calculations of Project emissions
Additional comment	None

Data / Parameter	CFE_{ww}
Unit	-
Description	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems
Source of data	Default value as per paragraph 30(a) Eq 10 of AMS-III.H version 16
Value(s) applied	0.9
Choice of data Or measurement methods and procedures	In line with AMS-III.H version 16 Para 30(a)
Purpose of data/parameter	Calculations of Project emissions
Additional comment	None

Data / Parameter	MCFww,PJ,discharge
Unit	-
Description	Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake)
Source of data	Table III.H.1 in AMS-III.H (version 16)
Value(s) applied	0.1
Choice of data Or measurement methods and procedures	The treated wastewater in the project scenario will be discharged to nearby river.
Purpose of data/parameter	Calculations of baseline emissions
Additional comment	None

Data / Parameter	$EF_{EL,j,y}$
Unit	tCO2/MWh
Description	Emission factor for electricity generation for source j in year y, where j is the source of electricity consumption in the project
Source of data	Default value under option B2 of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (EB 39, Annex 7)
Value(s) applied	1.3

Choice of data Or measurement methods and procedures	In line with AMS-III.H version 16 Para 29
Purpose of data/parameter	Calculations of Project emissions
Additional comment	None

Data / Parameter	Hflare
Unit	-
Description	Flare efficiency
Source of data	Default value for open flaring as per "Project emissions from flaring"
Value(s) applied	0.5, if flare is detected in a minute. 0, otherwise
Choice of data Or measurement methods and procedures	The flaring system used in the project activity is open flaring. Default value of 50% flare efficiency can be used if the flare is detected in a minute . Otherwise, the default efficiency to be considered as 0%.
Purpose of data/parameter	Calculation of project emissions
Additional comment	Considered zero for current monitoring period

Data / Parameter	Ru
Unit	(Pa.m3/kmol.K)
Description	Universal ideal gases constant
Source of data	Tools to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	8,314
Choice of data Or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions
Additional comment	None

Data / Parameter	Mmi
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 02.0.0)
Value(s) applied	Compound Structure: Methane CH4 — Molecular mass (kg / kmol): 16.04
Choice of data Or measurement methods and procedures	The default value from Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 02.0.0).
Purpose of data/parameter	Calculation of project emission
Additional comment	None

D.2. Data and parameters monitored

Data/Parameter	$Q_{ww,i,y}$
Unit	m^3
Description	Monthly volume of untreated wastewater entering (inflow) the anaerobic digester in project activity
Measured/calculated/ default	Measured
Source of data	Measurements undertaken using flow meter.
Value(s) of monitored parameter	90691
Monitoring equipment	Measurements are undertaken by using flow meter at inlet of the anaerobic digester. Make-Endress+Hauser Type. PROMAG 10 P3 Serial No. FB02E020000 Accuracy-±0.5 % Calibration Frequency- once in 3 years Date of calibration- 20/08/2014
Measuring/reading/recording frequency	Continuous monitoring, Hourly measurement, Monthly recording
Calculation method (if applicable)	Not applicable
QA/QC procedures	The flow is monitored continuously and based on hourly reading aggregated daily and monthly values. Calibration of the flow meters is conducted as specified by manufacturer i.e. once in 3 years.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	$COD_{untreated,i,y}$ or $COD_{inflow,i,y}$
Unit	$tCOD/m^3$
Description	Chemical Oxygen Demand of the wastewater entering the Anaerobic Digester
Measured/calculated/ default	Measured
Source of data	Representative Sampling by PP
Value(s) of monitored parameter	0.86705 (average over monitoring period)
Monitoring equipment	Make-HACH Company Type-DR/890 Calorimeter Serial No.-101190C80529 Class- 1 LED Product The measurement of COD is conducted as per standard practice. The COD measured through representative sampling on daily or at least weekly basis. The COD measurement is conducted using COD Calorimeter, a digital meter, wherein the sample is used to measure the COD value at specified temperature inline with manual. The COD calorimeter is a digital meter and can be reset to factory calibration as per user requirement.
Measuring/reading/recording frequency	Weekly test, monthly average.

Calculation method (if applicable)	The data is recorded on at least weekly basis based on sample test and monthly average has been taken for calculation of emission reduction. As per monitoring plan of registered PDD the sample size for proposed project was calculated using 10 days campaign in beginning of monitoring period inline with Best Practice Examples Focusing on Sample Size and Reliability Calculations" (Annex-6, EB 67), which comes out to be around 52 samples per annum, the same is calculated based on COD values monitored during current monitoring period, which comes much lower than value mentioned in PDD, however actual practice at site the PP is conducting daily or at least weekly COD test in house laboratory which is conservative.
QA/QC procedures	Average value used through sampling with 90/10 confidence/precision level.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**$COD_{ww,treated,y}$**
Unit	$tCOD/m^3$
Description	Chemical oxygen demand of the treated wastewater leaving the anaerobic digester
Measured/calculated/ default	Measured
Source of data	Representative Sampling by PP
Value(s) of monitored parameter	0.021245 (average over monitoring period)
Monitoring equipment	Make-HACH Company Type-DR/890 Calorimeter Serial No.-101190C80529 Class- 1 LED Product The measurement of COD is conducted as per standard practice. The COD measured through representative sampling on daily basis or at least weekly basis.. The COD measurement is conducted using COD Calorimeter, a digital meter, wherein the sample is used to measure the COD value at specified temperature inline with manual. The COD calorimeter is a digital meter and can be reset to factory calibration as per user requirement.
Measuring/reading/recording frequency	Daily reading, monthly aggregation
Calculation method (if applicable)	The data is recorded on based on daily or at least weekly sample test basis and monthly average has been taken for calculation of emission reduction. As per monitoring plan of registered PDD the sample size for proposed project was calculated using 10 days campaign in beginning of monitoring period inline with Best Practice Examples Focusing on Sample Size and Reliability Calculations" (Annex-6, EB 67), which comes out to be around 52 samples per annum, the same is calculated based on COD values monitored during current monitoring period, which comes much lower than value mentioned in PDD, however actual practice at site the PP is conducting daily or at least weekly COD test in house laboratory which is conservative.
QA/QC procedures	Average value used through sampling with 90/10 confidence/precision level.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**$COD_{ww,discharge,pj,y}$**
Unit	$tCOD/m^3$

Description	Chemical oxygen demand of the treated wastewater discharged into sea river or lake
Measured/calculated/ default	Measured
Source of data	Representative Sampling by PP
Value(s) of monitored parameter	0.00035 (average over monitoring period)
Monitoring equipment	Make-HACH Company Type-DR/890 Calorimeter Serial No.-101190C80529 Class- 1 LED Product The measurement of COD is conducted as per standard practice. The COD measured through representative sampling on daily or at least weekly basis. The value has been cross-checked periodically through an accredited laboratory. The COD measurement is conducted using COD Calorimeter, a digital meter, wherein the sample is used to measure the COD value at specified temperature inline with manual. The COD calorimeter is a digital meter and can be reset to factory calibration as per user requirement.
Measuring/reading/recording frequency	Daily reading, monthly aggregation
Calculation method (if applicable)	The data is recorded on daily or at least weekly based on COD sample test and monthly average has been taken for calculation of emission reduction. As per monitoring plan of registered PDD the sample size for proposed project was calculated using 10 days campaign in beginning of monitoring period inline with Best Practice Examples Focusing on Sample Size and Reliability Calculations" (Annex-6, EB 67), which comes out to be around 52 samples per annum, the same is calculated based on COD values monitored during current monitoring period, which comes much lower than value mentioned in PDD, however actual practice at site the PP is conducting daily or at least weekly COD test in house laboratory which is conservative.
QA/QC procedures	Average value used through sampling with 90/10 confidence/precision level.
Purpose of data/parameter	Calculation of project emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**vi,t,db**
Unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Onsite record
Value(s) of monitored parameter	0.7177
Monitoring equipment	Make-Endress+Hauser Type: PROWIRL 73 F3 Serial No. FB02D820000 Accuracy-±1.5% Calibration Frequency- once in 3 years Date of calibration- 11/08/2014
Measuring/reading/recording frequency	Daily measurement, Monthly recording
Calculation method (if applicable)	Not applicable

QA/QC procedures	Calibration includes zero verification with an inert gas (e.g. N2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases will have a certificate provided by the manufacturer and under their validity period.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**Vt,db**
Unit	m^3 dry gas/h
Description	Volumetric flow rate of the gaseous stream in time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Measured on site
Value(s) of monitored parameter	267 (Average over current monitoring period)
Monitoring equipment	Volumetric flow measurement refers to the actual pressure and temperature. 1.Gas flow meter installed on flare line Make-Endress+Hauser Type: PROSONIC FLOW B 200 DN150 / 6" Serial No. K508BF02000 Accuracy-±1.50% Calibration Frequency- once in 3 years Date of calibration- 11/08/2014 2. Gas flow meter on boiler line Make-Endress+Hauser Type: PROWIRL 73 F3 Serial No. FB02D820000 Accuracy-±1.5 % Calibration Frequency- once in 3 years Date of calibration- 11/08/2014
Measuring/reading/recording frequency	Continuous monitoring, Hourly measurement, Monthly recording
Calculation method (if applicable)	Measured using gas flow meters, the two stream measured are added to calculate volumetric flow rate of residual gas. calculated based on gas flow measured on flare line and boiler line using gas flow meter
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data/parameter	Calculation of project emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**Flame,m**
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/ default	Measured
Source of data	Flare detection system
Value(s) of monitored parameter	0
Monitoring equipment	No flare detector was installed during current monitoring period
Measuring/reading/recording frequency	Not applicable

Calculation method (if applicable)	Not applicable
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of project emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**$EC_{PJ,j,y}$**
Unit	MWh/yr
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Measured/calculated/ default	Measured
Source of data	Electricity meters
Value(s) of monitored parameter	14.3
Monitoring equipment	Energy meter of accuracy class 0.5s. Make-Schneider Model No. EM6436 Serial No. 34170811203 Accuracy class: 0.5s Date of calibration- 01/04/2015
Measuring/reading/recording frequency	Continuous monitoring, Monthly recording
Calculation method (if applicable)	The data will be recorded on a monthly basis from main meter at the site. Based on the recorded data, Joint Meter readings will be issued to the PP on a monthly basis.
QA/QC procedures	Calibration of the meter is conducted according to the manufacturer's specification i.e. once in a year.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**Tt**
Unit	K
Description	Temperature of the gaseous stream in time interval t (K)
Measured/calculated/ default	Measured
Source of data	Temperature meter
Value(s) of monitored parameter	Not used as methane content is directly monitored by gas flow meter
Monitoring equipment	NA
Measuring/reading/recording frequency	NA
Calculation method (if applicable)	NA
QA/QC procedures	NA
Purpose of data/parameter	Calculation of baseline emission

Additional comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency). However, if the applicability condition related to the gaseous stream flow temperature being below 60”C is adopted, this parameter must be monitored continuously to assure the applicability condition is met. The data will be archived electronically and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data/Parameter	**Pt**
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Measured/calculated/ default	Measured
Source of data	Pressure transmitter
Value(s) of monitored parameter	Not used as methane content is directly monitored by gas flow meter
Monitoring equipment	NA
Measuring/reading/recording frequency	NA
Calculation method (if applicable)	NA
QA/QC procedures	NA
Purpose of data/parameter	Calculation of project emission
Additional comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency) The data will be archived electronically and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data/Parameter	**TDLi,y**
Unit	--
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Measured/calculated/ default	Measured
Source of data	Tool to calculate baseline, project and/or leakage emissions from electricity consumption
Value(s) of monitored parameter	0
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Not applicable
Calculation method (if applicable)	Measurement is not required as default value of 0 is used for scenario B according to the Tool to calculate baseline, project and/or leakage emissions from electricity consumption.
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of project emission

Additional comments	The data will be archived electronically and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data/Parameter	**$BG_{burnt\ ,\ y}$**
Unit	m3
Description	Biogas volume in year y
Measured/calculated/ default	Measured
Source of data	Measurements undertaken using flow meter.
Value(s) of monitored parameter	2424351
Monitoring equipment	1.Gas flow meter installed on flare line Make-Endress+Hauser Type: PROSONIC FLOW B 200 DN150 / 6" Serial No. K508BF02000 Accuracy-±1.50% Calibration Frequency- once in 3 years Date of calibration- 11/08/2014 2. Gas flow meter installed on boiler line Make-Endress+Hauser Type: PROWIRL 73 F3 Serial No. FB02D820000 Accuracy-±1.5 % Calibration Frequency- once in 3 years Date of calibration- 11/08/2014
Measuring/reading/recording frequency	Continuous monitoring, Hourly measurement, Monthly recording
Calculation method (if applicable)	In all cases, the amount of biogas recovered, fuelled, flared has been monitored using continuous flow meters. The biogas streams flared and fuelled (or utilized) are monitored separately, the two fractions has been added together to determine the total biogas recovered, without the need to monitor the recovered biogas before the separation. The methane content measurement is carried out close to a location in the system where a biogas flow measurement takes place i.e. by biogas meter installed on boiler line. The flare line and boiler line measured value added together to determine the total amount of biogas. Total gas flared 452843 m^3 and total gas combusted in boiler is 1971508 m^3. Hence the parameter is calculated as $BG_{burnt,y}=BG_{flae,y} + BG_{combusted,y}$ $BG_{burnt,y}=452843 + 1971508$ $BG_{burnt,y}= 2424351\ m^3$
QA/QC procedures	The flow is monitored continuously and based on hourly reading aggregated daily and monthly values. Calibration of the flow meters is conducted as specified by manufacturer i.e. once in 3 years.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Data will be archived for 2 years from the end of the crediting period or the last request for issuance whichever is later.

Data/Parameter	**$\eta_{flare,h}$**
Unit	Percentage
Description	Flare efficiency in hour h based on measurements or default values.
Measured/calculated/ default	Measured

Source of data	Based on default value given in methodology
Value(s) of monitored parameter	0.5, if flare is detected in a minute. 0, otherwise 0 is used as no flare detector at site during current monitoring period
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	NA
Calculation method (if applicable)	NA
QA/QC procedures	NA
Purpose of data/parameter	Calculation of project emission
Additional comments	The data will be archived electronically and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data/Parameter	$S_{final,PJ,final}$
Unit	Tonnes
Description	Amount of dry matter in final sludge
Measured/calculated/ default	NA
Source of data	Onsite measurement
Value(s) of monitored parameter	Total Sludge generated is used for land application, hence not monitored
Monitoring equipment	NA
Measuring/reading/recording frequency	NA
Calculation method (if applicable)	NA
QA/QC procedures	NA
Purpose of data/parameter	Calculation of project emission
Additional comments	The data will be archived electronically and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data/Parameter	$w_{CH4,y}$
Unit	%
Description	Methane content in the biogas in year y.
Measured/calculated/ default	Measured
Source of data	Onsite measurement using gas flow meter.
Value(s) of monitored parameter	71.77
Monitoring equipment	Make-Endress+Hauser Type: PROWIRL 73 F3 Serial No. FB02D820000 Accuracy-±1.5% Calibration Frequency- once in 3 years Date of calibration- 11/08/2014
Measuring/reading/recording frequency	Daily measurement, Monthly recording

Calculation method (if applicable)	The fraction of methane in the gas is being measured with a continuous analyser or, alternatively, with periodical measurements at a 90/10 confidence/precision level by appointed staff of the project owner. It is being measured using equipment that can directly measure methane content in the biogas - the estimation of methane content of biogas based on measurement of other constituents of biogas such as CO2 is not permitted. The methane content measurement is carried out close to a location in the system where a biogas flow measurement takes place. The biogas content is measured using gas flow meter capable of monitoring the methane content in gas residual gas stream.
QA/QC procedures	The measurement is being taken regularly and the analyser used is calibrated periodically as per vendor's specifications.
Purpose of data/parameter	Calculation of project emission
Additional comments	The data will be archived and kept for minimum of two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

D.3. Implementation of sampling plan

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During monitoring period, the COD level will be determined through sampling. Representative sample size is being taken to ensure the 90/10 confidence/precision level requirement. COD levels will be monitored based on the table below.

Parameters for monitoring	Minimum sample size required for 90/10 confidence/precision level[1]	Actual sample size
COD of untreated, treated, and discharged wastewater	30 (based on a population of 54 samples)	52(once every week)

The sample size is being determined as below based on 10 days campaign for COD inflow to digester conducted in May 2015 inline with Annex 6 of EB67 and registered PDD.

Mean Value- 72403 mg/L
Standard Deviation- 2620 mg/l

Sample size is calculated as n= {(1.645x2620)/(0.1x72403)}^2 =0.35=1

The calculation is repeated for sample size 1,

Sample size is calculated as n= {(6.314x2620/(0.1x72403)}^2 =5.22=6

The calculation is repeated for sample size 6,

Sample size is calculated as n= {(2.015x2620)/(0.1x72403)}^2 =0.40=1

The value repeats 1 and 6.

Hence sample size is considered as 6 per year. The actual practice is at least weekly test, which is conservative.

[1] "Easy Sample"- a sampling software used for determining sample size.

The sample size is being determined as below based on 10 days campaign for COD outflow from digester

Mean Value- 19338 mg/L
Standard Deviation- 1618 mg/l

Sample size is calculated as n= {(1.645x1618)/(0.1x19338)}^2 =1.89=2

The calculation is repeated for sample size 2,

Sample size is calculated as n= {(6.314x1618)/(0.1x19338)}^2 =27.9=28

The calculation is repeated for sample size 28,

Sample size is calculated as n= {(1.703x1618)/(0.1x19338)}^2 =2.03=3

The calculation is repeated for sample size 3,

Sample size is calculated as n= {(2.921x1618)/(0.1x19338)}^2 =5.96=6

The calculation is repeated for sample size 6,

Sample size is calculated as n= {(2.0151x1618)/(0.1x19338)}^2 =2.84=3

The value repeats as 3 and 6, hence 6 is considered.
Hence sample size is considered as 6 per year. The actual practice is at least weekly test which is conservative

The sample size is being determined as below based on 10 days campaign for COD of wastewater discharge to sea/river from project

Mean Value- 340 mg/L
Standard Deviation- 32 mg/l

Sample size is calculated as n= {(1.645x32)/(0.1x340}^2 =2.39=3

The calculation is repeated for sample size 3,

Sample size is calculated as n= {(2.92x32)/(0.1x340)}^2 =7.55=8

The calculation is repeated for sample size 8,

Sample size is calculated as n= {(1.895x32)/(0.1x340)}^2 =3.18=4

The calculation is repeated for sample size 4,

Sample size is calculated as n= {(2.353x32)/(0.1x340}^2 =4.90=5

The calculation is repeated for sample size 5,

Sample size is calculated as n= {(2.132x32)/(0.1x340}^2 =4.02=5

The value repeats at 5, hence sample size 5 is considered.

The sample size determined in registered PDD is found to be higher side, hence the same has been considered for compliance check to monitoring plan, however in practice the test is conducted more frequently i.e. daily or at least once in a week which is conservative.

Further to confirm on the required confidence level/precision of sample, the sample size as per registered PDD is calculated which comes 6, 6 and 5 for COD inflow, COD treated and COD discharge respectively, whereas the actual sample size is much larger than the mentioned above i.e. 250, 200 and 193 respectively. Moreover, to check reliability/compliance mean value and standard deviation is calculated for monitoring period, which indicates the precision level of 0.40%, 1.09% and 0.0% for COD inflow, COD treated and COD discharge respectively at 90% confidence level is acceptable and appropriate.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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Baseline emissions

The baseline emissions are calculated as follow:

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

Baseline emissions from wastewater treatment system

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

Value of parameters used in baseline emissions calculations:

Parameters	Value	Source
$B_{o,ww}$	0.25 kg CH_4/kgCOD	Value as per AMS-III.H (version 16) paragraph 20.
$COD_{untreated,i,y}$	0.086705 tCOD/m^3	Average value over current monitoring period i.e. 16/04/2015 to 30/04/2016
$\eta_{COD,BL,i}$	85%	Designed value as per manufacturer specification established in line with paragraph 28 (2) (b) of AMS-III.H version 16. Please refer Appendix-4 for details.
$Q_{ww,i,y}$	90691 m^3	Total wastewater treated during current monitoring period i.e. 16/04/2015 to 30/04/2016
$MCF_{ww,treatment,BL,i}$	0.8	IPCC value as per Table III.H.1 in AMS-III.H version 16. The plausible baseline scenario is the anaerobic lagoons with depth of more than 2m, therefore value of 0.8 is applied which is in line with the requirements of the methodology.
UF_{BL}	0.89[2]	Value as per AMS-III.H (version 16) paragraph 20.
GWP_{CH4}	25	IPCC default value

$BE_{ww,treatment,y}$ = 90691* (0.086705*85%*0.8)*0.25*0.89*25
= 29,743.28 tCO_2e

$BE_y = BE_{ww,treatment,y}$
= 29,743 tCO_2e (rounded down)

E.2. Calculation of project emissions or actual net removals

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Project emissions

The emission from project activity is as follow:

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

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

Project emissions calculations due to electricity consumption ($PE_{EC,y} = PE_{power,y}$)

$PE_{EC,y} = EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$

$PE_{EC,y} = 14.3 * 1.3 * 1$

$PE_{EC,y} = 18.59\ tCO_2e$

Project emissions from the treated wastewater discharged

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

$= 90691*25*0.25*1.12*0.00035*0.1$

$= 22.21\ tCO_2e$

Project emissions from biogas release in capture system

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

$= 90691*0.25*1.12* 0.065451*0.8$

$= 1329.63$ tonnes CH_4

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

$= (1 - 0.9) * 1329.63 * 25$

$= 3324.08\ tCO_2e$

$PE_{fugitive,y} = PE_{fugitive,ww,y} = 3324.08\ tCO_2e$

Value of parameters used in project emissions calculation

Parameter	Value	Source
$Q_{ww,i,y}$	90691 m^3	Total wastewater treated during current monitoring period i.e. 16/04/2015 to 30/04/2016
$COD_{inflow,i,y}$	0.086705 $tCOD/m^3$	Average over current monitoring period i.e. 16/04/2015 to 30/04/2016
$\eta_{COD,PJ}$	85 %	Designed value from manufacturer specification
$B_{o,ww}$	0.25 kg CH_4/kg COD	Value as per AMS-III.H (version 16) paragraph 20.
UF_{PJ}	0.89	Value as per AMS-III.H (version 16) paragraph 29.
$MCF_{ww,treatment,PJ,k}$	0.80	IPCC value as per Table 6.8 Volume 5 Chapter 6 of IPCC 2006 Guideline for anaerobic reactor

Project emissions due to incomplete flaring

$PE_{flaring,y} = F_{CH4,RG,m} * (1-\eta_{Flare,m}) * \rho_{CH4} * 10^{-3} * GWP_{CH4}$

Where,

$F_{CH4,RG,m} = 452843\ m^3$

$\eta_{Flare,m} = 0$

$\rho_{CH4} = 0.716\ tCH_4/m^3$

$GWP_{CH4} = 25$

$PE_{flaring,y} = 5817.53\ tCO_2e$

The total project emission

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

PE_y =18.59 +22.219 +3324.08 + 5817.53

PE_y =9182.41 tCO_2e

PE_y =9,183 tCO_2e (rounded up)

E.3. Calculation of leakage emissions

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The project activity does not involve equipment transfer from another activity thus there are no leakages to be accounted for this project activity.
$LE_y = 0$

E.4. Calculation of emission reductions or net anthropogenic removals

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

$BG_{burnt,y}$ Annual volume of biogas burnt in year y (m3)
$w_{CH4,y}$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/m3)
FE Flare efficiency in year y (fraction). If the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100% will be applied

Parameter	Value	Unit	Source
η_{flare}	0.5	--	default value as conservative
$BG_{burnt,y}$	2424351	m^3	Monitored by PP value taken as aggregate over current monitoring period
$fv_{CH4,RG,h}$/ $w_{CH4,y}$	71.77%	--	Value monitored by PP on hourly basis and averaged over current monitoring period
$\rho_{CH4,n}/D_{CH4}$	0.716		IPCC default value
GWP_{CH4}	25	--	Default value

MD_y =(2424351*71.77%*0.716*0.5*25)/1000

MD_y =15572.44 tCO_2e

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

$ER_{y, ex\ post} = \min ((20560, (15572.44-18.59)$

$ER_{y, ex\ post}$ =15553 tCO_2e

	Baseline GHG emissions or	Project GHG emissions or actual net	Leakage GHG emissions	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)

				Before 01/01/2013	From 01/01/2013	Total amount
Total	29743	9106	0	0	15553[3]	15553

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
15553	60167

E.6. Remarks on increase in achieved emission reductions

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There is a decrease of 74.15% from estimated ERs in registered PDD has been observed during this monitoring period (381 days). The palm oil mill was not operational at full load resulting lower value of POME, which is main input to project activity. Further as flare efficiency has been considered as zero has also increased project emission.

[3] The ex-post calculation value is considered as final emission reduction in line with applied methodology.

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Document information

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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