Monitoring Report

Version 05.2

Date 25/10/2010

Bangna Starch Wastewater Treatment and Biogas Utilization Project

UNFCCC Reference No: 2556

GS VER Verification (Pre CDM)
Monitoring Period: 10/11/2008 – 09/11/2009(Including both days)

Net Emission reductions: 22,591 tCO_2e

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1. Introduction

1.1. General Project Information:

The project activity consists of the installation of an upflow anaerobic sludge blanket technology (UASB) biogas reactor, tapioca pulp treatment and power generation (2.85 MW_{el} gas engine (3 X 0.95 MW) at an existing starch manufacturing plant for:

- extraction of methane (biogas) from the wastewater stream through the biogas reactor, and
- reuse of biogas as fuel for power generation (installed capacity of 2.85 MW_{el} gas engines).

The project replaces the existing wastewater treatment practice (open lagoon system) and thus avoids the release of methane into the atmosphere that results from the anaerobic digestion of the organic content in the wastewater treated in the lagoon system (anaerobic conditions, leading to methane generation within the lagoon are the result of lagoon depth (> 2m) and an average atmospheric temperature of about 28°C). The biogas reactor system is expected to handle a wastewater flow rate of 3,750m^3/day and an expected average COD concentration of 18.000 mg/l.

The biogas reactor produces sufficient quantities of biogas to fuel a number of gas engines for the production and sale to the electricity grid, thus displacing the production of power from fossil sources in the EGAT (Electricity Generation Authority of Thailand) electricity grid. Therefore, the project activity will reduce green house gases due to avoidance of methane emissions from the existing lagoon system and displacement of fossil fuel based electricity from the grid.

The project is implemented by P&Papop Renewable Co. Ltd. on a BOOT (Build Own Operate Transfer) basis at the Yangthalat starch production facility of Bangna Tapioca Flour Co., Ltd.

This means that P&Papop Renewable Co. Ltd. is responsible for arranging finance, constructing and operating the project. As the owner of the wastewater treatment plant, P&Papop Renewable Co. Ltd. will be the entity entitled to all the emission reductions generated from the project.

Further background information on the project activity can be found in the Project Design Document (PDD) and associated documents, which have been registered on November 10th, 2009, and available on the UNFCCC website: http://cdm.unfccc.int/Projects/DB/RWTUV1241593452.75/view

1.2. Status of Project Implementation:

The project proponent, P&Papop Renewable Co. Ltd, successfully commissioned the project activity 'Bangna Starch Wastewater Treatment and Biogas Utilization Project' in October 2007[1]. The gas engine was commissioned in December 2007[2] and the first biogas usage was registered during January 2008.

The starch plant or biogas plant are not operational for full year and have some off days as per the national holidays and seasonal availability of the raw material.

Operation days during the monitoring period: 282
Days with no production: 83

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[1] Waste water was sent to anaerobic reactors starting in October 2007. Commissioning report of UASB.

[2] Refer to the commissioning report of gas engines.

The project is implemented in line with the description in the registered PDD.

The technical specifications of the equipments deployed in the project activity are as listed below:

Sl. No.	Equipment	Specifications	Supplier / Technology Provider
1	UASB Reactor	Capacity: 6581 m^3	Papop
2	Gas Engine – 3unit	Capacity: 0.95 MW each	Guascor
3	Flare System	Capacity: 1250 Nm^3/hr	BKE Flare system

1.3. Project layout

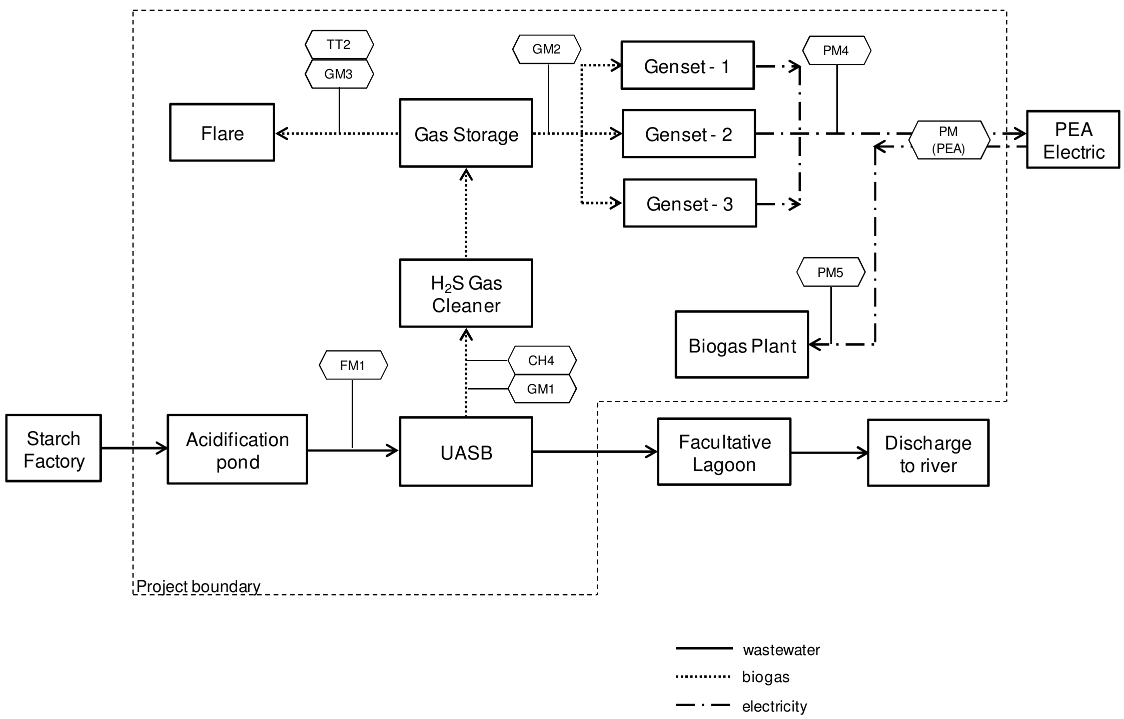


Figure 1. Project layout

1.4. Forecasted emission reductions versus actual emission reductions:

The forecasted emission reduction as per the PDD is 41,701tCO_2/year. The emission reduction over this monitoring period is 22,591 tCO_2/year. The difference between the ex-ante estimate and the actual figures is for the lower values of starch production and waste water generation.

2. Reference

Sections B.6 and B.7 of the registered PDD[3] provide all details in regard to the calculation of emission reductions and monitoring plan to be followed by the project activity.
Both the emission reduction calculations and the monitoring plan are based on the approved CDM methodologies:

1. Methane avoidance component:

Type III:	Other project activities
Category III.H:	Methane Recovery in Wastewater Treatment
Reference:	III.H./Version 9, Sectoral Scope 13

2. Electricity generation component:

Type I:	Renewable energy projects
Category I.D:	Grid connected renewable electricity generation
Reference:	I.D./Version 13, Sectoral Scope 1

The methodologies and tools mentioned above can be found on the UNFCCC's website at:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

3. Monitoring Background

3.1. Monitoring period

This is pre CDM GS VER monitoring report of this project activity. It covers the period from 10th November 2008 to 9th November 2009 (both days included)[4]. This is in line with the GS guidelines, for verification of the emission reductions one year prior to the CDM registration.

The DNA in Thailand was established during early 2007, before which the procedural requirements for LoA were not transparent. The LoAs were issued by Office of Natural Resources and Environmental Policy and Planning (**ONEP**)[5]. The reason for the delay in the CDM registration date and project operation start date are due to long delay in project validation for CDM registration. The project also had to face some delay on account of request of review raised during the CDM registration. The brief timeline of the events before registration is as follow:

Event	**Date**
Appointment of DOE	17th September 2007
DNA Application	10th October 2007
Biogas usage start	January 2008

[3] http://cdm.unfccc.int/Projects/DB/RWTUV1241593452.75/view

[4] http://www.cdmgoldstandard.org/fileadmin/editors/files/6_GS_technical_docs/GSv1/GS_changes,clarifications%20December%2007.pdf

[5] First approval by DNA in Jan 2007: http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=17&Itemid=29&limit=1&limitstart=0

LoA from Thai DNA	16th July 2008
UNFCCC upload – validation	27th Sep 2008
Review Requested	Sep 2009
Project Registered	Nov 2009

3.2. Presentation of monitoring results

All monitoring data and calculations are made available in form of and excel sheet.
The spreadsheet includes:

a) A summary worksheet containing the measurements and calculations of the daily monitoring for the monitoring period
b) Parameters fixed in validated PDD
c) Summary of Monitoring Data

4. Parameters monitored according to the monitoring plan

For the project activity, the following parameters are monitored in the method described individually:

4.1. Parameters fixed at validation for entire 1st crediting period:

The values of each of the following parameters are determined ex-ante and fixed for the crediting period.

Data / Parameter :	GWP_{CH4}
Data unit	
Description	Global warning potential
Source of data used	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value applied	GWP_{CH4} 21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	IPCC default value is used for both baseline and project emissions.
Any comments :	

Data / Parameter :	$B_{o,ww}$
Data unit	Kg CH_4/kg COD
Description	IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation
Source of data used	IPCC default value
Value applied	$B_{o,ww}$ 0.21

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	IPCC default value is used for baseline and project emissions.
Any comments :	As per AMS.III.H Version 09, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Data / Parameter :	MCF
Data unit	Fraction
Description	Methane correction factor
Source of data used	Table III.H.1 from AMS-III.H, Version 09 methodology and "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site (version 02)"
Value applied	$MCF_{ww, treatment, i}$ = 0.8 (for baseline emissions) $MCF_{ww, final}$ = 0.2 (For waste water released into river) $MCF_{ww, 1}$ = 1.0 (For Project Emissions from lagoon system)
Indicate what the data are used for (Baseline/ Project/ Leakage emission Calculations)	The values are used for both baseline and project emissions.
Any comments :	The original source of data can be checked for IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions. All MCF values have been chosen in a conservative manner (highest values for project and lower for baseline) according to table III.H.1 from AMS-III.H, Version 09 methodology. The value of $MCF_{s, final}$ is the MCF maxima value according to the "table MCF" from the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site (version 02)"; which is conservative.

Data / Parameter :	CFE_{ww}
Data unit	Fraction
Description	Capture and flare efficiency of the methane recovery and combustion efficiency
Source of data used	Default value specified in AMS-III.H, Version 09 methodology
Value applied	CFE_{ww} 0.9
Indicate what the data are used for (Baseline/ Project/ Leakage emission Calculations)	The value is used for both baseline and project emissions.
Any comments:	In absence of an appropriate value the methodology describes to use an IPCC default value of 0.9.

Data / Parameter :	$EF_{grid, y} = EF_{y}$
Data unit	tCO_2/MWh

Description	CO_2 emission factor of the grid
Source of data used	Validated as part of registered PDD. pdf version submitted.
Value applied	0.5057
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The value is used for both baseline and project emissions.
Any comments:	Data from publically available source, published by DEDE (Ministry of Energy).

Data / Parameter :	$[CH_4]_{y,ww,treated}$
Data unit	Tonnes/m^3
Description	Dissolved methane content in the treated wastewater
Source of data used	Methodology AMS IIIH
Value applied	$[CH_4]_{y,ww,treated}$ 0.0001
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This value is used for project emissions.
Any comments:	A default value as per the methodology is used to estimate emissions on account of dissolved methane in waste water.

Data / Parameter :	D_{CH4}
Data unit	Kg / Nm^3
Description	Density of Methane Gas
Source of data used	UNFCCC: Flaring Tool[6]
Value applied	0.716
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The value is used for estimating MD_y (one of the approach to estimate the baseline emissions) and to estimate project emissions from flaring.
Any comments:	For Estimation of flare emissions.

4.2. Parameters monitored during crediting period:

The parameters provided below are monitored ex-post and used for GHG emission reduction calculations

Parameter:	$Q_{y,ww}$
Unit:	m^3
Description:	Volume of wastewater treated in the year y
Measured /Calculated /Default:	Measured

[6] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf

Source of data:	Flow Meter at the entrance of the anaerobic reactor.
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 63,303 **2009 (01/10-09/11)**: 472,391
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The daily monitored values of waste water volume are used to estimate the COD loading into and out of the reactor. Baseline Emissions: Daily waste water flow value into the anaerobic digester system. Project Emissions: Same as above in line with the hydraulic balance of the project activity. Leakages: No leakage emissions calculated from the project.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Monitoring Equipment Type: PROMAG 10 W DN200 Accuracy Level: ±0.5% Serial No. 93120819000 Calibration Frequency: As per the registered PDD, the calibration should be done annually. Date of Calibrations: Initial test certificate: 28th March 2007 / Project commissioned in October 2007. Second Calibration Certificate: 30th Nov 2009. Validity: 29th Dec 2010.
Measuring/Recording frequency	The meter has continuous monitoring of the flow of waste water, whereas the recording is done into log sheet on daily basis.
Calculation method (if applicable):	Refer to Section 5 of the Monitoring Report.
QA/QC procedures to be applied (if any):	For the period prior to project registration the project proponent refers to the EB 54 Annex-14 and the latest calibrations available. As per EB 54, Annex-14; " *Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in 3 years;"* For the waste water flow meters no applicable manufacturer specifications are available for the calibration frequency. There is a gap of 2 years between installation and the second calibration, which is not in line with registered monitoring plan; however the second calibration shows no deviation from standard error of meter. Moreover the calibration is within three years of first calibration and is in line with the SSC WG[7] guidelines for calibration.
Any comment:	

Parameter:	$COD_{y,removed,i}$
Unit:	mg/l
Description:	The chemical oxygen demand removed by the treatment system j i.e. project activity.
Measured /Calculated /Default:	Calculated value (Based on COD_{inlet} and COD_{outlet} readings)

[7] http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf

Source of data:	Calculated
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 13,746 **2009 (01/10-09/11)**: 13,543
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for estimation of the baseline emissions and of project emissions (in the calculation of $MEP_{y,ww,treatment}$.)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(Based on COD_{inlet} and COD_{outlet} readings)
Measuring/Recording frequency	The above figure is an annually calculated number.
Calculation method (if applicable):	The daily $COD_{y,removed,i}$ is calculated based on the COD_{inlet} and COD_{outlet} readings for the digester system. For the estimation of baseline emissions, the COD load removed in tonnes on daily basis is added up and the result is divided by the total annual volume of wastewater. Thereby the figures above represent the weighted average COD load removed.
QA/QC procedures to be applied (if any):	
Any comment:	

Parameter:	COD_{inlet}
Unit:	mg/l
Description:	The chemical oxygen demand of waste water entering the anaerobic treatment system.
Measured /Calculated Default:	Measured
Source of data:	Test Analysis done in laboratory
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 13,902 **2009 (01/10-09/11)**: 13,778
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for estimating baseline and project emissions. The above values are simple averages, where as the calculation approach uses the daily values of the COD readings and daily waste water flow volumes to estimate the COD load entering the anaerobic treatment system in tones.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Hach DR/890 Series Colorimeter. This is a microprocessor-controlled, LED-sourced filter photometer. The equipment has a wavelength accuracy ±1 nm Standard solution is used to calibrate the equipment regularly, preferably once a week to ensure correctness of readings. The procedure was explained during the site visit.
Measuring/Recording	Three samples are taken every day and the analysis is performed once a day on this composite sample. This procedure

frequency	is followed during the monitoring period.
Calculation method (if applicable):	The daily COD_{inlet} reading is multiplied by the daily waste water flow to estimate the COD load on daily basis into the UASB system. The approach is transparently applied in excel sheet.
QA/QC procedures to be applied (if any):	Standard solution is used to calibrate the equipment regularly, preferably once a week to ensure correctness of readings. As a normal practice, the standard solution is used for calibration on a daily basis.
Any comment:	

Parameter:	COD_{outlet}
Unit:	mg/l
Description:	The chemical oxygen demand of waste water leaving the anaerobic system.
Measured /Calculated /Default:	Measured
Source of data:	Test Analysis done in laboratory
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 452 **2009 (01/10-09/11)**: 473
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for estimating baseline emissions. The above values are simple averages, where as the calculation approach uses the daily values of the COD readings and waste water flow volumes to estimate the COD load exiting the anaerobic treatment system in tones.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Hach DR/890 Series Colorimeter. This is a microprocessor-controlled, LED-sourced filter photometer. The equipment has a wavelength accuracy ±1 nm Standard solution is used to calibrate the equipment regularly, preferably once a week to ensure correctness of readings.
Measuring/Recording frequency	Three samples are taken every day and the analysis is performed once a day on this composite sample. This procedure is followed during the monitoring period.
Calculation method (if applicable):	The daily COD_{outlet} reading is multiplied by the daily waste water flow to estimate the COD load on daily basis out of the UASB system. The approach is transparently applied in excel sheet.
QA/QC procedures to be applied (if any):	Standard solution is used to calibrate the equipment regularly, preferably once a week to ensure correctness of readings. As a normal practice, the standard solution is used for calibration on a daily basis.
Any comment:	

Parameter:	$COD_{y, ww, treated}$
Unit:	tonnes/m^3
Description:	Chemical oxygen demand of the wastewater prior to discharge
Measured /Calculated /Default:	Measured – Calorimetric analysis

Source of data:	Third Party test reports.
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 0.00017 **2009 (01/10-09/11)**: 0.00017
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emissions. The maximum value reported is used for conservative estimation of project emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	As per the registered Monitoring Plan, the COD readings are taken on daily basis; however the COD readings for last lagoon are a statutory requirement for release of waste water to water bodies. Thereby one third party reading on monthly basis is the current practice at the project activity.
Measuring/Recording frequency	Monthly – this is not in line with the monitoring plan, but is addressed by using a conservative approach.
Calculation method (if applicable):	Third party test report. The highest value reported in the third party test over a year is used to conservatively estimate the project emissions.
QA/QC procedures to be applied (if any):	
Any comment:	The monitoring of this parameter being not in line with the monitoring plan, a conservative approach is used to estimate project emissions. The maximum value reported in the external test reports is used to estimate the project emissions. The value reported above is the maximum reported COD value in the third party test reports. http://www.pcd.go.th/info_serv/en_reg_std_water04.html#s1 Notification of the Pollution Control Committee, No. 3, B.E. 2539 (1996) dated August 20, B.E. 2539 (1996) has issued types of factories (category of factories issued under the Factory Act B.E.2535 (1992) that are allowed to discharge effluent having different standards from the Ministerial Notification No. 3 above as follows : BOD upto 60 mg/l: starch factories (category 9 (2)) COD upto 400 mg/l: food furnishing factories (category 13 (2))

Parameter:	$S_{y, final}$
Unit:	Tonnes
Description:	Amount of final sludge generated by the wastewater treatment.
Measured /Calculated /Default:	Measured
Source of data:	Log Records, of all the sludge removed is used.
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 0 **2009 (01/10-09/11)**: 0
Indicate what the data are used for (Baseline/ Project/ Leakage emission	

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The sludge quantity is monitored using the weigh bridge, before end use.
Measuring/Recording frequency	Whenever the sludge is removed, it is monitored.
Calculation method (if applicable):	If the sludge generated is disposed an-aerobically, the project emissions from the sludge disposal are accounted into the emission reductions.
QA/QC procedures to be applied (if any):	The weigh bridge shall be calibrated regularly.
Any comment:	During this monitoring period, no sludge has been removed from the wastewater treatment system.

Parameter:	%CH_4
Unit:	%
Description:	Methane content in biogas
Measured /Calculated /Default:	Measured
Source of data:	As per the Monitoring plan, there should be an online methane monitoring. However during the period the methane analyzer is not working and portable methane analyzer is used to estimate methane in biogas and recorded in the log book.
Value (s) of monitored parameter:	<table><tr><th></th><th>2008 (10/11-31/12)</th><th>2009 (01/10-09/11)</th></tr><tr><td>Average value</td><td>62.69%</td><td>58.97%</td></tr><tr><td>95% lower</td><td>60.66%</td><td>57.62%</td></tr><tr><td>95% higher</td><td>64.72%</td><td>60.33%</td></tr></table>
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for both baseline and project emissions. The above values are simple average values. The methane percentage is used to estimate the MD_y estimate. The lower value of 95% confidence interval is used in the estimation of MD_y. This has no affect on the emission reduction as the COD reduction approach is more conservative and is used for baseline emissions. The methane percentage is used for project emissions of the flare emissions; in this case the higher limit of 95% confidence interval is used to estimate the project emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Online methane analyzer is not available; thereby the portable analyzer is used. Till February 2009: G6259 (Serial number of the methane analyzer); Equipment test certificates: 13/07/2006, 10/06/2009 Accuracy: 3% March 2009 onwards: BM11452 (Serial number of methane analyzer) Equipment test certificates: 18/12/2008 Frequency of testing: Annual

	Accuracy: ± 3%
Measuring/Recording frequency	The biogas sample is analyzed more than 3 times a day and daily methane percentage is determined using the simple average.
Calculation method (if applicable):	Simple average is estimated on daily basis. The value on annual basis is estimated using the 95% confidence interval. The higher value of 95% confidence interval is used to estimate the project emissions, in compliance with conservative principle. The lower value is used for estimation of baseline emissions.
QA/QC procedures to be applied (if any):	The first portable gas analyser was used from October 2007 to February 2009. The manufacturer's operational manual recommends that the analyzer be serviced and recalibrated once every 6 months. It also recommends field calibration is required at regular intervals. The zero-check is required to be performed on daily basis. In this case the gas analyzer is tested in June 2006 and June 2009, i.e. at a gap of three years which is not in line with manufacturer's specification; however the test report shows satisfactory results. This implies that gas analyzer is working fine. The internal field calibrations are done regularly; on weekly basis and are done using standard gas. The zero check is performed daily. The internal calibration records are submitted along. For the second gas analyzer, the instrument is used since March 2009, and the test report is available for January 2009. The zero check is done daily for this instrument as well. The weekly calibrations using a standard gas are done and the records are submitted.
Any comment:	The concept of zero check and field calibration are detailed in the documentation provided during site visit. The zero check ensures, no extra gases (especially methane) are already present in apparatus. The field check is done for mixture-3 which is high methane percentage mixture. This is in line with actual range of methane in the biogas.

Parameter:	$Q_{biogas, total, y}$
Unit:	Nm^3
Description:	Amount of biogas that is generated in year y
Measured /Calculated /Default:	Measured
Source of data:	Gas Flow meter provided at the outlet of UASB. Denoted as GM1.
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 264,495 **2009 (01/10-09/11)**: 2,299,218
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for estimating baseline emissions.
Monitoring equipment (type,	Gas flow meter available at the outlet of UASB is used. Endress + Hauser t-mass 65

accuracy class, serial number, calibration frequency, date of last calibration, validity)	Serial Number: 9502C002000 Accuracy class: ±1 Calibrations: 09/05/2007; 05/08/2008; 16/11/2009 Frequency: the meter should be calibrated annually or as per the manufacturer's specification. Validity: 15/11/2010
Measuring/Recording frequency	Continuous monitoring, but recording is done every day in the log books.
Calculation method (if applicable):	
QA/QC procedures to be applied (if any):	For the period prior to project registration the project proponent refers to the EB 54 Annex-14 and the latest calibrations available. As per EB 54, Annex-14; " *Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in 3 years;"* For the gas flow meters no applicable manufacturer specifications are applicable for the calibration period. The meter is calibrated internally using standard gas meter. The calibrations are done in Aug 2008 and Nov 2009. The errors reported are lower than standard error and the calibrations take place within 3 years of previous calibrations.
Any comment:	The biogas produced for year 2008 is represented by the biogas consumed in the gas engine and the flare equipment. The PP is confident that no leakage occurs during monitoring period in 2008, however there is a gap in the biogas volumes for the last two months of 2008.

Parameter:	$Q_{biogas, flare, y}$
Unit:	Nm^3
Description:	Amount of biogas that is flared in year y
Measured /Calculated /Default:	Measured
Source of data:	Measured – Gas Flow meter provided at the inlet of flare system. Denoted as GM3
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 16,890 **2009 (01/10-09/11)**: 48,633
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The values are used for the project emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last	Gas flow meter available before the flare system. Endress + Hauser t-mass 65 Serial Number: 9A070502000 Accuracy class: ±1. Calibrations: 16/10/2007; 02/08/2008; 20/11/2009

calibration, validity)	Continuous monitoring, but recording is done every day in the log books. Frequency: the meter should be calibrated annually or as per the manufacturer's specification. Validity: 19/11/2010
Measuring/Recording frequency	Continuous monitoring, but recording is done every day in the log books.
Calculation method (if applicable):	The values are used for the estimation of project emissions.
QA/QC procedures to be applied (if any):	For the period prior to project registration the project proponent refers to the EB 54 Annex-14 and the latest calibrations available. As per EB 54, Annex-14; " *Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in 3 years;"* For the gas flow meters no applicable manufacturer specifications are applicable for the calibration period. The meter is calibrated internally using standard gas meter. The calibrations are done in Aug 2008 and Nov 2009. The errors reported are lower than standard error and the calibrations take place within 3 years of previous calibrations. In case of project emissions, to be conservative project proponent applies the standard error of gas flow meter to the measured volumes of gas starting from 02 august 2009.
Any comment:	

Parameter:	$Q_{biogas, generator, y}$
Unit:	Nm^3
Description:	Amount of biogas that is sent to the electricity generator.
Measured /Calculated /Default:	Measured
Source of data:	Flow meters provided at the inlet of the electricity generator system. Denoted as GM2
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 247,605 **2009 (01/10-09/11)**: 2,249,695
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The values are used for the MD_y approach of baseline emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Gas flow meter available before the flare system. Endress + Hauser t-mass 65 Serial Number: 9502C102000 Accuracy class: ±1 Calibrations: 09/05/2007; 03/08/2008; 18/11/2009 Frequency: the meter should be calibrated annually or as per the manufacturer's specification. Validity: 17/11/2010

Measuring/Recording frequency	Continuous monitoring, but recording is done every day in the log books.
Calculation method (if applicable):	
QA/QC procedures to be applied (if any):	For the period prior to project registration the project proponent refers to the EB 54 Annex-14 and the latest calibrations available. As per EB 54, Annex-14; " *Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in 3 years;"* For the gas flow meters no applicable manufacturer specifications are applicable for the calibration period. The meter is calibrated internally using standard gas meter. The calibrations are done in Aug 2008 and Nov 2009. The errors reported are lower than standard error and the calibrations take place within 3 years of previous calibrations.
Any comment:	

Parameter:	T_{flare} Sufficient temperature in flare detection period
Unit:	˚C
Description:	Temperature of exhaust gases.
Measured /Calculated /Default:	Measured
Source of data:	Temperature is recorded in an automated system, using a thermocouple.
Value (s) of monitored parameter:	Not monitored in the current monitoring period.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	A thermocouple is used which is fitted not far from the top edge of the flare stack. The monitoring is not done in this monitoring period.
Measuring/Recording frequency	If the automated data recording is available, it is done on a minute by minute basis. When the automatic system is not available, the operators shall manually record the monitored data.
Calculation method (if applicable):	Amount of minutes per hour where a flame has a higher temperature then 500°C, whenever biogas is sent to the flare. The parameter monitors the amount of time for which the temperature of flare is above the set point, during the flare operation period. If flame temperature is detected for less than 20 minutes in an

	hour (whenever biogas is sent to flare), flare efficiency is assumed to be 0%. Otherwise flare efficiency is assumed to be 50%.
QA/QC procedures to be applied (if any):	The thermocouple is calibrated regularly once in a 3 years as stated in the GS-annex. In addition to that, if the thermocouple is not functioning satisfactorily, it is replaced by a new thermocouple or repaired / calibrated accordingly. .
Any comment:	For this monitoring period, since no temperature readings are available, the flare efficiency is assumed to be 0.

Parameter:	EC_y
Unit:	MWh
Description:	Electricity consumed by waste water treatment facility over the year.
Measured /Calculated /Default:	Measured
Source of data:	Electricity meter is available at the distribution panel in control room. This meter monitors the amount of power supplied to the equipment in the waste water treatment plant. The electricity meter is also available at the point where power is exported and imported from PEA.
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 41.98 **2009 (01/10-09/11)**: 176.88
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The values are used for estimating the project emissions. If the PEA meter value is used for estimation of baseline emissions, the value from same meter shall be taken for import value of electricity. This will ensure no double counting of project emissions during the particular month. The monthly consolidated reports are available for all the months and are used for estimation of project emissions. For the months of Nov 2008 and Nov 2009, the time in the monitoring period is not a complete month. A different approach is followed for two months i.e. Nov 2008 and Nov 2009, since these months are part of monitoring period only partially. The details of approach are explained below in the section 'Comment'.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Internal Meter Equipment: DIN Integra 1630; 3 phase meter Accuracy: 0.2% Serial No. 402786 Calibrations: To be done every 3 years, meter installed in January 2008 Validity: January 2011 PEA Meter: Equipment: PEA as per the national standards Serial No. 20963014 Accuracy Class of PEA meter: 0.5%
Measuring/Recording frequency	Internal Meter: The electricity consumed is monitored continuously and recorded everyday in the log sheets. PEA Meter: The PEA officials and plant operator take reading on first day of every month and based on these official readings, the invoices are raised.

Calculation method (if applicable):	The value of power consumption depends on the point at which power export reading is taken in calculation of baseline emissions. The internal power meter (incomplete months) is compared to PEA import meter for Nov 2008 and Nov 2009 and higher of the two values is used for project emission estimation. This ensures conservativeness of project emissions for the incomplete months.
QA/QC procedures to be applied (if any):	The meters are calibrated by PEA and copies of calibration are provided. The date of calibration is 27th Feb 2009. The internal meters are not calibrated. These meters are still within first 3 years of the installation and shall be calibrated in line with the monitoring plan or as per latest version of general guidance.
Any comment:	For the months when the consolidated monthly reading is not available, the following method is used for estimation. Internal export meter – Maximum(Internal import meter, PEA meter) Here the internal readings are available on daily basis, so internal readings are added up for that month for the specific number of days which is part of the monitoring period. The approach will be applied for Nov 2008 and Nov 2009. This ensures that a conservative value is taken. However the above calculation is for net electricity. The terms are mentioned separately in the monitoring report and excel sheet.

Parameter:	EG_y
Unit:	MWh/y
Description:	Electricity generated during year y by power generation facility
Measured /Calculated /Default:	Measured
Source of data:	The electricity exported to grid is measured at each generator and the control panel. The cumulative power is again monitored at the point of upload. This monthly reading is the basis of electricity invoices that are sent to the Provincial Electricity Authority (PEA).
Value (s) of monitored parameter:	**2008 (10/11-31/12)**: 515.88 **2009 (01/10-09/11)**: 3,834.55
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for estimating baseline emissions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Internal Meter Equipment: EPM-07S, ENTES Accuracy: 0.2% Serial No. M10190010-00 Calibrations: To be done every 3 years, meter installed in January 2008 Validity: January 2011

	PEA Meter: Equipment: PEA as per the national standards Serial No. 20964863 Used till 9th December 2008 Serial No.: 20963040 Meter used after 9th December 2008. Accuracy class of PEA meters: 0.5%
Measuring/Recording frequency	Internal Meter: The electricity generated is monitored continuously and recorded everyday in the log sheets. PEA Meter: The PEA officials and plant operator take reading on first day of every month and based on these official readings, the invoices are raised. Continuous monitoring in both meters. The meter was changed on 9th December 2009. Details of both meters provided above.
Calculation method (if applicable):	Since the data at the point of grid supply is more conservative (it accounts for the transmission losses). The reading for complete months is taken from export readings as per PEA meter. However for months when only half of the months are part of monitoring report i.e. Nov 2008 and Nov 2009, the approach as explained in comment is followed.
QA/QC procedures to be applied (if any):	The meters are calibrated by PEA and copies of calibration are provided. The date of calibration are Meter Sr. No. 20964863: 19th May 2006 Meter Sr. No. 20963040: 27th February
Any comment:	For the months when the consolidated monthly reading is not available, the following method is used for estimation. Internal export meter – Maximum(Internal import meter, PEA meter) Here the internal readings are available on daily basis, so internal readings are added up for that month for the specific number of days which is part of the monitoring period. The approach will be applied for Nov 2008 and Nov 2009. The internal meters are not calibrated. These meters are still within first 3 years of the installation and shall be calibrated in line with the monitoring plan or as per latest version of general guidance. This ensures that a conservative value is taken. However the above calculation is for net electricity. The terms are mentioned separately in the monitoring report and excel sheet.

5. Emission reduction calculation

As per the monitoring plan in the registered PDD, the calculation approach should ensure the conservativeness of the emission reductions estimated, the two approaches used for estimation of the emission reductions are as follows:

- The Emission reduction based on ex-ante formulas, using the ex-post monitored values of the COD, biogas usage, power consumption etc.

- The Emission Reductions based on the amount of biogas collected, used and destructed by the project activity. This is a more direct approach. In this case the only project emissions are from the power usage.

The formulae for the two approaches are briefly mentioned as below. The detailed calculations are part of excel files provided.

5.1. Baseline emissions

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS.III.H version 9) and the emission due to the displacement of electricity from the grid (calculated according to AMS.I.D version 13).

$$BE_y = BE_{y,el} + BE_{y,ww} \qquad (1)$$

Where :

BE_y	Baseline emissions in the year "y" (t CO_2e).
$BE_{y,el}$	Baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e.
$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y".

$$BE_{y,el} = EF_y \cdot EG_y \qquad (2)$$

Where :

$BE_{el,y}$	the baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e/MWh.
EG_y	Electricity generated during year y by power generation facility (MWh)
EF_y	Emission factor from the electricity displaced by the project activity during year "y". As electricity is exported to the grid, the emission factor of the national grid will be chosen: $EF_y = EF_{grid,y}$. (Calculated – Fixed ex-ante)

In line with para 18 of AMS I.D version 13; a comparison is made between the amount of electricity generated using the biomass fuels (biogas) and electricity generation based on the specific fuel consumption and amount of fuel used in the project activity. The specific fuel consumption is available in terms of 100% load factor and design performance efficiency. In actual conditions the efficiency and load factor would be lower than design values.

For the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery (option (vi) according to AMS.III.H), Paragraph 24 of AMS III.H. Version 09, applies to baseline emissions as follows: (Ex-Ante Approach)

$$BE_{y,ww} = Q_{y,ww} \cdot \sum_j (COD_{y,removed,j} \cdot B_{o,ww} \cdot MCF_{ww,treatment,j} \cdot GWP\_CH_4) \qquad (3)$$

Where:

$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2/yr).
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)

$COD_{y,removed,i}$ Chemical oxygen demand removed by the anaerobic wastewater treatment systems “i” in the baseline situation in the year “y” to which the sequential anaerobic treatment step is being introduced in tonnes/m^3 (COD content of in the inlet and outlet of the lagoon system has been monitored for determination of the COD removed)

$B_{o,ww}$ Methane producing capacity of the wastewater (The IPCC default value for domestic wastewater of 0.21 kg CH_4/kg COD)[8]

$MCF_{ww,treatment,j}$ Methane correction factor for the existing anaerobic wastewater treatment systems “i” to which the sequential anaerobic treatment step is being introduced (MCF lower value in Table III.H.1.)

GWP_CH_4 Global Warming Potential for methane (value of 21 is used)

$BE_{y,\ biogas}$ = ($Q_{biogas,\ generator,\ y}$ * $\%CH_4 * D_{CH4}/1000 * GWP_{CH4}$) + ($Q_{biogas,flare,y}$ * $\%CH_4$ * D_{CH4} /1000 * GWP_{CH4}* Flare Efficiency)

$Q_{biogas,\ generator,\ y}$ The biogas quantity destructed in gas engine for electricity production.

$Q_{biogas,flare,y}$ The biogas quantitiy flared by the project activity.

Flare Efficiency The efficiency of the flare operation.

For biogas approach it shall be noticed that the project facility has a gas storage available at the site. The amount of biogas generated shall not be equivalent to the sum of biogas used in gas engine and the flare, due to the gas storage system.

5.2. Project emissions

<u>Project emissions</u>

The project activity emissions are calculated as follows:

$$PE_{y,ww} = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} + PE_{y,upgrading} + PE_{y,leakage,pipeline} \quad (4)$$

Where:

PE_y Project activity emissions in the year “y” (tCO_2e)

$PE_{y,power}$ Emissions from electricity or fossil fuel consumption in the year “y”

$PE_{y,ww,treated}$ Emissions from degradable organic carbon in treated wastewater in year “y”

$PE_{y,s,final}$ Emissions from anaerobic decay of the final sludge produced in the year “y”.

$PE_{y,fugitive}$ Emissions from methane release in capture and utilization/combustion/flare systems in year “y”

$PE_{y,dissolved}$ Emissions from dissolved methane in treated wastewater in year “y”.

$PE_{y,upgrading}$ Emissions related to the upgrading and compression of biogas in year “y”

$PE_{y,leakage,pipeline}$ Emissions due to physical leakage from the dedicated piped network in year “y”.

Project activity emissions from degradable organic carbon in the treated wastewater ($PE_{y,ww,treated}$)

[8] As per AMS.III.H, the IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties.

$$PE_{y,ww,treated} = Q_{y,ww} \cdot COD_{y,ww,treated} \cdot B_{o,ww} \cdot MCF_{ww,final} \cdot GWP_{CH4} \qquad (5)$$

Where:

$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2e)
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater in the year "y" (tonnes/m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH4/kg COD)[9]
$MCF_{ww,final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (as per AMS.III.H a value of 0.2 shall be used for wastewater discharge to sea, river or lake)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

Project activity emissions from anaerobic decay of the final sludge ($PE_{y,s,final}$)

$$PE_{y,s,final} = S_{y,final} * DOC_{y,s,final} * \frac{16}{12} * MCF_{s,final} * DOC_F * F * GWP_{CH4} \qquad (6)$$

Where:

PEy,s,final	Methane emissions from the anaerobic decay of the final sludge generated in the wastewater system in the year "y" (tCO2e)
Sy,final	Amount of final sludge generated by the wastewater treatment in the year "y" (tonnes)
DOCy,s,final	Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used.
MCFs,final	Methane correction factor of the landfill that receives the final sludge, estimated as described in category AMS III.G. A default conservative value of 1 will be used.
DOCF	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH4 in landfill gas (IPCC default of 0.5)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

The sludge removed from project activity is used for starting new anaerobic digesters or restarting other digesters by the same technology provider and is not dumped on a landfill site. Thereby no emissions from sludge removal take place in project activity.

Fugitive emissions from methane release in capture and flare systems ($PE_{y,fugitive}$)

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s} \qquad (7)$$

Where:

$PE_{y,fugitive,ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in year "y" (tCO2e);
$PE_{y,fugitive,s}$	Fugitive emissions through capture and ulitization/combustion/flare inefficiencies in the anaerobic sludge treatment in the year "y" (tCO2e)

[9] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

The second term of the equation above is not applicable because the project activity does not comprise an anaerobic treatment system for sludge; it consists of an anaerobic treatment system for wastewater only. Hence, the term $PE_{y,fugitive,s}$ is neglected.

The first term of the equation above is calculated as follows:

$$PE_{y,fugitive,ww} = (1 - CFE_{ww}) \cdot MEP_{y,ww,treatment} \cdot GWP_{CH4} \qquad (8)$$

Where:

CFE_{ww} Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment (a default value of 0.9 is used).

GWP_{CH4} Global Warming Potential for methane (value of 21 is used)

$MEP_{y,ww,treatment}$ Methane emission potential of the wastewater treatment plant in the year "y" (tonnes), which is calculated according to the equation below:

$$MEP_{y,ww,treatment} = Q_{y,ww} \cdot B_{o,ww} \cdot \sum_j COD_{y,removed,j} \cdot MCF_{ww,j} \qquad (9)$$

Where:

$Q_{y,ww}$ Volume of wastewater treated in the year "y" (m^3/yr)

CODy,removed,j The chemical oxygen demand removed by the treatment system "j" of the project activity equipped with methane recovery in the year "y" (tonnes/m^3)

MCFww, j Methane correction factor for the wastewater treatment system "j" equipped with methane recovery and combustion/flare/utilization equipment (MCF higher values in table III.H.1)

$B_{o,ww}$ Methane producing capacity of the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH4/kg COD)[10]

For this project we will only consider one treatment system j :

- The treatment system will be the UASB digester. CODy,removed,j will be estimated as the difference of the COD values between the inlet and outlet of the digester.

Emissions from dissolved methane in treated wastewater ($PE_{y,dissolved}$)

$$PE_{y,dissolved} = Q_{y,ww} \cdot [CH_4]_{y,ww,treated} \cdot GWP_{CH4} \qquad (10)$$

Where:

$PE_{y,dissolved}$ Emissions from dissolved methane in treated wastewater in year "y" (t CO_2e).

$Q_{y,ww}$ Volume of wastewater treated in the year "y" (m^3/yr)

$[CH4]_{y,ww,treated}$ Dissolved methane content in the treated wastewater (tonnes/m3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of $10e^{-4}$ tonnes/m3 can be used

GWP_{CH4} Global Warming Potential for methane (value of 21 is used)

Here a the default value for the dissolved methane in anaerobic treatment has been applied: $[CH4]_{y,ww,treated} = 10^{-4}$ tonnes/m^3

Emissions from flaring of biogas ($PE_{y,flare}$)

[10] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

The project emissions from flaring are incorporated into the emission reduction calculations as per the clarifications to the version 09 of the methodology[11].

$$PE_{y,flare} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000} \quad (11)$$

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in hour h (kg/h)
$\eta_{flare,h}$	Flare efficiency in hour h.

If the flare efficiency is constant / proved to be default value over the whole monitoring period. The formula can be rewritten as follows:

$$\sum_{h=1}^{8760} TM_{RG,h} = Q_{biogas,flare,y} \text{ X } \%CH_4 \text{ X } D_{CH4}$$

$Q_{biogas,flare,y}$	The biogas quantitiy flared by the project activity (Nm3)
$\% CH_4$	Methane % in biogas, based on 95% confidence limit, for conservative estimation.
D_{CH4}	Density of methane at normal conditions

Emission from upgrading and use of bottled biogas $PE_{y,upgrading}$ and from pipeline leakage $PE_{y,leakage,pipeline}$

No production, upgrading, pipeline transportation and use of bottled biogas is planned in this project, thus:

$PE_{y,leakage,pipeline} = 0$
$PE_{y,upgradining} = 0$

Project activity emissions from electricity or fossil fuel consumption ($PE_{y,power}$)

All the equipments that are involved in operation of biogas generation and consumption are to be included in estimation of power consumption. The power consumption (MWh) will be multiplied with the national grid emission factor of electricity (t $CO2_2$/MWh).

$$PE_{y,power} = EF_y * EC_y \quad (12)$$

Where :

$PE_{y,Power}$	Emissions from electricity or fossil fuel consumption in the year "y" (t CO_2e)
EC_y	Electricity consumed during year y from the national grid (MWh)
$EF_{grid,y}$	Emission factor from the national grid electricity consumed by the project activity during year "y" (t CO_2e/MWh)

No fossil fuel will be used for the operation of the project activity. Only electricity will contribute to $PE_{y,Power}$.. $EF_{grid,y}$ is calculated ex-amte and remains fixed during the whole crediting period.

[11] http://cdm.unfccc.int/UserManagement/FileStorage/AM_CLAR_7MXW3CMZV4OVLA7J2QFUJ0MAMUKBVA

5.3. Emission reductions

In the absence of any leakage, emission reductions are the difference between the baseline emissions and the project emissions:

$$ER_y = BE_y - PE_y - L_y \qquad (13)$$

There are no leakages as per AMS IIIH and AMS ID, and the same is clearly demonstrated in the registered PDD.

Ex-ante Approach: $BE_{y,ww} + BE_{y,el} - PE_{y,power} - PE_{y,ww,treated} - PE_{y,fugitive} - PE_{y,dissolved}$

Ex-Post Approach: $BE_{y,biogas} + BE_{y,el} - PE_{y,\,power}$

6. QA/QC aspects of Monitoring.

6.1. Monitoring Management

1. Monitoring Management

The registered monitoring plan for the project activity and the actual plan are to use SCADA system to capture the data on regular basis from the continuous basis. This would ensure limiting the errors caused due to human intervention. However during this monitoring period, the automated records are not available as SCADA system is not fully stable.

For the current monitoring period, the errors are addressed as follows:

- The plant manager checks the data on regular basis and after the readings are input in excel from log sheet a recheck is done. This reduces the scope of errors during data transfer.
- Since the totalizer readings are reported in log sheets, even if a wrong value is entered on one day, the same would come under suspicion on the following day when a new totalized value is recorded. This ensures the errors are minimized over a period of time such as a month or a year.

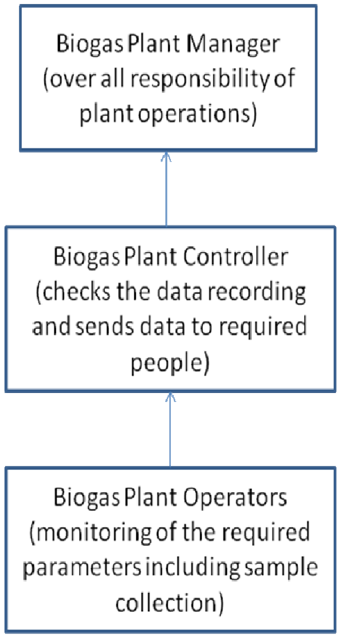
Flow meters are regularly calibrated to recognize procedures by the operator (who is also the turn-key supplier of technology) and sampling is carried out by the onsite staff according to appropriate industrial standards.

Data acquisition for the gas and wastewater flow meters is executed through the process control unit of the biogas plant and the plant operations software.

2. Data Storage and Filing – Electric Workbook

All relevant data is stored electronically with the process control computer unit, external storage media and transferred. A daily log is printed.

The data collection and checking is done as follows:



Biogas Plant manager: The plant manager is responsible for overall operation of plant and is also responsible for all CDM related procedural and monitoring requirements. He makes sure that staff members discharge their responsibilities rightly and efficiently.

Biogas Plant Controller: The controller takes care of day to day activities and coordination of various CDM related monitoring and procedural requirements. He makes sure that all data is integrated and timely sent to the required people on monthly basis.

Biogas Plant Operators: Responsible for operation of the biogas plant along with the power generation component. The sample collection and maintaining the log records for various measurements are made sure by the plant operators. In addition, there are couples of support staff available.

The project staff is provided on the job training to perform various tasks.

3. Additional information about the monitoring period:

- In the current Monitoring period, the methane utilization ratio for biogas is approximately 97%, which is over 65% limit as per GS regulations.
- For the current monitoring period, the flare emissions cannot be calculated based on monitoring procedures as per the applicable methodology because the information in the PDD was not in line with actual project implementation and created some confusion for the operation staff. This was later clarified and discussed upon how to rectify changes and implement the monitoring plan. The monitoring plan in the PDD shall be revised in the coming months.

7. Summary of results

7.1. Monitoring Data

Monitored Parameters

Parameter	Unit	10 Nov-31 Dec 2008	1 Jan-9 Nov 2009
Q_{ww}	m^3	63,303	472,391
COD_{inlet}	mg/l	13,902	13,778
COD_{outlet}	mg/l	452	473
$COD_{y,removed}$	mg/l	13,746	13,543
$COD_{y,ww,treated}$	t/m^3	0.000170	0.000170
$S_{y,final}$	tonnne	-	-
% CH4	%	62.7%	59.0%
$Q_{biogas,total,y}$	Nm^3	264,495	2,299,218
$Q_{biogas,generator,y}$	Nm^3	247,605	2,249,695
$Q_{biogas,flare,y}$	Nm^3	16,890.0	48,633
EG_y	kWh	515,883	3,834,550
EC_y	kWh	41,981	176,880

7.2. Emission reduction calculation

Baseline emissions

		2008 10 Nov - 31 Dec	2009 1 Jan - 9 Nov
$Q_{y, ww}$	m^3	63,303	472,391
$COD_{y, removed}$	mg/l	13,746	13,543
$B_{o, ww}$	$kgCH_4/kgCOD$	0.21	0.21
$MCF_{ww, treatment, i}$		0.80	0.80
GWP_{CH4}		21	21
$Q_{biogas,total,y}$	Nm^3	264,495	2,299,218
$Q_{biogas,generator,y}$	Nm^3	247,605	2,249,695
D_{CH4}	kg/Nm3	0.716	0.716
%CH4		60.7%	57.6%

$BE_{y, power}$	tCO_2	261	1939
$BE_{y,ww}$(COD)	tCO_2	3070	22570
$BE_{y,ww}$ (biogas)	tCO_2	2258	19489

Project emissions

		2008 10 Nov - 31 Dec	2009 1 Jan - 9 Nov
$Q_{y, ww}$	m^3	63,303	472,391
GWP_{CH4}		21	21
$B_{o, ww}$	$kgCH_4/kgCOD$	0.21	0.21
$COD_{y, ww, treated}$	t/m^3	0.000170	0.000170
$MCF_{ww, final}$		0.2	0.2
$PE_{y, ww, treated}$	tCO_2	**9**	**71**
$PE_{y, s, final}$	tCO_2	**0**	**0**
$MEP_{y, ww, treatement}$		182.7	1343.5
$Q_{biogas, flare, y}$	Nm^3	16,890	48,633
Flare Efficiency		0%	0%
CH4% -	%	64.72%	60.3%
$PE_{y,flare}$	tCO_2	**164.4**	**441.2**
$PE_{y, fugutive, ww}$	tCO_2	**384**	**2821**
$PE_{y, dissolved}$	tCO_2	**132.9**	**992.0**
EF_y	tCO_2/MWh	0.5057	0.5057
EC_y	MWh	41.98	176.88
$PE_{y, power}$	tCO_2	**21.2**	**89.4**

Emission reduction

		2008 10 Nov - 31 Dec	2009 1 Jan - 9 Nov
ER (COD Approach)	tCO_2	2,619	20,095
ER (Biogas Approach	tCO_2	2,498	21,339
ERy (final)	**tCO_2**	**2,497**	**20,094**

7.3. Summary

The project activity achieves **22, 591** tCO_2 Emission Reductions during the monitoring period from November 10th, 2008 to November 9th, 2009.

Annex – Gold Standard Monitoring Parameters

No		1
Indicator		Air quality: *Odour from the wastewater treatment plant*
Chosen parameter		Volume of biogas production and combustion (Nm^3)
Implications on monitoring requirements and justification		Approach as per GS Annex: As explained by the project owner during the public consultation, the odour will be reduced as a result of the project activity, because the new system is a closed system and the biogas produced is utilized for electricity and heat generation. Any gases that would lead to odour emissions (mainly H_2S and other sulphur compounds) are captured with the biogas and removed in the desulphurization system (gas scrubber) prior to reaching the engines, without release of odour emissions to the atmosphere.
Way of monitoring	How	Measured using gas flow meters at the reactor outlet and at the inlet of the engine/generator sets and flare system. The gas meters are capable of monitoring the biogas volume in normalized conditions and the same is reported as per the monitoring plan. The combustion of the biogas, and consequently the destruction of any gases that would lead to odour emissions, is monitored through measurement of the energy output of the engine/generator systems as well as the flame detection period of the flare system. More details about all these parameters are provided in the monitoring plan (Section B.7) of the registered PDD.
	When	Continuously using totaliser meters
	By who	Bangna biogas plant operator
QA/QC procedures to be applied		Meters will undergo maintenance / calibration subject to appropriate industry standards. In the event of technical problems with a biogas flow meter, the value can be calculated based on a mass balance using the other installed gas meters (e.g. biogas sent to gas engine = total biogas produced – biogas sent to flare). The calculations which use biogas volumes from various gas flow meters have to make sure that the gas volumes are monitored under similar conditions. The gas meters for the project activity monitor the biogas volumes at normalized conditions.
Monitored Value & Frequency		2008 (10 Nov - 31 Dec): 247,605 Nm^3 (Biogas Combusted) 2009 (1 Jan – 9 Nov): 2,249,695 Nm^3(Biogas Combusted) Related to $Q_{biogas,generator,y}$ and $Q_{biogas,flare,y}$

No		2
Indicator		Employment (numbers)
Chosen parameter		Number of employed staffs who come from the local community and the level of income generation into the area.
Implications on monitoring requirements and justification		Approach as per GS Annex: Reference to the organisation chart is also made available to show number jobs created by the project activity; the project owner expects to increase the number. Note that it was the request of the local stakeholders for priority to be given to local people for employment at the project plant. Since the project owner confirmed that it is the company's policy to give priority to qualified villagers for employment. The purpose of this monitoring parameter is to assure that the project owner complies with this pledge.
Way of monitoring	How	Number of employees and the level of income generation will be recorded through salary payment records.
	When	Monthly
	By who	P & Papop Renewable Co., Ltd., management

QA/QC procedures to be applied	NA. Careful monitoring of salary payments and expenditures is a general practice of the company required for financial accounting as per Thai regulations.
Monitored Value & Frequency	Recorded Monthly and Monthly records provided as attachments. On an average 11 people are employed at a given time at the project site. Out of these 10 people are from the same or nearby province in a radius of 100km from the project site. The provinces include Sarakham: 3 Khon-Khaen: 2 Roi Et : 2 Kalasin.3 All positions of responsibility at project site are taken care by above people except for the plant head.

No		3
Chosen parameter		Power generation capacity of project activity
Implications on monitoring requirements and justification		This is to ensure the authenticity of the explanation given by the project proponent that there is no plan to increase the power generation capacity of the project activity. Only reason that would justify an investment of additional gas engine would be that its operation and maintenance would have taken around 3-4 weeks, meaning a loss of revenue (from power generation) to the project owner. Thus, the new addition of power generation capacity, if implemented, would only be there to allow a continuation of electricity generation during this period, and not because of an increase in biogas generation capacity due to reason such as change in starch production capacity.
Way of monitoring	How	The project proponent proposes that the DOE verify the operational condition of the available gas engines. In case it is found that the gas engine(s) is replaced with a new one during any verification, adequate reason (e.g. only as a backup engine) must be given to allow claim of emission reductions.
	When	Periodical (along with the verification of the project activity)
	By who	DOE responsible for the verification of the project activity during each monitoring period.
QA/QC procedures to be applied		-
Monitoring Value and Frequency		2.85 MW Checked during verification

Parameter 4, 5 and 6 are related to flare. These parameters were not monitored during this period. The flare efficiency is assumed 0 for this period to ensure that non-monitoring has no affect on the emission reduction estimate.

No		7
Chosen parameter		Occurrence of wastewater overflow and its compensation measure.
Implications on monitoring requirements and justification		As evidence during the stakeholder consultation meeting, one concern of the local stakeholders is in regards to the wastewater overflow that happened with the baseline situation. Note that the occurrence of such event will be reported by the affected stakeholders to the local authority (e.g. local governor office), who will then pass on the message to local Industrial office for further inspection, as well as guidance for the necessary mitigation and compensation measures. Despite already clear procedures on the same, this parameter is included in the sustainability monitoring plan so that the occurrence of such incidents and the implementation of necessary compensations are well documented.
Way of monitoring	How	Internal report shall be made to record the occurrence of such event and the amount of money spent to compensate the affected

		stakeholders for the damage cause.
	When	Periodical (depending on the occurrence of wastewater overflow)
	By who	P & Papop Renewable Co., Ltd., management
QA/QC procedures to be applied		Government archive (from the Provincial Industrial Office) can be requested for cross-checking of such event.
Monitoring Value and Frequency		No occurrence recorded during the monitoring period.

No		8
Chosen parameter		Amount of treated wastewater released to the villagers (m^3)
Implications on monitoring requirements and justification		Approach as GS Annex: This is in respond to the request from the local stakeholders during the consultation process. The local stakeholders enquired as to whether treated wastewater can be released to the villagers to be used as fertilizer; the project owner agreed to such request under the condition approval is given by local authority. The purpose of the monitoring parameter is to ensure that the wish of the stakeholders can be satisfied.
Way of monitoring	How	In the absence of volumetric wastewater flow meter to monitor the same, weighing bridge is used to measure the weight of vehicle before and after it transport wastewater out of the plant; the difference is deemed as the amount of wastewater released to the villagers. In recording this parameter, plant's operators shall manually archive the monitored data onto hard copy log sheets then transfer to the computer for electronic storage.
	When	Periodical (depending on the amount of wastewater given to farmers)
	By who	Bangna biogas plant operator
QA/QC procedures to be applied		Villagers' signatures are needed on the records. The weighbridge shall also undergo regular maintenance and calibration as per acceptable national or international standards. The calibration shall be performed at a minimum of once in three years as per general CDM requirement.
Monitoring Value and Frequency		No occurrence recorded during the monitoring period.