

Monitoring Report

Voluntary Carbon Standard 2007.1

SD Biosupply Wastewater Treatment and Biogas Utilization Project

VCS Reference Project ID: 416

Monitoring Period: March 28th, 2006- December 31st, 2008

1st Periodic Verification

Emission Reductions claimed in this Monitoring Period: **39,137 tCO₂e**

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1. Introduction

1.1. Project background

The project was implemented at SD Starch Co. Ltd. on August 18th, 2005. Prior to implementation of the project activity, the wastewater of the starch plant the plant was treated in 8 cascading open anaerobic lagoons.

The project activity entails the installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) biogas reactor technology, at the existing starch manufacturing plant, replacing the open anaerobic lagoon based system. The biogas reactor system generates and recovers biogas for energy generation purposes, avoiding methane emissions to the atmosphere. The captured methane is used as fuel in existing heat generating devices in the starch plant replacing heavy fuel oil partially, which leads to further green house gas emission reductions (CO₂) by replacing fossil fuel. Any surplus methane is flared in an open flare. The boiler in this case already exists at the project site as an integral part of starch plant operation.

1.2. Project layout

The project boundary is shown in the Figure 1 below.

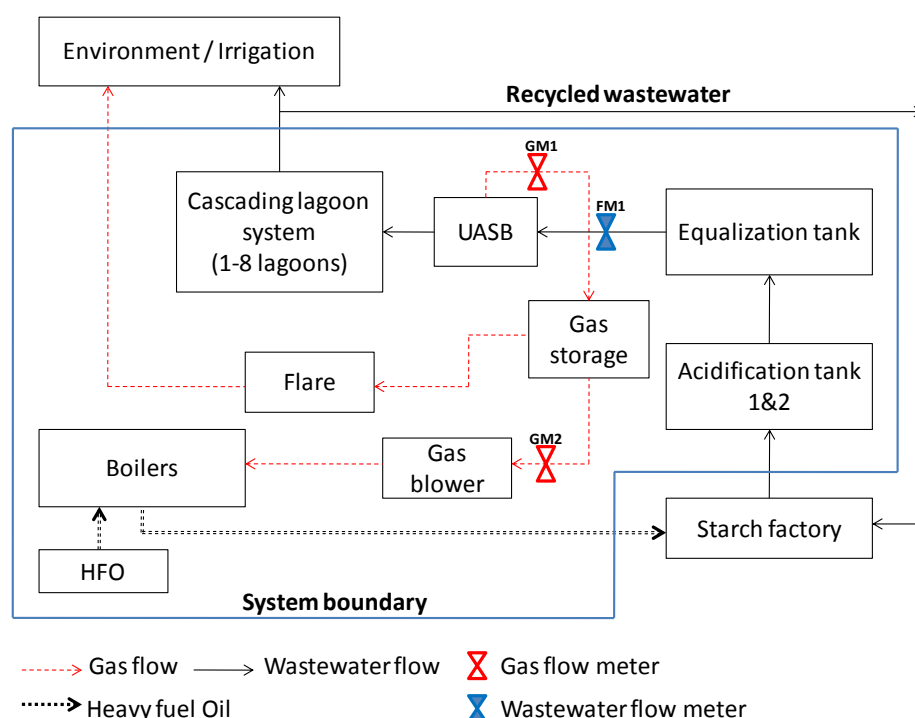


Figure 1: The project system boundary (after UASB digester implementation)

1.3. Purpose of the monitoring

In the absence of the project, the wastewater from the tapioca processing plant would have been treated in open anaerobic lagoons. After the implementation of the UASB reactor, methane

generated is recovered and used as an alternative to fossil fuel. This achieves emission reduction in two ways:

- Avoidance of fugitive methane emissions to the environment by using UASB digesters.
- Avoidance of carbon dioxide emissions from replacement of fossil fuel with biogas.

By means of this Monitoring Report greenhouse gas emission reductions achieved by the project activity “**SD Biosupply Wastewater Treatment and Biogas Utilization Project**” at SD Biosupply Co. Ltd. Thailand are being verified and certified as per requirements of the Voluntary Carbon Standard, Version 2007.1.

Further background information on the project activity can be found in the Project Design Document (PD) and associated documents, which have also been submitted for validation as per requirements of the Voluntary Carbon Standard, Version 2007.1. The PD and associated documents are available on the VCS project data base at the following link: <https://vcsprojectdatabase1.apx.com/mymodule/ProjectDoc/EditProjectDoc.asp?id1=416>

VCS PD dated Nov 19th 2009 version 6.4 is the final validated version of PD, which has been uploaded on the VCS registry.

2. Reference

Section 3.3 of the PD (Application of the baseline and monitoring methodology) provides all details in regard to calculation of emission reductions and the 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 AMS III.H., Version 12 and AMS I.C., Version 14:

Methane avoidance component:

Type III: Other Project Activities
Category III.H: Methane Recovery in Wastewater Treatment
Sectoral Scope 13: Waste Handling and Disposal
Version 12

Thermal energy generation component:

Type I: Renewable energy projects
Category I.C: Thermal energy for the user with or without electricity
Sectoral Scope 1: Energy Industries
Version 14

3. Monitoring Results

3.1. Monitoring period

This is the first monitoring report of this project activity. It covers the period from March 28th, 2006 to December 31st, 2008 (Both days included).

3.2. Presentation of monitoring results

All monitoring data is available in an Excel spreadsheet that includes:

1. The monitored parameters during the monitoring period.
2. Calculation of emission reductions for the monitoring for every day of the monitoring period on a yearly basis.
3. Calculation of Emission reduction

3.3. Emission reductions

The calculated emission reductions achieved by the project activity within the covered monitoring period amount to 39,137 tCO₂e.

3.4. Monitoring Parameters

In addition to parameters which are available at validation and fixed ex-ante for the whole crediting period, the following parameters were monitored during the monitoring period.

Data / Parameter:	Q _{ww, y}
Data unit:	m ³
Description:	Volume of wastewater in year y
Source of data to be used:	Measured - Volumetric flow meters – FM1
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 227,287.9 m ³ Jan 01, 2007 to Dec 31, 2007 = 295,408.5 m ³ Jan 01, 2008 to Dec 31, 2008 = 258,509.1 m ³
Description of measurement methods and procedures to be applied:	A flow meter for wastewater measurement is provided.
QA/QC procedures to be applied:	Periodic calibrations for flow meter are ensured. The meter is high accuracy magnetic kind. For the time period, which is not covered by calibration reports, a correction factor in accordance with the maximum error probability of flow meter (0.5%) is applied to the reported meter readings. The meter is found to be within permissible limit after calibration.
Any comment:	This is the amount of waste water entering the UASB system.

Data / Parameter:	COD _{ww, untreated, y}
Data unit:	mg/l
Description:	COD of wastewater entering the UASB treatment plant
Source of data to be used:	Measured – Colorimeter analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 23,218.66 Jan 01, 2007 to Dec 31, 2007 = 23,178.78 Jan 01, 2008 to Dec 31, 2008 = 20,857.48
Description of measurement methods and procedures to be applied:	The COD content is analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results are logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The colorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{y, out, UASB} = COD_{y, ww, treated}$
Data unit:	mg/l
Description:	COD of water exiting the UASB treatment process.
Source of data to be used:	Measured – Colorimeter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 1,033.44 Jan 01, 2007 to Dec 31, 2007 = 1,619.7 Jan 01, 2008 to Dec 31, 2008 = 1,280.37
Description of measurement methods and procedures to be applied:	The COD content is analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results are logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The colorimetric method is well documented and well accepted either by national or international standards.
Any comment:	During the days when COD out is not available. The maximum value of COD out observed during the particular year is used in rest of the days. This is a conservative approach.

Data / Parameter:	$S_{final, PJ, y}$
Data unit:	Tonnes or m^3 and type of application
Description:	The amount of final sludge generated by the wastewater treatment in the year y and type of application/disposal
Source of data to be used:	Data made available by technology supplier.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 0 tonne Jan 01, 2007 to Dec 31, 2007 = 1,000 tonne Jan 01, 2008 to Dec 31, 2008 = 0 tonne
Description of measurement methods and procedures to be applied:	The amount of sludge removed from the project activity is made available for this monitoring period and the end use condition of the same is confirmed by technology provider.
QA/QC procedures to be applied:	The technology provider, holds the rights to procure all sludge from the project proponent and makes sure that the sludge removed is either used for soil application or start up of other anaerobic reactors (most of times).
Any comment:	The reading has no affect on the final estimation of emission reductions.

Data / Parameter:	$BG_{prod, y}$
Data unit:	Nm^3
Description:	Amount of biogas produced by the digester
Source of data to be used:	Measured – Gas flow meter (GM1)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 2,739,134.00 Jan 01, 2007 to Dec 31, 2007 = 4,529,572.00 Jan 01, 2008 to Dec 31, 2008 = 4,182,894.00
Description of measurement methods and procedures to be applied:	The biogas produced is monitored using the gas flow meters directly. The reading is already adjusted for the time period when the calibration is not available.
QA/QC procedures to be applied:	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	A correction of 0.6% is applied to the biogas produced on the positive side from 15/11/2007 to 8/09/2008. The values above are not the corrected results as the corrected results have only a negative impact on emission reductions.

Data / Parameter:	W_{CH_4}
Data unit:	%
Description:	Methane content in the biogas in the year y
Source of data to be used:	Ex-post monitored values (conservative approach)

Value of data applied for the purpose of calculating expected emission reductions in section B.5	As per the monitoring plan the methane content in biogas shall be monitored on regular basis. The methane analyzer is not available for first monitoring period and thereby conservative approach is used to estimate the emission reductions. The deviation is explained in Annexure to this document (Deviation 3). A value of 71.4% is used based on ex-post monitored data. The high value ensures more conservative emission reductions.
Description of measurement methods and procedures to be applied:	In future, Project proponent is planning to put a methane analyzer, to closely monitor the amount of methane generated in biogas. The methane analyzer readings are available after 19 Jan 2010. The sample readings are provided with this submission.
QA/QC procedures to be applied:	
Any comment:	Please refer to Deviation 3

Data / Parameter:	$BG_{TOFlare, y}$
Data unit:	Nm^3
Description:	Amount of biogas sent to flare in the year y
Source of data to be used:	Calculated from total biogas produced and biogas utilized in boiler.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 781,092 Jan 01, 2007 to Dec 31, 2007 = 989,033 Jan 01, 2008 to Dec 31, 2008 = 480,036 The exclusion of some negative flaring data is done as the conservativeness approach for emission reduction estimation.
Description of measurement methods and procedures to be applied:	The biogas sent to flare system is calculated using measured values of total biogas generated and biogas utilized in boiler system. Total biogas generated is measured using gas meter - GM1; and biogas utilized in boiler using gas meter - GM2.
QA/QC procedures to be applied:	The daily logs of volume of biogas production and biogas sent to boiler are maintained by biogas plant operators under the biogas plant manager's supervision; as an internal process to ensure the reliability of data.
Any comment:	Please refer to Deviation 4 presented in the Annex 1.

Data / Parameter:	$BG_{combusted, y}$
Data unit:	Nm^3
Description:	Amount of biogas sent to boiler in the year y
Source of data to be used:	Measured using gas flow meter (GM2).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 1,958,907.00 Jan 01, 2007 to Dec 31, 2007 = 3,620,676.00 Jan 01, 2008 to Dec 31, 2008 = 3,852,238.49 For 29 th February to 31 st December 2008, a correction factor of 0.6% is applied to these readings to ensure conservativeness for the period when calibration is not available.
Description of measurement methods and procedures to be applied:	These flow meters are integrated with Supervisory Control And Data Acquisition system (SCADA).
QA/QC procedures to be applied:	Periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	A correction factor of 0.6% is applied to these readings to ensure conservativeness for the period when calibration is not available. 0.6% represents the standard error in the reading of the flow meter.

Data / Parameter:	$Q_{FO, y} = FC_{HFO, y}$
Data unit:	Litres
Description:	Quantity of fossil fuel co – fired or fired along with biogas during a year y .
Source of data to be used:	Fuel usage records available. Value can be used for conservative esti-

	mation of biogas / methane used in replacement of fossil fuel during an year y. The approach is not in line with the monitoring plan and is explained the deviation 6 of the Annex – I.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 874,560 Jan 01, 2007 to Dec 31, 2007 = 526,810 Jan 01, 2008 to Dec 31, 2008 = 273,300
Description of measurement methods and procedures to be applied:	A proper record of all the fossil fuel consumed shall be maintained at the project site. However this record is not available during monitoring period. During monitoring period the purchase records of the fuels are used for estimation of the project emissions in the project activity.
QA/QC procedures to be applied:	The annual monitored values for fuel oil consumption shall be compared to the fuel oil purchase invoices.
Any comment:	

Data / Parameter:	$Q_{\text{starch}, y}$
Data unit:	Tonnes
Description:	Quantity of starch produced
Source of data to be used:	Monitored from company monthly / weekly / daily records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 43,824,345 Jan 01, 2007 to Dec 31, 2007 = 64,876,080 Jan 01, 2008 to Dec 31, 2008 = 60,944,315
Description of measurement methods and procedures to be applied:	Production records of the starch manufacturing unit.
QA/QC procedures to be applied:	The starch production records are kept carefully and can be compared against transportation records as well. However the production records are quite exhaustive.
Any comment:	-

Data / Parameter:	EC_y
Data unit:	MWh
Description:	Electricity consumption by UASB plant in a year y
Source of data to be used:	Electricity transmission meter provided at point of supply to entire waste water treatment plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Mar 28, 2006 to Dec 31, 2006 = 136.43 Jan 01, 2007 to Dec 31, 2007 = 350.95 Jan 01, 2008 to Dec 31, 2008 = 509.75 (includes Jan 2009)
Description of measurement methods and procedures to be applied:	As per Meter readings from PEA bills.
QA/QC procedures to be applied:	Maintained by PEA.
Any comment:	The value for 2008 includes the Jan 2009 reading also to make the estimation more conservative. This is in response to TR comment.

Data / Parameter:	$\eta_{\text{flare-h}}$
Data unit:	%
Description:	Efficiency of flare
Source of data to be used:	Flare design parameters.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50%

Description of measurement methods and procedures to be applied:	The flare is an automatic open flare and the flare system ensures the flare operation when gas is sent to the flare unit. The flare specifications are provided.
QA/QC procedures to be applied:	Flare maintenance is ensured on regular basis.
Any comment:	-

4. Calculation of GHG emissions

Emission reduction calculations are split in two parts, (A) methane avoidance component according to AMS III.H Version 12, and (B) heat generation component according to AMS.I.C, Version 14.

A) Methane avoidance component

According to the paragraph 31 AMS III.H, emission reduction achieved by the project activity is limited to the ex-post calculated baseline emissions minus project emissions using the actual monitored data for the project activity.

Emission reductions achieved on any year are the lowest value of the following;

$$ER_{y, ex-post} = \min(BE_{y, ex-post} - PE_{y, ex-post} - LE_{y, ex-post}), (MD_y - PE_{power, y} - PE_{biomass, y} - LE_{y, ex-post}) \quad (1)$$

Where,

Parameter	Details
$ER_{y, ex-post}$	Emission reductions achieved by the project activity based on monitored values for year y (tCO ₂ e)
$BE_{y, ex-post}$	Baseline emissions calculated <i>ex post</i> based on monitored values
$PE_{y, ex-post}$	Project emissions calculated <i>ex post</i> based on monitored values
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year y

1) Baseline emissions as per AMS.III.H (BE_y):

According to the paragraph 16 of AMS III.H, baseline emissions for the systems affected by the project activity may consist of:

- Emissions on account of electricity or fossil fuel used ($BE_{power, y}$);
- Methane emissions from baseline wastewater treatment systems ($BE_{ww, treatment, y}$);
- Methane emissions from baseline sludge treatment systems ($BE_{s, treatment, y}$);
- Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww, discharge, y}$);
- Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s, final, y}$).

For this project activity, as explained in the VCS PD:

$$BE_{power, y} = 0$$

$$BE_{ww, discharge, y} = 0$$

$$BE_{s, treatment, y} = 0$$

$$BE_{s, final, y} = 0$$

Therefore, the baseline emissions are calculated as follows:

$$BE_y = BE_{ww, treatment, y} \quad (2)$$

Where the methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww, treatment, y}$) are determined using the methane generation potential of the wastewater treatment systems as per the paragraph 20 of AMS III.H version 12. The following equation is used.

$$BE_{ww, treatment, y} = \sum_i Q_{ww, i, y} * COD_{removed, i, y} * MCF_{ww, treatment, BL, i} * B_{o, ww} * UF_{BL} * GWP_{CH4} \quad (3)$$

Where,

Parameter	Details
$BE_{ww, treatment, y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO ₂ e)
$Q_{ww, i, y}$	Volume of wastewater treated in baseline wastewater treatment system i in year y (m ³)
$COD_{removed, i, y}$	Chemical oxygen demand removed by baseline treatment system i in year y (tonnes/m ³) measured as the difference between inflow COD and the outflow COD in system i
$MCF_{ww, treatment, BL, i}$	Methane correction factor for the baseline anaerobic wastewater treatment i (MCF values as per table III.H.1)
i	Index for baseline wastewater treatment system
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC lower value for domestic wastewater of 0.21 kg CH ₄ /kg COD)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)
GWP_{CH4}	Global Warming Potential for methane (value of 21)

2) Project emissions as per AMS.III.H (PE_y):

As per the paragraph 26 of AMS III.H, Project activity emissions from the systems affected by the project activity are:

- CO₂ emissions on account of power and fuel used by the project activity facilities ($PE_{power, y}$);
- Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{ww, treatment, y}$);
- Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s, treatment, y}$);
- Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww, discharge, y}$);
- Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s, final, y}$);

- (vi) Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive, y}$);
- (vii) Methane emissions due to incomplete flaring ($PE_{flaring, y}$);
- (viii) Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{biomass, y}$).

As explained in the VCS PD, the following emissions are not taken into consideration:

$PE_{s, treatment, y}$, $PE_{ww, discharge, y}$, $PE_{s, final, y}$ and $PE_{biomass, y}$. Therefore, the project emissions are calculated as follows:

$$PE_y = PE_{power, y} + PE_{ww, treatment, y} + PE_{fugitive, y} + PE_{flaring, y} \quad (4)$$

Where,

Parameter	Details
PE_y	Project emissions in year y (tCO ₂ e)
$PE_{power, y}$	Emissions from electricity or fuel consumption in the year y (tCO ₂ e)
$PE_{ww, treatment, y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (tCO ₂ e)
$PE_{fugitive, y}$	Methane emissions from biogas release in capture systems in year y (tCO ₂ e)
$PE_{flaring, y}$	Methane emissions due to incomplete flaring in year y (tCO ₂ e)

Emissions from electricity consumption ($PE_{y, power}$)

Emissions from electricity consumption by the project activity facilities are calculated according to the paragraph 19 of AMS III.H as given below.

$$PE_{Power, y} = EC_y * EF_y \quad (5)$$

Where,

Parameter	Details
$PE_{y, power}$	Emissions from electricity consumption in the year y (tCO ₂ e)
EC_y	Electricity from the grid consumed by the project activity (wastewater treatment, biogas recovery and biogas utilisation/flaring systems) (MWh)
EF_y	Thailand National Grid emission factor (tCO ₂ e/MWh)

Emissions from degradable organic carbon in treated wastewater ($PE_{y, ww, treated}$)

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation are calculated as per equation 2/paragraph 20 in AMS.III.H using an uncertainty factor of 1.06. The following equation is used.

$$PE_{ww, treatment, y} = \sum Q_{ww, k, y} * COD_{removed, PJ, k, y} * MCF_{ww, treatment, PJ, k} * B_{o, ww} * UF_{PJ} * GWP_{CH4} \quad (6)$$

Where,

Parameter	Details
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$PE_{ww, treatment, y}$	Emissions from degradable organic carbon in treated wastewater in year y (tCO ₂ e)
$Q_{ww, k, y}$	Volume of wastewater treated in project wastewater treatment system k in year y (m ³)
$COD_{y, removed, PJ, k}$	Chemical oxygen demand removed by project wastewater treatment system k in year y (tonnes/m ³), measured as the difference between inflow COD and the outflow COD in system k
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH ₄ /kg COD)
$MCF_{ww, treatment, PJ, k}$	Methane correction factor for project wastewater treatment system k
UF_{PJ}	Model correction factor for uncertainties (1.06)
GWP_{CH_4}	Global Warming Potential for methane (value of 21 is used)

Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive, y}$)

Project activity emissions from methane release in capture systems are determined as per paragraph 27 of AMS III.H as given below.

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

Where,

Parameter	Details
$PE_{fugitive, y}$	Emissions from methane release in capture and utilization/combustion/flare systems in year y (tCO ₂ e)
$PE_{fugitive, ww, y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (tCO ₂ e)
$PE_{y, fugitive, s}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (tCO ₂ e)

a. Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment ($PE_{fugitive, ww, y}$)

These emissions are calculated as follows;

$$PE_{fugitive, ww, y} = (1 - CEF_{ww}) * MEP_{ww, treatment, y} * GWP_{CH_4} \quad (8)$$

Where,

Parameter	Details
CEF_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww, treatment, y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (tonnes)

$$MEP_{ww, treatment, y} = Q_{ww, y} * B_{o, ww} * UF_{PJ} * \sum_k COD_{removed, PJ, k, y} * MCF_{ww, treatment, PJ, k} \quad (9)$$

Where,

Parameter	Details
$Q_{ww,y}$	Volume of wastewater treated in project wastewater treatment system k in year y ($m^3/year$)
$B_{o,ww}$	Methane producing capacity of the wastewater
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)
$COD_{removed, PJ, k, y}$	The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y (tonnes/ m^3)
$MCF_{ww, treatment, PJ, k}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment (MCF values as per table III.H.1)

b. Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y ($PE_{y, fugitive, s}$):

Sludge will be used only for land application, therefore no sludge treatment envisaged in the project activity. Therefore emission from sludge treatment is not taken into consideration.

Methane emissions due to incomplete flaring ($PE_{flaring, y}$)

Methane emissions due to incomplete flaring in year y are calculated as per the “Tool to determine project emissions from flaring gases containing methane” (tCO_2e). The project proponent has installed an open flaring system. For the determination of the flare efficiency, the default value of 50% will be used for the ex-ante calculation of project emissions from flaring gases. The ex-post factor to be used for flare efficiency is subject to monitoring requirements as described in Section 3.3.

Steps 1 to 7 of the “Tool to determine project emissions from flaring gases containing methane” (hereafter the flaring tool) are used to determine the project emissions from flaring of the biogas stream (called residual gas stream in the flaring tool) as explained in the VCS PD.

It should be noted that, although not explicitly mentioned in the flaring tool, Steps 1 and 2 are not required for calculation of Steps 5 to 6, since all input values required in Steps 5 to 6 are either measured during the monitoring of the project or are calculated without use of the parameters defined under Steps 1 and 2. Hence, project emissions from flaring are calculated on the basis of Steps 5 and 6 of the tool as follows:

$$PE_{flaring, y} = \sum_{h=1}^{8760} TM_{RG, h} * (1 - \eta_{flare-h}) * GWP_{CH_4} / 100 \quad (10)$$

Where:

Parameter	Details
$PE_{flare, y}$	Project emissions due to flaring of biogas (tCO_2e)
$TM_{RG, h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)
$\eta_{flare-h}$	Flare efficiency in hour h (%), default value of 0.5
GWP_{CH_4}	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

The formula can be rewritten as follows:

$$\sum_{h=1}^{8760} TM_{RG, h} = Q_{biogas, flare, y} * \%CH_4 * D_{CH_4} \quad (11)$$

Parameter	Details
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)
$Q_{biogas,flare,y}$	The biogas quantity flared by the project activity (Nm^3)
% CH_4	Methane % in biogas
D_{CH_4}	Density of methane at normal conditions

The amount of biogas sent to flare is not directly monitored. Please refer to the **Deviation 4** explained in the Annex 1 of the report.

The methane percentage in biogas is not monitored but assumed as per ex-post data available after the monitoring period. Please refer to **Deviation 3**.

3) Calculation of Methane captured and destroyed

As per paragraph 32 in AMS III.H., in case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} * w_{CH_4,y} * D_{CH_4} * FE * GWP_{CH_4} \quad (12)$$

Where:

Parameter	Details
$BG_{burnt,y}$	Biogas flared/combusted in year y (m^3)
W_{CH_4}	Methane content in the biogas in the year y (mass fraction)
D_{CH_4}	Density of methane at the temperature and pressure of the biogas in the year y (tonnes/ m^3)
FE	Flare efficiency in year y (fraction)

As per answers to authors of query by the SSC WG “in the case that the biogas is combusted for a gainful use of the released energy as in an engine or a power plant, a destruction efficiency of 100% can be used for the portion of biogas that is combusted when applying AMS III.H., i.e. use a value of 100% for FE in equation 16 in paragraph 32 for the portion of biogas that is combusted for a gainful use”¹. Based on this, the alternative MD_y value is deviated from the approved methodology and can be calculated as follows:

$$MD_y = W_{CH_4} * D_{CH_4} * GWP_{CH_4} * [(BG_{TOFlare,y} * FE) + (BG_{combusted,y} * DE)] \quad (13)$$

Where:

Parameter	Details
$BG_{TOFlare}$	Biogas sent to flare in year y (Nm^3 /year)
FE	Flare efficiency (fraction)
$BG_{combusted,y}$	Biogas combusted for gainful use in year y (Nm^3 /year)

¹ <http://cdm.unfccc.int/UserManagement/FileStorage/VNWAGY8MS92ZXDKUHEF5LB07QICT1P>

DE	Destruction efficiency of biogas combusted for a gainful use (fraction)
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With reference to the clarification made by the SSC WG, this approach can be considered as not impact negatively on the conservativeness of the applied methodology's criteria and procedures to quantify data leading to GHG emission reductions or removals. The clarification from EB, as referenced above, can be used to substantiate this statement. Please refer to the deviation 1 explained in the Annex 1.

B) Heat generation component

1) Baseline emissions as per AMS.I.C:

As per paragraph 15 of AMS I.C, for steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

$$BE_{thermal,CO2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO2} \quad (14)$$

Where:

Parameter	Details
$BE_{thermal,CO2,y}$	the baseline emissions from steam/heat displaced by the project activity during the year y in tCO ₂ e
$EG_{thermal,y}$	the net quantity of steam/heat supplied by the project activity during the year y in TJ.
$EF_{FF,CO2}$	the CO ₂ emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO ₂ / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used.
$\eta_{BL,thermal}$	the efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

As per the VCS PD, the amount of energy delivered by the dual fuel fired boiler shall be used to estimate the baseline emissions. Due to incompleteness of the monitoring equipments, a deviation has been made, based on amount of heat required for starch drying, which in turn is estimated on heat requirements per tonne of starch based on historical data. The approach estimates the thermal energy delivered by the project activity based on historical fuel oil consumption and starch production for the given year.

The deviated approach ensures that efficiency lost in system due to dual fired system is conservatively adjusted in baseline emissions. This means that if any efficiency loss happens due to dual fired system and the energy of same is supplied by fuel oil, using the given approach the loss is accounted in biogas usage, thereby estimating lower fuel oil replacement for baseline emission estimation. The conservativeness of approach is ensured comparing the total energy delivered by the fuels burnt in the project activity and thermal energy estimate based on historical fuel oil consumption values.

Please refer to the **Deviation 2** explained in the Annex 1.

2) Project emissions as per AMS.I.C:

According to paragraph 24 of AMS-I.C, CO₂ emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”.

$$PE_{FC,y} = FC_{HFO,y} * NCV_{HFO} * EF_{HFO,CO_2} \quad (15)$$

Parameter	Details
PE _{FC, y}	Project emissions due to combustion of fossil fuel in year y (tCO ₂ e)
FC _{HFO, y}	Amount of fossil used in the boiler in ton/yr
NCV _{HFO}	NCV of fossil fuel used in the process (0.0404 TJ/tonne)
EF _{HFO,CO₂}	Emission factor of Heavy fuel oil as per IPCC (77.4 tCO ₂ /TJ)

The fossil fuel consumption at the project site is monitored for estimation of project emissions.

C) Leakage emissions (LE_v) as per AMS.III.H and AMS.I.C:

The used technology is not equipment transferred from another activity, therefore according to AMS.III.H and AMS.I.C, there is no leakage to be considered.

5. QA/QC procedure and Calibration for monitored parameters

1) Monitoring Management

The required monitoring equipment is installed by the operator. Flow meters are regularly calibrated to recognize procedures by the operator (who is also the turn-key supplier of technology) and sampling of wastewater is carried out on daily basis by the onsite biogas plant operator 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. Lab data is fed into the operations software through a manual data entry user interface.

2) Quality Assurance and Quality Control

The biogas plant manager monitors overall performance of the plant, ensures proper and timely calibration, data acquisition and storage.

The biogas plant operators and staffs are trained according to operating manual of biogas system before they start to work at this department.

3) On-site Procedures

The operations software creates daily logs of plant performance which are printed out and recorded electronically for periodic download onsite or remote transfer for further processing.

Procedures for Calibration of Equipment

The biogas plant operator carries out calibration according to international standards.

4) Data Storage and Filling – Electric Workbook

All relevant data is stored electronically in excel sheet. The monitoring records shall be archived for a period of crediting period + 2 years.

Calibration Record

The calibration record of Waste water flow meter is shown below;

Flow meter	Serial number	Position	Calibration record
FM1	S/N 6B00F220000	Waste water volume flow to UASB	External calibration by Endress+Hauser Date : 08/12/2004 Date : 25/03/2008

The calibration record of Gas meter are shown bellow;

Gas meter	Serial number	Position	Calibration record
GM1	C9-9086	Biogas produced Installed since biogas plant start commissioning.	External calibration by Endress+Hauser Date : 15/11/2004
GM1	6571	Biogas produced Meter installed on September 9 2008	External calibration by FOX Date : 05/09/2008
GM2	EJ-10209	Biogas sent to Boiler	External calibration by Endress+Hauser Date : 26/02/2005

The calibration record of COD measurement is shown below;

Equipment	Serial number	Model	Calibration record
Colorimeter	HAC041090C53333	DR/890	External calibration by Envi Science Co.,Ltd Date : 06/05/08

The calibration record of electricity consumption of SD Biosupply Co., Ltd.

Electricity consumption of SD Biosupply Co., Ltd. is the meter of The Provincial Electricity Authority (PEA) who is the government organization of Thailand. Therefore, they do not have any respond for calibration of this meter.

6. Summary of Results

6.1 Project Activity Emissions

Project Emissions (AMS.III.H)

		2006	2007	2008
UF _{PJ}		1.06	1.06	1.06
COD _{out,UASB}	tonnes	235.9	448.5	326.6
PE _{treated,y}	t CO ₂	773.1	1469.7	1070.2

MEP _{ww, treatment,y}	tonnes	895	1063	876
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PE _{fugitive, ww,y}	tCO ₂ /yr	1879	2233	1839
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PE _{flaring,y}	t CO ₂	4195.36	5312.24	2578.34
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EF _y	tCO ₂ /MWh	0.52	0.52	0.52
EC _y	MWh	136.43	350.95	509.75
PE _{power,y}	tCO ₂ /yr	71.08	182.84	265.58

PE _{s, final,y}	tCO ₂ /yr	0	0	0
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PE - ex post	tCO ₂ /yr	6918	9198	5753
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Project emissions (AMS.I.C)

PE _{FC,y} - Fossil Consumption =	tCO ₂ /yr	2543	1532	795
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6.2 Baseline Activity Emissions

Baseline Emissions (AMS.III.H)

		2006	2007	2008
$Q_{ww,y} =$	m ³	228430	296893	259296
$COD_{y, loading} =$	tonne	5260.031812	6418.836665	5245.131359
COD - removal efficiency baseline		0.876235962	0.876235962	0.876235962
$B_{o, ww} =$		0.21	0.21	0.21
UF_{BL}		0.94	0.94	0.94
$MCF_{ww, treatment, i} =$		0.8	0.8	0.8
$GWP_{CH_4} =$		21	21	21
BE_y - Ex post (COD)		15285.01516	18652.36167	15241.71625

$BG_{prod, y} =$	Nm ³	2739134	4529572	4182894
$BG_{combusted,y} =$	Nm ³	1958907	3620676	3852238.494
$BG_{ToFlare,y} =$	Nm ³	781092	989032.698	480035.626
$D_{CH_4} =$	kg/Nm ³	0.716	0.716	0.716
$W_{CH_4} =$		0.714437928	0.714437928	0.714437928
FE =		0.5	0.5	0.5
DE =		1	1	1
MD_y =	tCO ₂	25238.50237	44206.5842	43960.19861

Baseline emission (AMS.I.C)

		2006	2007	2008
$Q_{starch, y} =$	kg	43824345	64876080	60944315
$q_{FO, starch} =$	l/kg	0	0	0
$Q_{FO, y} =$	litres	874560	526810	273300
Density of fuel Oil (D_{FO}) =	ton/m ³	1	1	1
$NCV_{FO} =$	GJ/tonne	40	40	40
$EF_{FF,CO_2} =$	tCO ₂ /TJ	77	77	77
$NCV_{CH_4} =$	TJ/tonne	0	0	0
$EG_{thermal,y}$ - Fuel energy input	GJ	82977	112428	108827
$EG_{thermal,y}$ - Historical data basis	GJ	55734	82506	77506
BE_{Thermal, CO₂, y}	tCO₂	4314	6386	5999

6.3 Emission Reductions

This table summarizes the ER according to the ex-post approach (based on the biogas production) and might closer to the real performance of the project. The values are calculated as per para 31 of AMS III.H version 12.

Emission reductions (methane avoidance)

ER y _{expost} - AMS IIH (tCO ₂ /yr)	COD	8367	9455	9488
	MD _y	25167	44024	43695

Emission reductions (AMS.I.C)

ER - AMS IC (tCO ₂ /yr)		1771	4854	5204
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Emissions reductions Total

Emission Reduction - Total	tCO ₂	10137	14308	14692
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Hence Emission Reductions for this monitoring period as calculated are 39,137 tCO₂eq VERs.

Annex – I

Explanation of conservative approach for deviations in monitoring period

Approach in VCS PD	Approach in Monitoring Period – Deviated approach.	Explanation of Conservativeness
1) In the case that biogas is combusted for a gainful use of the released energy, it is unrealistic to assume a destruction efficiency of the flare system in the calculation of MD_y as prescribed in paragraph 32 of AMS III.H.	A destruction efficiency of 100% is used for the portion of biogas that is combusted for gainful use i.e. in boiler or gas engines. For the portion of biogas that is sent to flare, default flare efficiency is the same according to the prescribed value for an open flare system (50%).	This approach has been confirmed by the SSC WG; also agreed to include that such approach will be included in a future revision of AMS III.H. Based on this reference, it can be concluded that the approach is conservative and does not impact negatively on the conservativeness of emission reduction calculation and the additionality of the project.
2) Baseline emissions for estimating the fossil fuel replaced. The methodology AMS I.C., version 14 (paragraph 15), <i>the baseline emissions are estimated based on the amount of heat/steam delivered by the equipment.</i>	The project proponent uses a conservative approach, based on amount of heat required for starch drying, which in turn is estimated on heat requirements per tonne of starch based on historical data. The approach estimates the thermal energy delivered by the project activity based on historical fuel oil consumption and starch production for the given year.	Due to incompleteness of the monitoring equipments, a deviation has been made to the approach specified in validated PD. The deviated approach ensures that efficiency lost in system due to dual fired system is conservatively adjusted in baseline emissions. This means that if any efficiency loss happens due to dual fired system and the energy of same is supplied by fuel oil, using the given approach the loss is accounted in biogas usage, thereby estimating lower fuel oil replacement for baseline emission estimation. The conservativeness of approach is ensured comparing the total energy delivered by the fuels burnt in the project activity and thermal energy estimate based on historical fuel oil consumption values.
3) Methane percentage in biogas is monitored using online methane analyzer and is used to estimate the amount of methane collected and destroyed.	The methane percentage in biogas is not monitored but assumed as per ex-post data available after the monitoring period.	The methane analyzer is installed recently and the readings are available for comparison. For baseline emissions, the methane percentage has no affect as the COD approach is much more conservative than the biogas approach. However for project emissions, the 95% confidence interval value is determined and is used to determine the project emission from the project activity. The ex-post data is more conservative than the design value from the design specifications of the technology

		supplier (65%) for project emissions and is thereby applied.
4) Amount of biogas captured and amount of biogas utilized is monitored using continuous gas flow meters.	The biogas produced and utilized in the boiler is measured using the gas meter, however the gas sent to flare is estimated as difference of the two values.	As per para 36 of methodology, In all cases, <i>“the amount of biogas recovered, fuelled, flared or utilized (e.g., injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored ex post, using continuous flow meters.”</i> The emission reductions are estimated based on COD approach as this approach is much more conservative than the biogas approach.
5) Amount of sludge removed is monitored regularly	The amount of sludge removed is usually monitored on irregular basis. However the same can be estimated as suggested by the technology provider i.e. 5% of the COD removed by the reactor.	Since all the sludge removed is used for soil application (as confirmed during site visit and verified), the amount of sludge removed doesn't affect the emission reduction estimation. This approach doesn't make the emission reductions any less conservative.
6) The amount of heavy fuel oil consumed shall be monitored using continuous flow meter.	During the monitoring period, the readings from continuous flow meter are not recorded and thereby not available as part of monitored data. However the invoice for the fuel oil purchase are available and the total fuel invoices are used as a reading for fuel oil consumed.	As per the monitoring plan, the fuel consumption shall be monitored directly using a flow meter. All the consumed fuel is purchased and the invoices are available. So all the fuel purchased is considered for estimation of project emissions, even though the meter records are not available to cross check that if all the purchased fuel is consumed or not.

Deviation 1:

Easily justified as per the response to clarification <http://cdm.unfccc.int/UserManagement/FileStorage/VNWAGY8MS92ZXDKUHEF5LB07QICT1P>

The efficiency for flare system is still considered at 50%, based on the specifications as per the technology provider i.e. the system installed is an automatic flare system. The automatic flare system ensures the combustion of flared gas. The flare specification and operation logic is provided along.

Deviation 2:

As per the monitoring methodology, the amount of heat delivered shall be directly monitored for baseline emissions, i.e. amount of fuel that would be used in baseline scenario $BE_{thermal, CO_2, y} = (EG_{thermal, y} / \eta_{BL, thermal}) * EF_{FF, CO_2}$. The project emissions are based directly on amount of fossil fuel consumed by the project activity.

The only use of heat energy is to dry the wet starch from production process. Two approaches can be used to estimate the $EG_{thermal,y}$ in absence of monitored data.

- Methodological Approach: Amount of heat energy delivered by the project activity is calculated using the amount of fuels burnt in the project system. This gives an estimate of energy content made available by the fuels burnt in the project activity.
- Deviated Approach: The amount of fossil fuel that would have been consumed in the absence of project activity is estimated based on historical consumption of fossil fuel per tonne of starch production. This provides an estimate of $EG_{thermal,y}$. This approach is mentioned in the methodology as per 29(d) for a different situation i.e. if it can be demonstrated that it is difficult to monitor the direct heat supplied, in which case historical data can be used. In this scenario, the ex-post estimations the data is not available for the monitoring period and thereby the deviated approach is used. The actual usage of fuel oil i.e. project emissions in the project is monitored as per monitoring plan.

Explanation of why historical data is conservative:

The data is available for 3 years of starch production. The starch production is compared with fuel oil consumption and amount of fuel oil consumed per tonne of starch is established.

In the excel sheet a comparison is made between the amount of energy estimated theoretically using the default factor approach determined above against the actual energy delivered by the fuels on input side using the monitored values. These values clearly demonstrate that energy supplied by fuel based on theoretical approach is much lower than the actual energy supplied by fuels in the project activity.

Deviation 3:

For Baseline Emissions:

For baseline emissions, the methane percentage has no affect as the COD approach is much more conservative. The same is demonstrated in the comparison sheet in the excel worksheet.

For Project emissions:

The methane analyzer is installed recently and the readings are available for comparison. Methane percentage readings are available for year 2010 for the month of February and March. The 95% confidence interval value is determined and is used to determine the project emission from the project activity. This value is more conservative than the design value of methane percentage from Papop proposal (65%).

The calculation of the emission reductions has been done for the two values:

Methane percentage (%)		Emission reductions over the monitoring period (tCO ₂)
Design value:	65%	40,533
Ex-post value:	71.4%	39,448

Therefore, the value of 71.4% is used for determination of project emissions.

Deviation 4:

The deviation is explained in respect to the fact that as per the latest version of the AMS IIIH, version 14, para 36. Moreover the COD approach is much more conservative than biogas approach. A 5-10% variation in the biogas quantity will have no affect on the baseline emissions. For estimation of project emissions, the proponent already uses the most conservative approach of determining the flare emissions.