

Monitoring Report

Voluntary Carbon Standard 2007

Wastewater Treatment with Biogas production (UASB) and heat utilization at General Starch Co., Ltd.

Monitoring Period: 1st April 2008 to 31st August 2009

3rd Verification

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1. Project Background

By means of this Monitoring Report greenhouse gas emission reductions achieved by the project activity “Wastewater Treatment with Biogas production (UASB) and heat utilization at General Starch Co., Ltd.” are being verified and certified as per requirements of the Voluntary Carbon Standard, version 2007.

The project was successfully validated and verified under VCS 1 in 2007, and the reference documents are available. The first report is dated on 31st August 2007.

2. Monitoring Background

Section B of the PDD (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 AM0022 version 4.

3. Monitoring Results

3.1 Monitoring period

This is the third monitoring report of this project activity. It covers the period from 1st April 2008 to 31st August 2009 (both days included).

Papop Renewable Co., Ltd. is the Built Operating Transfer (BOT) Project for biogas plant project of General Starch Co., Ltd. They set up a well-defined management and operational system. This system includes the operation and management of the monitoring plan, which specifies the requirements and procedures for parameters monitoring, data recording and data archiving according to ISO9001:2000 since 8th February 2007 which is certified by Global Certification Limited.

The System Control And Data Acquisition (SCADA) is used to record operating data of biogas plant such as Wastewater flow of UASB #1 (ref. FM3) and UASB #2 (ref. FM5), Biogas produced by UASB #1 (ref. GM1) and UASB #2 (ref. GM2), Biogas sent to boiler (ref. GM3), Biogas sent to flare (ref. GM4), %CH₄ etc. The SCADA flow diagram is shown as figure 1.

A new gas meter (GM4) was installed at the pipeline between surge tanks and flare system to measure the amount of biogas sent to flare system on 29th January 2008. The new revision of SCADA flow diagram is shown in figure 2.

List of Serial no. of main monitoring equipments are provided in the following table;

Flow meter	Serial number	Position	Calibration record
FM3	6B00EB20000	Wastewater volume flow to UASB #1	External calibration by Endress+Hauser Date: 18/03/2008 Date: 02/07/2009
FM5	6B00E920000	Wastewater volume flow to UASB #2	External calibration by Endress+Hauser Date: 08/12/2004 Date: 18/03/2008 Date: 02/07/2009

Gas meter	Serial number	Position	Calibration record
GM1 (Old meter)	EJ-10214	Biogas produced from UASB #1	Internal calibration by Papop Co., Ltd. Date: 10/01/2008
GM 1 (Temporarily used)	A9010402000	Biogas produced from UASB #1	External calibration by Endress+Hauser Date: 17/09/2008 Installation at GM1 on 22nd September 2008 (Used during 22nd September 2008 – 15th May 2009)
GM 1 (New Meter)	C3010D02000	Biogas produced from UASB #1	External calibration by Endress+Hauser Date: 09/04/2009 Installation at GM1 on 15th May 2009
GM2 (Old meter 1)	EJ-10211	Biogas produced from UASB #2	External calibration by Endress+Hauser Date: 07/12/2004 (Pressure test report) Date: 24/01/2005
GM2 (Old meter 2)	F8-12093	Biogas produced from UASB #2	External calibration by Endress+Hauser Date: 24/01/2007 Internal calibration by Papop Co., Ltd. Date: 11/01/2008
GM2 (New meter)	AA083102000	Biogas produced from UASB #2	External calibration by Endress+Hauser Date: 21/10/2008 Installation at GM2 on 5th November 2008
GM3 (Old meter 1)	F8-12094	Biogas sent to Boiler	External calibration by Endress+Hauser Date: 13/12/2005 (Pressure test) Date: 20/12/2005
GM3 (Old meter 2)	EJ-10213	Biogas sent to Boiler	External calibration by Endress+Hauser Date: 07/02/2006 Internal calibration by Papop Co., Ltd. Date: 27-28/03/2007

GM3 (Removed from flare and put at boiler, GM3)	9B09BD02000	Biogas sent to Boiler	External calibration by Endress+Hauser Date: 29/11/2007 Un-installation at GM3 (to be sent back to GM4) on 8th October 2008
GM3 (New meter)	A9059602000	Biogas sent to Boiler	External calibration by Endress+Hauser Date: 19/09/2008 Installation at GM3 on 8th October 2008 (used onward)
GM4	9B09BD02000	Biogas sent to Flare	External calibration by Endress+Hauser Date: 29/11/2007 First Installation at GM4 on 12 th January 2008 Temporary un-installation at GM4 (to be used at GM3) on 1st September 2008 Second installation at GM4 on 8th October 2008 (used onward)
GM4 (Temporary meter- non used now- taken meter from other plant)	96092802000	Biogas sent to Flare	External calibration by Endress+Hauser Date: 25/06/2007 Temporary installation at GM4 on 10th September 2008 (used until 8th October 2008)
There is no meter available from 1 st September 2008 to 10 th September 2008 to measure the biogas sent to flare system. The biogas sent to flare is anyway conservatively estimated based on mass balance approach, from the data available from three other meters.			
%CH ₄	ABB EL 1020-IR 3.241376.5	Blower (prior at Boiler)	Internal calibration by Papop Co. Ltd. Date: 12/10/2007 Date: 29/01/2008 Calibration by using standard gas 70% Methane balance Carbon dioxide
Master Cal	69160049	Turbine gas meter	External calibration by PTT Public Co., Ltd. Date: 26 January 2007
COD Vario Photometer	38397	COD measurement	External calibration by ILAB Fluid Co., Ltd. Date: 22 May 2008

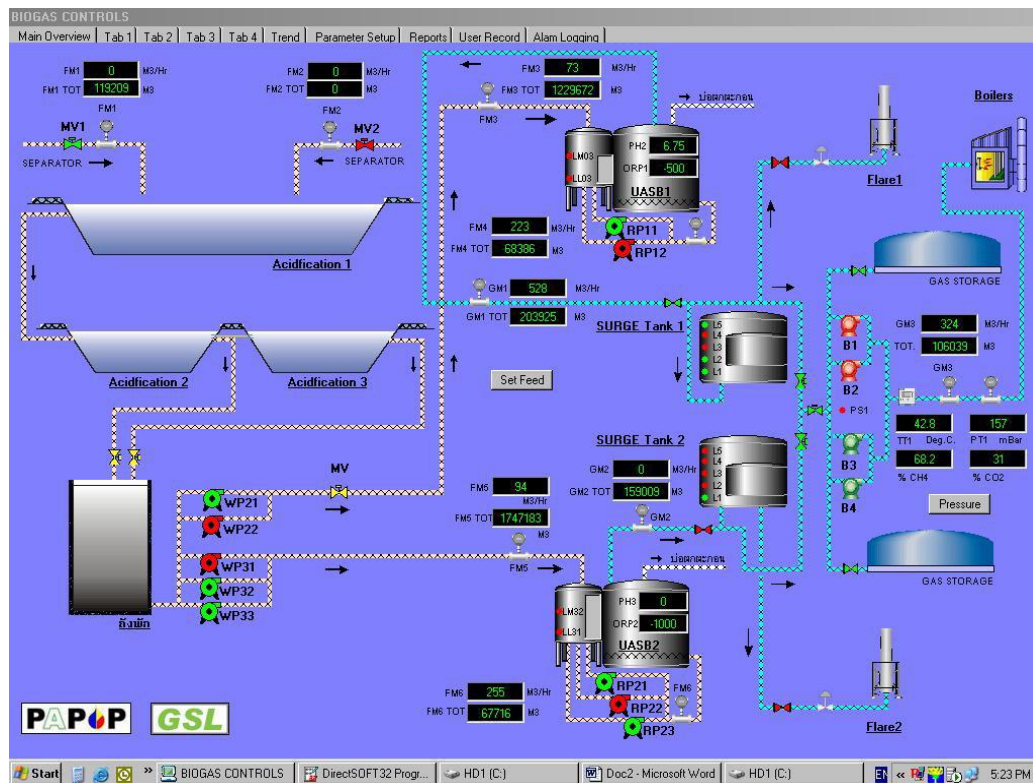


Figure 1: SCADA flow diagram of biogas plant before install gas meter at flare system (GM4)

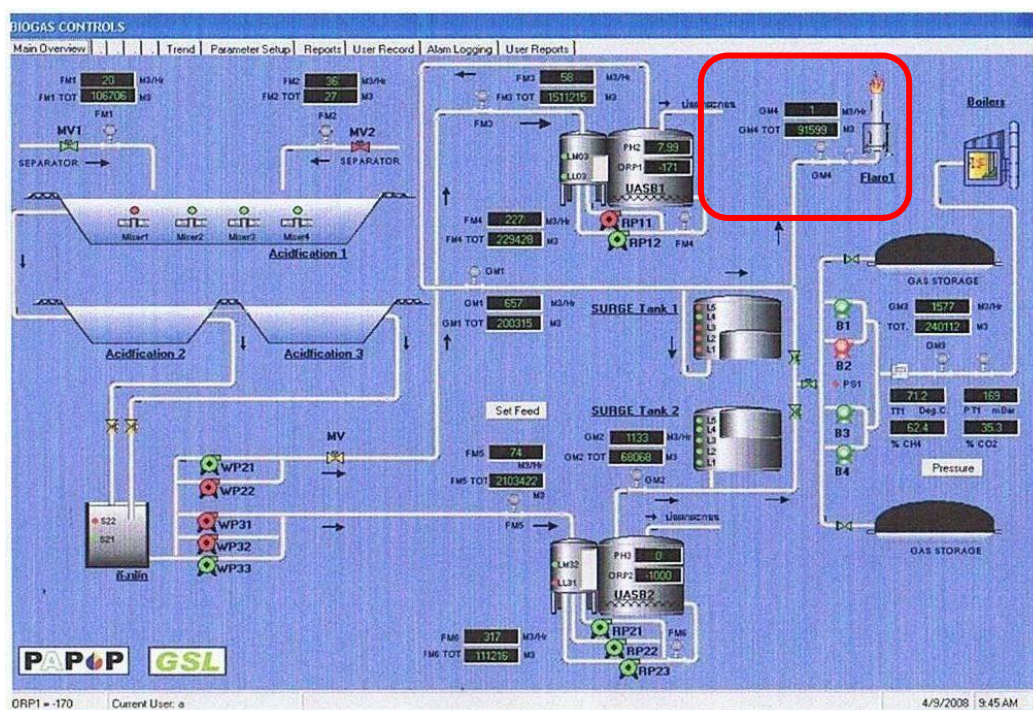


Figure 2: SCADA flow diagram of biogas plant after installed gas meter at flare system (GM4)

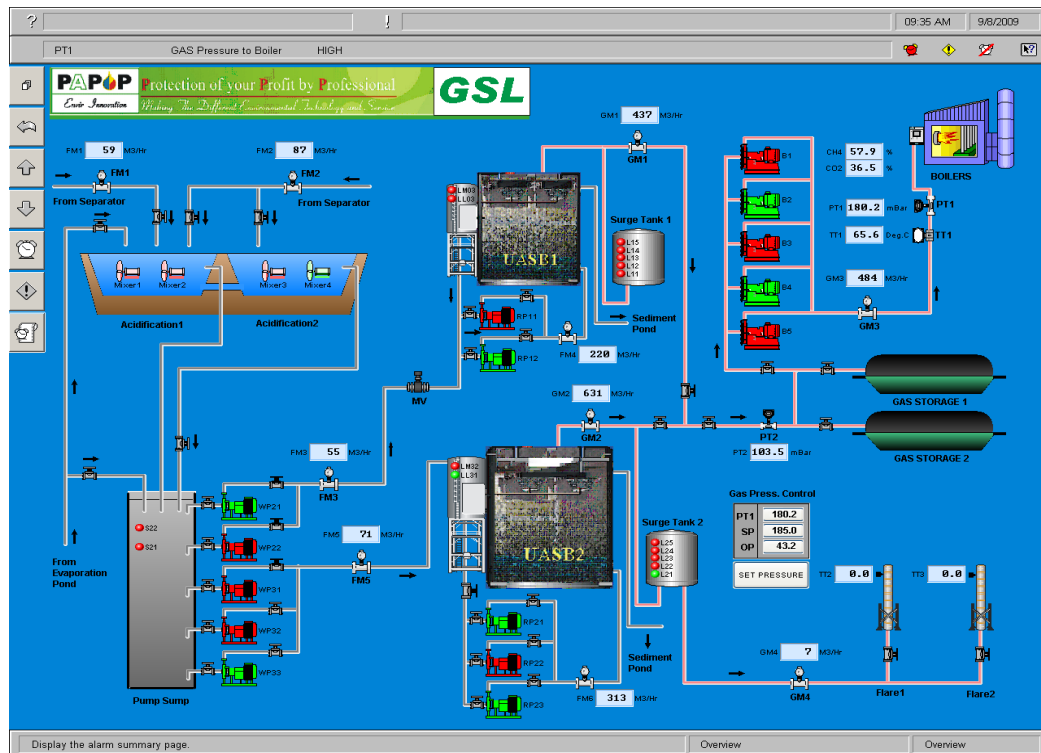


Figure 3: SCADA flow diagram of biogas plant after updating the SCADA screen (updated on September 2009)

3.2 Presentation of monitoring results

All monitoring data is available in excel sheet "044_GSL_3rdVerification_091202.xls".

The spreadsheets include an extract of the log of monitored data of the project activity:

- Covering the parameters associated with wastewater volume (FM3, FM5), biogas volume (i.e. generated biogas as per GM1 and GM2, utilized biogas as per GM3 and flared as per GM4), COD_{in} and COD_{out} concentration, methane concentration in biogas represented as monitoring parameters ID no 1-5, 8-12, 16 of AM0022
- Baseline and emission reduction calculation

3.3 Calculation methodology

Emission reductions were calculated on the basis of formula provided in AM0022 version 4 and applied to the project on the basis of an ex-ante calculation in the project PDD.

A. Project emissions

As per the equations set out in AM0022, the following equations are used to calculate project emission reductions from monitored data.

Total estimated project emissions are the summation of fugitive methane emissions from (1) the existing lagoon-based wastewater treatment system, (2) the possible methane emissions, (3) the new anaerobic wastewater treatment facility, (4) incomplete biogas combustion, and (5) biogas leaks.

$$E_{project} = E_{CH_4_lagoons} + E_{CH_4_NAWTF} + E_{CH_4_IC+Leaks}$$

Where:

$E_{project}$ are the Total Project Emissions (tCO₂e)

$E_{CH_4_lagoons}$ are the fugitive methane emissions from lagoons from equations 2 (tCO₂e)

$E_{CH_4_NAWTF}$ are the fugitive methane emissions from the new anaerobic waste water treatment facility (tCO₂e)

$E_{CH_4_IC+leakss}$ are the methane emissions from inefficient combustion and leaks (tCO₂e)

Formula 1	April 08 - December 08	January 09- August 09
$E_{project}$	9,456	7,884
$E_{CH_4_lagoons}$	0	1,929
$E_{CH_4_NAWTF}$	0	0
$E_{CH_4_IC+Leaks}$	9,456	5,955

- Fugitive Methane Emissions from Lagoons:**

$$E_{CH_4_lagoons} = M_{lagoon_anaerobic} \cdot EF_{CH_4} \cdot GWP_{CH_4} / 1000$$

Where:

$E_{CH_4_lagoons}$ is the methane emissions from the lagoons (tCO₂e)

$M_{lagoon_anaerobic}$ is the amount of organic material removed by anaerobic processes in the lagoon system (kg COD³)

EF_{CH_4} is the methane emission factor (kg CH₄ / kg COD). A default COD to Methane conversion factor of 0.21kg CH₄/kgCOD is used⁴. If the methodology is used for waste water containing materials not akin to simple sugars a CH₄, a different emissions factor different has to be estimated and applied. Where a metric for organic wastewater flows other than COD is to be applied, the developer should set out the case for a relevant carbon emission factor.

GWP_{CH_4} is the Global Warming Potential of methane ($GWP_{CH_4} = 21$)

Formula 2 (project)	April 08 - December 08	January 09- August 09
$E_{CH_4_lagoons}$	0	1,929
$M_{lagoon_anaerobic}$	0	381
EF_{CH_4}	0.241	0.241
GWP_{CH_4}	21	21

Whereby the mass balance in the considered lagoon system provides the amount of organic material removed by anaerobic processes.

$$M_{lagoon_anaerobic} = M_{lagoon_total} - M_{lagoon_aerobic} - M_{lagoon_chemical_ox} - M_{lagoon_deposition}$$

Where:

M_{lagoon_total} is the total amount of organic material removed in the lagoon system from equation 5 (kg COD)

$M_{lagoon_aerobic}$ is the amount of organic material degraded aerobically in the lagoon system (kg COD).

Surface aerobic losses of organic material in pond based systems equal to 254 kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.

Where other more project specific losses can be determined, these should be applied.

$M_{lagoon_chemical_ox}$ is the amount of organic material lost through chemical oxidation in the lagoon system (kg COD)

$M_{lagoon_deposition}$ is the amount of organic material lost through deposition in the lagoon system from equation 6 (kg COD)

Formula 3 (project)	April 08 - December 08	January 09- August 09
$M_{lagoon_anaerobic}$	0	381
M_{lagoon_total}	885	1,369
$M_{lagoon_aerobic}$	1,118	988
$M_{lagoon_chemical_ox}$	0	0
$M_{lagoon_deposition}$	0	0

Registered project No. 1040 (Korat Waste to Energy)¹ carried out a sensitivity analysis to determine the suitability of the surface oxidation factor utilised in this project analysis. Also, deposition, total removal and chemical oxidation are project specific factors that must be quantified on a project-specific basis. Considering strong similarities between the two projects, the analysis was applied to this project.

To assess the amount of COD entering the lagoon system the amount two waste water flows need to be quantified:

- the amount of COD actually entering the lagoon system from the new wastewater treatment facility which is equivalent to the amount of COD entering the new wastewater treatment facility minus the amount of COD removal as a result of the new wastewater treatment facility, and
- the amount of COD actually entering the lagoon system, bypassing the new wastewater treatment facility.

The first part is determined with:

$$M_{lagoon_input} = M_{input_total} \cdot (1 - R_{NAWTF})$$

¹Project 1040 : Korat Waste To Energy available on website: <http://cdm.unfccc.int/Projects/DB/KPMG1175141470.89/view>

Where:

$M_{\text{lagoon_input}}$ is the input of organic material from the new project anaerobic waste water treatment facility into the lagoon system (kg COD)

$M_{\text{input_total}}$ is the total amount of organic material fed into the new project water treatment facility (kg COD)

R_{NAWTF} is the total organic material removal efficiency of the new project water treatment facility (-). It is a project specific factor used to estimate how much COD will be removed from the system. The most appropriate manner to estimate this factor is to undertake pilot plant trials with a pilot scale digester system prior to project implementation. Where this is not possible, manufacturers estimates as to equipment removal efficiencies may be applied. This factor will be used to determine estimates of COD flows to the project lagoon system, and the related monitoring methodology (AM0022 “Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector”) sets out how the actual amount of COD can be monitored to allow calculation of actual project emissions.

The second part is determined with $M_{\text{lagoon_input_bypass}} = M_{\text{input_bypass}}$

Where

$M_{\text{input_bypass}}$ is the total organic material that is entering the lagoon untreated. It is equivalent to the waste water flow of the bypass and the same COD load (mg/l) as measured for the waste water entering the lagoon.

The second part is not recognized by AM0022 even though AM0022 monitoring method identifies this parameters. It is, however, not included in the calculation for AM0022 projects. For the purposes of this calculation $M_{\text{lagoon_input}}$ is defined as

$M_{\text{lagoon_input}}$ (as defined in AM0022) plus $M_{\text{lagoon_input_bypass}}$

Total Material Removed in the Lagoon System:

$$M_{\text{lagoon_total}} = M_{\text{lagoon_input}} \cdot R_{\text{lagoon}}$$

Where:

$M_{\text{lagoon_total}}$ is the total amount of organic material removed in the lagoon system through various routes (kg COD)

R_{lagoon} is the total organic material removal ratio of the lagoon (-). It is a project specific factor, and is equal to the proportion of organic material removed (through all routes) within the boundaries of the lagoon system under consideration. This factor should be determined by carrying out a series of biochemical tests prior to project implementation. These tests will determine the COD flows into the system, and the COD flows out of the system at the system boundary. The relative difference of COD flowing in and out of the system over a period of time will allow determination of the Total Organic Material Removal Ratio.

and where $M_{\text{lagoon_input}}$ includes $M_{\text{lagoon_input_bypass}}$

$M_{\text{lagoon_input_bypass}} = 0$, because no waste water was bypassing the new waste water treatment facility due to the capacity expansion of the new waste water treatment facility since 2006 (UASB #2).

$M_{\text{lagoon_anaerobic}}$ becomes zero when all wastewater is treated in the new wastewater treatment facility as all remaining COD entering the lagoon is removed on aerobic basis.

Material Deposition into the Lagoon System:

$$M_{\text{lagoon_deposition}} = M_{\text{lagoon_input}} \cdot R_{\text{deposition}}$$

Where:

$R_{\text{deposition}}$ is the organic material deposition ratio of the lagoon. It is equal to the proportion of organic material physically sedimented in lagoons within the project boundaries. It is a project specific factor derived by assessing the relative ability of COD in the waste water stream to sediment in the project boundaries, through pre project analysis.

Formula 4 (project)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_input}}$	1,007	1,558
$M_{\text{input_total}}$	17,885	22,551
R_{NAWTF}	94.37%	93.09%
$M_{\text{input_lagoon_bypass}}$	0	0
Formula 5 (project)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_total}}$	885	1,369
$M_{\text{lagoon_input}}$	1,007	1,558
R_{lagoon}	87.88%	87.88%
Formula 6 (project)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_deposition}}$	0	0
$M_{\text{lagoon_input}}$	1,007	1,558
$R_{\text{deposition}}$	0	0

- Methane emissions from new anaerobic waste water treatment facility:**

In accordance with AM0022, methane emissions from the Anaerobic Buffer Reactor (ABR) at Korat Waste To Energy (KWTE) should be assessed and estimated based on measurements, technology supplier data and expert estimates. They may be disregarded if documented evidence for their insignificance is given.

- Methane emissions from Inefficient Combustion Emissions:**

Methane emissions from inefficiency combustion are calculated as:

$$E_{\text{CH}_4\text{_IC+Leaks}} = \left(\sum_r V_r \cdot C_{\text{CH}_4_r} \cdot (1 - f_r) \cdot GWP_{\text{CH}_4} \right) + PE_{\text{flare}}$$

Where:

the sum is made over two routes r for methane destruction (heating and power generation);

V_r is the biogas combustion process volume in route r (Nm^3)

C_{CH_4} is the methane concentration in biogas (tCH_4/Nm^3) to be measured on wet basis.

f_r is the proportion of biogas destroyed by combustion (-)

PE_{flare} are the project emissions from flaring of the residual gas stream (tCO_2e) calculated following the procedures described in the "Tool to determine project emissions from flaring gases containing Methane". PE_{flare} can be calculated on an annual basis or for the required period of time using this tool.

Formula 7	April 08 - December 08	January 09- August 09
$E_{CH_4_IC+Leaks}$	9,456	5,955
$E_{CH_4_IC_heat}$	1,235	1,437
V_{heat} (used in boiler)	8,914,508	10,923,112
f_{heat}	98.5%	98.5%
$E_{CH_4_IC_elec}$	0.0	0
V_{elec}	0	0
f_{elec} -Not applicable in this project		
PE_{flare}	8,221	4,518
$\rho_{CH_4,n}$	0.716	0.716
$V1_{(flare)}$	408,416	157,008
$V1_{leakage}$ - correspond to CAR 3	481650	358181
$\eta_{flare,h}$	0%	0%
GWP_{CH_4}	21	21
Methane % - Average	61%	58%

In the project, flaring efficiency is assumed to be zero, thereby all the biogas sent to flare is assumed as leakage. In addition the inconsistency observed in reading of biogas is adjusted by accounting all the biogas (missing in mass balance) as potential project leakage. Since the flare efficiency is assumed zero, all the biogas not burnt in boiler but generated is assumed to be sent to flare. The flare emissions thus represent both leakage and flare emissions at zero percent efficiency.

The flaring tool calculations are simplified to be simply based on average annual methane concentration, normal density of methane and global warming potential of methane.

All the steps of flaring tool are avoided for simplification.

- **Methane Emissions from Leaks in Biogas System**

Leaks in the biogas system include leaks from the anaerobic digester and leaks from the biogas pipeline delivery system. These leakages are taken into account by comparing gas volumes generated and combusted in the boiler. The remaining biogas is assumed to be flared in installed flare at 0% efficiency.

However, the inconsistency does not mean that any of the safety requirements is not taken into account. The UASB reactor gas collection system consists of a gas-tight concrete, coated gas dome and the delivery pipe to the boiler site is less than 2 km in length.

Moreover, pipeline system is well designed by using High Density Polyethylene (HDPE) as the piping material which has the appropriate properties and good chemical resistance of biogas. Therefore, the leakage of biogas due to pipeline system is negligible in the project emissions.

B. Baseline emissions

The baseline scenario for the project is based on what would have happened in the absence of the project activities. In this case, the baseline scenario would be continued operation of the open lagoon system:

Formula (8) AM0022 version 4

$$E_{BL} = E_{CH4_lagoons_BL} + E_{CO2_heat_BL} + E_{CO2_power_BL}$$

Where:

E_{BL} are the Total Baseline Emissions (tCO₂e)

$E_{CH4_lagoons_BL}$ are the fugitive methane emissions from lagoons in the baseline case (tCO₂e). They are calculated with baseline data based on equation 2 in the section on project emissions.

$E_{CO2_heat+powers_BL}$ are the CO₂ emissions from on site fossil heat and/or power generation in the baseline case (tCO₂) that are displaced by generation based on biogas collected in the anaerobic treatment facility.

$E_{CO2_grid_BL}$ are the CO₂ emissions related to electricity supplied by the grid in the baseline case (tCO₂) that are displaced by generation based on biogas collected in the anaerobic treatment facility.

Total baseline emissions are calculated:

Formula 8	April 08 - December 08	January 09- August 09
E_{BL}	89,456	113,409
$E_{CH4_lagoons_BL}$	73,889	95,299
$E_{CO2_heat_BL}$	15,566	18,110
$E_{CO2_power_BL}$	0	0

- **Baseline fugitive methane emissions from lagoons**

To calculate $E_{CH4_lagoons_BL}$, formulas 2 to 6 are applied using baseline data.

Formula (2 (baseline)) AM0022 version 4

$$E_{CH4_lagoons_BL} = M_{lagoon_anaerobic_BL} * EF_{CH4} * GWP_{CH4} / 1000$$

Formula 2 (baseline)	April 08 - December 08	January 09- August 09
$E_{CH4_lagoons_BL}$	73,889	95,299
$M_{lagoon_anaerobic_BL}$	14,600	18,830
EF_{CH4}	0.241	0.241
GWP_{CH4}	21	21

Formula (3 (baseline)) AM0022 version 4

$$M_{lagoon_anaerobic_BL} = M_{lagoon_total_BL} - M_{lagoon_aerobic_BL} - M_{lagoon_chemical_ox_BL} - M_{lagoon_deposition}$$

Formula 3 (baseline)	April 08 - December 08	January 09- August 09
$M_{lagoon_anaerobic_BL}$	14,600	18,830
M_{lagoon_total}	15,717	19,818
$M_{lagoon_aerobic}$	1,118	988
$M_{lagoon_chemical_ox}$	0	0
$M_{lagoon_deposition}$	0	0

Formula (11) AM0022 version 4 (corresponding to the logic of formula (4) AM0022 version 4 in the project scenario

$$M_{\text{lagoon_input_BL}} = M_{\text{input_total}}$$

Formula 4 (baseline)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_input}}$	17,885	22,551
$M_{\text{input_total}}$	17,885	22,551
R_{NAWTF}	0.00%	0.00%
$M_{\text{input_lagoon_bypass}}$	0	0

Formula (5 (baseline)) AM0022 version 4

$$M_{\text{lagoon_total_BL}} = M_{\text{lagoon_input_BL}} * R_{\text{lagoon}}$$

Formula 5 (baseline)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_total}}$	15,717	19,818
$M_{\text{lagoon_input}}$	17,885	22,551
R_{lagoon}	87.88%	87.88%

Formula (6 (baseline)) AM0022 version 4

$$M_{\text{lagoon_deposition_BL}} = M_{\text{lagoon_input_BL}} * R_{\text{deposition}}$$

Formula 6 (baseline)	April 08 - December 08	January 09- August 09
$M_{\text{lagoon_deposition}}$	0	0
$M_{\text{lagoon_input}}$	17,885	22,551
$R_{\text{deposition}}$	0	0

- **Baseline CO₂ emissions from heat generation**

Result from formula (9), AM0022 version 4:

Whereby on Site Heat Generation Emissions displaced by generation based on biogas collected in the anaerobic treatment facility are calculated as follows (replacement of power from the grid does not apply):

In calculating CO₂ emissions from on site heat displaced by biogas collected in the anaerobic treatment, the use of fossil fuels is considered:

Formula (9) AM0022 version 4

$$E_{\text{CO}_2_heat} = F \cdot NCV \cdot EF$$

Where:

F is the corresponding amount of fossil fuel displaced by the use of biogas for the generation of on site heat (unit). This is estimated as product of : (1) Average specific fuel consumption for the output of the facility, estimated using 3 years historical data; and (2) the annual production NCV is the net calorific value of the fossil fuel considered (TJ/unit). Site specific local NCV values should be applied where available; however, should this information not be available, IPCC data may suffice for that specific country.⁷

EF is the carbon emission factor of the fossil fuel considered (tCO₂/TJ).

Formula 9	April 08 - December 08	January 09- August 09
$E_{CO_2_heat}$	15,566	18,110
F	4,978	5,792
NCV	0.0404	0.0404
EF	77.4000	77.4000

In order to calculate the quantity of fuel that is displaced by biogas, the two fuels are substituted on the basis of equivalent delivered energy. The following energy densities are used:

- 1 m³ of 100% of CH₄ has NCV = 1.04² (MJ/ft³) / 0.02832 (m³/ft³) = 36.723 MJ
- 1 m³ biogas at x % concentration of methane = 36.723 * 59.7% = 21.93 MJ
- Combustion efficiency on HFO (η_{boiler}) as well as biogas is considered to be 98.5% in absence of the manufactures data.
- 1 ton of heavy fuel oil = 40,400 MJ³
- Therefore: 1 m³ biogas = (21.93/40,400) = 0.00054271 tons of heavy fuel oil

A 59.7% is the average actual value of Methane concentration of biogas is used in this crediting period of monitored data.

C. Emission reductions

$$ER = E_{BL} - E_{project}$$

Formula 12	April 08 - December 08	January 09- August 09
ER	80,000	105,525
E_{BL}	89,456	113,409
$E_{project}$	9,456	7,884

However, this figure needs to be adjusted should the determination of conservativeness show that deductions have to be made. As can be seen below, such adjustments are to be made, resulting in the following conservative estimate of emission reductions.

² Source: Oil and Thailand 2005.

http://www.dede.go.th/dede/fileadmin/usr/wpd/static/thai_oil_2005/50Conversion.pdf

³ IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction, Table 1.2, value for "Residual fuel oil"

	April 08 - December 08	January 09- August 09
ER_{conservative}	80,000	105,525
ER	80,000	105,525
Conservativeness estimate	-16,667	-6,939

The quantity of verifiable VER in the reporting period can therefore be summarized as:

Year	Estimation of emission reductions (tCO ₂ eq)	Conservative estimation of emission reductions (tCO ₂ eq)
April 08 - December 08	80,000	80,000
January 09- August 09	105,525	105,525
Total estimated reductions (tCO₂eq) of verification period	185,525	185,525

D. Determination of conservativeness:

It must be verified this equation delivers a conservative estimate of emission reductions i.e. that the emissions of CH₄ from the lagoons in the baseline situation are not higher than the total emissions of biogas from the digester and the lagoons in the project situation. Therefore calculate:

$$E_{CH_4_lagoon_BL} - (E_{CH_4_lagoon} + E_{CH_4_nawtf} + E_{CH_4_coll})$$

Formula 13	April 08 - December 08	January 09- August 09
=	-16,667	-6,939
E _{CH₄_lagoon_BL}	73,889	95,299
E _{CH₄_lagoon}	-	1,929
E _{CH₄_NAWTF}	0	0
E _{CH₄_Coll}	90,556	100,308

4. Table of Abbreviations

Abbreviations	Description
ABR	Anaerobic Buffer Reactor
BOT	Built Operating Transfer
COD	Chemical Oxygen Demand

COD _{in}	Chemical Oxygen Demand of wastewater at the inlet of UASB reactor
COD _{out}	Chemical Oxygen Demand of wastewater at the outlet of UASB reactor
CER	Certified Emission Reduction
CDM	Clean Development Mechanism
CH ₄	Methane
°C	Degree Celcius
FM 3	Wastewater flow meter of UASB reactor #1
FM 5	Wastewater flow meter of UASB reactor #2
GM 1	Biogas flow rate meter of the produced biogas from UASB #1
GM 2	Biogas flow rate meter of the produced biogas from UASB #2
GM 3	Biogas flow rate meter of the biogas sent to Boiler
GM 4	Biogas flow rate meter of the biogas sent to Flare
HDPE	High Density Polyethylene
HFO	Heavy Fuel Oil
ISO9001:2000	International Standard Organization (standards for quality management systems)
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
mg/l	Milligram per litre
MJ	Mega Joule
Nm ³	Normal cubic meter
NCV	Net Calorific Value
PDD	Project Design Document
SCADA	System Control And Data Acquisition
tCO ₂ eq	Tonne CO ₂ equivalent
UASB	Upflow Anaerobic Sludge Blanket
VER	Voluntary Emission Reduction
VCS	Voluntary Carbon Standard