

Monitoring Report

Voluntary Carbon Standard 2007.1

Wastewater Treatment with Biogas Production (UASB) and
Heat Utilization at General Starch Co., Ltd.

VCS Reference Project ID: 82

4th Monitoring period: 1st September 2009 to 31th August 2010
(Both days are included)

Emission reduction claimed: 111,517 tCO₂e

Monitoring report version no. 6

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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 2007.1.

The project was successfully validated and verified under VCS v1 in 2007. The first verification report is dated on 31st August 2007. The VCS registration number under Markit's database of this project is 82.

As per the VCS's guideline, the project is verified against the VCS 2007. 1¹.

Further background information on the project activity can be found in the VCS Project Design Document (PDD), which has been registered and available on the V-C-S as well as the combined Voluntary Validation and First Verification:

<https://vcsprojectdatabase1.apx.com/mymodule/ProjectDoc/EditProjectDoc.asp?id1=82>

This is the fourth verification of the project. The detail of previous monitoring period is explained below. All monitoring reports and verifications reports are available on the VCS registry.

- 1st monitoring period : 01-04-04 to 31-05-07 ; verification report issued 31-08-07
- 2nd monitoring period : 01-06-07 to 31-03-08 ; verification report issued 22-08-08
- 3rd monitoring period : 01-04-08 to 31-08-09 ; verification report issued 09-02-10

2. Monitoring Background

Section B of the PDD (application of the baseline and monitoring methodology) provides details on the calculation of emission reductions and the monitoring plan that is followed in the project activity. The emission reduction calculations and the monitoring plan are based on approved CDM methodology AM0022 version 4.

3. Monitoring Results

3.1 Monitoring period

This is the fourth monitoring period of this project activity. It covers the period from 1st September 2009 to 31st August 2010 (both days included).

Papop Renewable Co., Ltd. (henceforth called Papop) is the BOT (built operate transfer) entity for the biogas plant project of General Starch Co., Ltd. (henceforth called General Starch or GSL).

¹ Refer to paragraph 5.2.1 of the Voluntary Carbon Standard 2007.1 (<http://www.v-c-s.org/policydocs.html>)

Papop has 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 ISO 9001:2000 since 8th February 2007 which is certified by Global Certification Limited.

From May 2010 onwards, the operation of the wastewater treatment system has been transferred from Papop to General Starch (GSL), following the expiration of the BOT contract. The wastewater treatment system operational and management systems have been certified under ISO 14001 version 2004 by UKAS. This certificate is valid from 16th Dec 2008 to 15th Dec 2011. This certificate ensures that requirements and procedures for parameters monitoring, data recording and data archiving are well managed according to ISO14001 requirements².

Supervisory Control and Data Acquisition (SCADA) is used to record the following operating data of the biogas plant:

- 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 the boiler (ref. GM3)
- Biogas sent to the flare (ref. GM4)
- Percent CH₄

Figure 1 p.4 shows the latest SCADA flow diagram.

² http://www.fs.fed.us/ems/includes/sum_ems_elements.pdf

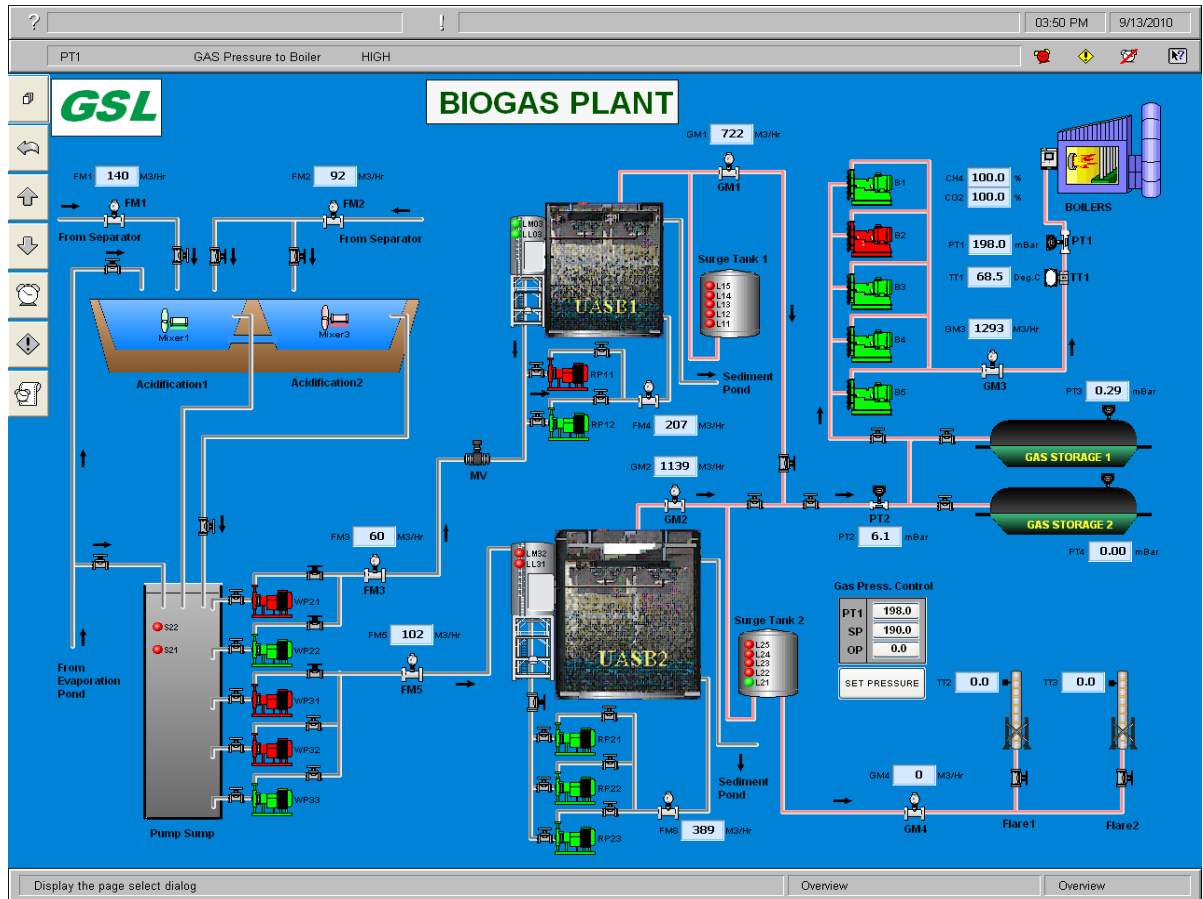


Figure 1: SCADA flow diagram of biogas plant
(saved from screen on September 2010)

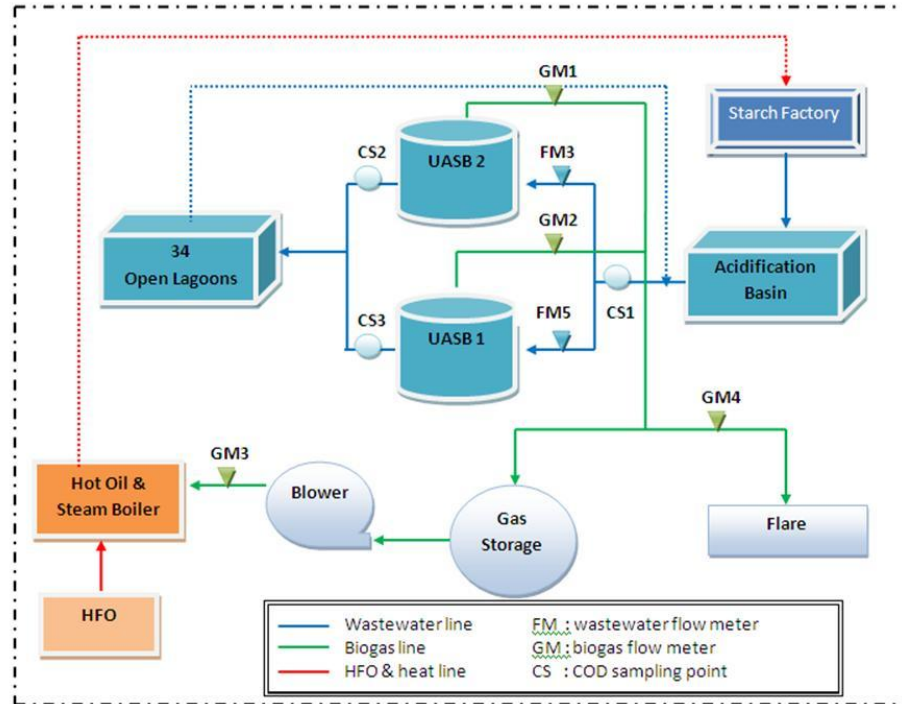


Figure 2 : Monitoring Diagram

3.2 Presentation of monitoring results

Monitoring data are available in Excel sheet. The spreadsheets include an extract of the project activity's log of monitored data showing:

- 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 calculations

Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	EF_{CH4}
Data unit:	kg CH ₄ / kg COD
Description:	Methane emission factor
Source of data used:	Expert selection based on AM0013 v4 guidance
Value(s) :	0.241
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Additional comment:	Details of the calculation and data used are provided in Annex 3 of registered VCS PD.

Data / Parameter:	R_{lagoon}
Data unit:	%
Description:	Organic material removal ratio
Source of data used:	Applied from registered project no 1040 "Korat Waste to Energy"
Value(s) :	87.88
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation
Additional comment:	The project developer did not carry out biochemical tests prior to project implementation. For this reason, comparable test results were used.

Data / Parameter:	R_{deposition}
Data unit:	%
Description:	Organic material deposition ratio
Source of data used:	Estimated by project developer on basis of experience
Value(s) :	0 (project scenario), 0 (baseline scenario)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation
Additional comment:	This corresponds to the assumptions made for the Korat Waste to Energy project, a registered AM0022 project in Thailand.

Data / Parameter:	E CH₄_NAWTF
Data unit:	tCO ₂ e
Description:	Methane emitted from UASB digesters
Source of data used:	IPCC default value
Value(s) :	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation

Leakage emission calculations)	
Additional comment:	

Data / Parameter:	R_{NAWTF}
Data unit:	Fraction
Description:	Total organic material removal efficiency of the new project wastewater facility.
Source of data used:	Calculated using COD concentration entering the project treatment facility and COD concentration leaving the treatment facility.
Value(s) :	95.92%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Additional comment:	

Data / Parameter:	EF
Data unit:	tCO ₂ /TJ
Description:	Carbon emission factor of fuel oil
Source of data used:	IPCC 2006
Value(s) :	77.367
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional comment:	

Data / Parameter:	NCV
Data unit:	TJ/t
Description:	Net calorific value of fuel oil
Source of data used:	IPCC 2006 P.1.18
Value(s) :	0.0404
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional comment:	

Data / Parameter:	Density of CH₄
Data unit:	kgCH ₄ / Nm ³ CH ₄
Description:	Density of methane at standard condition (0 degree Celsius, 1,013 bar)
Source of data used:	UNFCCC Methodological tool to determine project emissions from flaring gases containing methane, Table 1, page 12
Value(s) :	0.716
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation

Additional comment:	
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Data / Parameter:	Lagoon surface area
Data unit:	Hectare
Description:	Total lagoon area
Source of data used:	Project developer
Value(s) :	16
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional comment:	

Data / Parameter:	Flare efficiency
Data unit:	%
Description:	Flare efficiency for open flare
Source of data used:	Tool to determine project emissions from flaring gases containing methane
Value(s) :	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Additional comment:	When the flare is active, a flame can be visibly observed.

Data and parameters monitored

Data / Parameter:	AM0022 ID 1 Wastewater flows entering the project treatment facility														
Data unit:	m ³ /year														
Description:	The volume of wastewater flows entering into the new anaerobic digestion system														
Measured /Calculated /Default:	Measured														
Source of data:	Wastewater flow meter FM3 , FM5														
Value(s) of monitored parameter:	<table><tr><th>Parameter</th><th>Sep09 - Dec09</th><th>Jan10 - Aug10</th></tr><tr><td>WW_{input}</td><td>542,147</td><td>1,085,801</td></tr><tr><td>UASB 1 = FM3</td><td>221,800</td><td>437,153</td></tr><tr><td>UASB 2 = FM5</td><td>320,347</td><td>647,342</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	WW _{input}	542,147	1,085,801	UASB 1 = FM3	221,800	437,153	UASB 2 = FM5	320,347	647,342
Parameter	Sep09 - Dec09	Jan10 - Aug10													
WW _{input}	542,147	1,085,801													
UASB 1 = FM3	221,800	437,153													
UASB 2 = FM5	320,347	647,342													
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation														
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><th>Meter</th><th>FM3</th><th>FM5</th></tr><tr><td>Type of meter</td><td>Magnetic flow meter</td><td>Magnetic flow meter</td></tr><tr><td>Serial number</td><td>6B00EB20000</td><td>6B00E920000</td></tr></table>			Meter	FM3	FM5	Type of meter	Magnetic flow meter	Magnetic flow meter	Serial number	6B00EB20000	6B00E920000			
Meter	FM3	FM5													
Type of meter	Magnetic flow meter	Magnetic flow meter													
Serial number	6B00EB20000	6B00E920000													

	Accuracy	$\pm 0.5\%$ ³	$\pm 0.5\%$ ⁴	
	Calibration frequency	once every year	once every year	
	Last calibration	02/07/09	02/07/09	
Measuring/ Reading/ Re- cording frequency:	Continuous measuring / daily recording			
Calculation method (if appli- cable):	Total of FM3 and FM5			
QA/QC procedures applied:	The flow meter is calibrated at least once every year			
Any comment	The maximum error 0.5% is applied for correction the reading of FM3 and FM5 as the calibration delay from 2-Jul-10 to 31-Aug-10 for the conservativeness approach as per EB 52, annex 60. Applied -0.5% for BE calculation Applied +0.5% for PE calculation			

Data / Parameter:	AM0022 ID 2 Wastewater flows leaving the project treatment facility																				
Data unit:	m ³ /year																				
Description:	The volume of wastewater flows leaving the new anaerobic digestion system																				
Measured /Calculated /Default:	Measured																				
Source of data:	Established using ID 1 and assuming hydrological balance																				
Value(s) of monitored parameter:	<table><tr><th>Parameter</th><th>Sep09 - Dec09</th><th>Jan10 - Aug10</th></tr><tr><td>WW_{out}</td><td>542,147</td><td>1,085,801</td></tr><tr><td>UASB 1 = FM3</td><td>221,800</td><td>437,153</td></tr><tr><td>UASB 2 = FM5</td><td>320,347</td><td>647,342</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	WW _{out}	542,147	1,085,801	UASB 1 = FM3	221,800	437,153	UASB 2 = FM5	320,347	647,342						
Parameter	Sep09 - Dec09	Jan10 - Aug10																			
WW _{out}	542,147	1,085,801																			
UASB 1 = FM3	221,800	437,153																			
UASB 2 = FM5	320,347	647,342																			
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation																				
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><th>Meter</th><th>FM3</th><th>FM5</th></tr><tr><td>Type of meter</td><td>Magnetic flow meter</td><td>Magnetic flow meter</td></tr><tr><td>Serial number</td><td>6B00EB20000</td><td>6B00E920000</td></tr><tr><td>Accuracy</td><td>± 0.5%⁵</td><td>± 0.5%⁶</td></tr><tr><td>Calibration frequency</td><td>once every year</td><td>once every year</td></tr><tr><td>Last calibration</td><td>02/07/09</td><td>02/07/09</td></tr></table>			Meter	FM3	FM5	Type of meter	Magnetic flow meter	Magnetic flow meter	Serial number	6B00EB20000	6B00E920000	Accuracy	± 0.5% ⁵	± 0.5% ⁶	Calibration frequency	once every year	once every year	Last calibration	02/07/09	02/07/09
Meter	FM3	FM5																			
Type of meter	Magnetic flow meter	Magnetic flow meter																			
Serial number	6B00EB20000	6B00E920000																			
Accuracy	± 0.5% ⁵	± 0.5% ⁶																			
Calibration frequency	once every year	once every year																			
Last calibration	02/07/09	02/07/09																			
Measuring/ Reading/ Recording frequency:	Continuous measuring / daily recording																				
Calculation method (if applicable):	Total of FM3 and FM5																				

³ <http://www.endress.com/eh/e-direct/uk/en/home.nsf/?Open&DirectURL=C125703800321097C12575A00044C1C5>

⁴ <http://www.endress.com/eh/e-direct/uk/en/home.nsf/?Open&DirectURL=C125703800321097C12575A00044C1C5>

⁵ <http://www.endress.com/eh/e-direct/uk/en/home.nsf/?Open&DirectURL=C125703800321097C12575A00044C1C5>

⁶ <http://www.endress.com/eh/e-direct/uk/en/home.nsf/?Open&DirectURL=C125703800321097C12575A00044C1C5>

cable):	
QA/QC procedures applied:	The flow meter is calibrated at least once every year
Any comment	The maximum error 0.5% is applied for correction the reading of FM3 and FM5 as the calibration delay from 2-Jul-10 to 31-Aug-10 for the conservativeness approach as per EB 52, annex 60. - Applied -0.5% for BE calculation - Applied +0.5% for PE calculation

Data / Parameter:	AM0022 ID 3 Wastewater organic material concentration entering the project treatment facility														
Data unit:	kg COD / m ³														
Description:	COD concentration of the wastewater entering the new anaerobic digestion system														
Measured /Calculated /Default:	Measured														
Source of data:	Colorimetric analysis of wastewater														
Value(s) of monitored parameter:	<table><tr><th>Parameter</th><th>Sep09 - Dec09</th><th>Jan10 - Aug10</th></tr><tr><td>COD_{in}</td><td>15.88</td><td>15.61</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	COD _{in}	15.88	15.61						
Parameter	Sep09 - Dec09	Jan10 - Aug10													
COD _{in}	15.88	15.61													
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation														
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><th>Meter</th><th>COD Vario Photometer</th></tr><tr><td>Type of meter</td><td>Spectrophotometer</td></tr><tr><td>Serial number</td><td>38397</td></tr><tr><td>Accuracy</td><td>± 3.5%⁷</td></tr><tr><td>Calibration frequency</td><td>once every 3 years</td></tr><tr><td>Last calibration</td><td>22/05/2008</td></tr></table>			Meter	COD Vario Photometer	Type of meter	Spectrophotometer	Serial number	38397	Accuracy	± 3.5% ⁷	Calibration frequency	once every 3 years	Last calibration	22/05/2008
Meter	COD Vario Photometer														
Type of meter	Spectrophotometer														
Serial number	38397														
Accuracy	± 3.5% ⁷														
Calibration frequency	once every 3 years														
Last calibration	22/05/2008														
Measuring/ Reading/ Recording frequency:	Daily measuring														
Calculation method (if applicable):	The total of COD entering UASB 1 and 2 multiplied by its influent flow. Then divided by the WW _{input}														
QA/QC procedures applied:	The spectrophotometer is calibrated at least once every 3 years														

Data / Parameter:	AM0022 ID 4 Wastewater organic material concentration leaving the project treatment facility		
Data unit:	kg COD / m ³		
Description:	COD concentration of the wastewater leaving the new anaerobic digestion system		
Measured /Calculated /Default:	Measured		
Source of data:	Colorimetric analysis of wastewater		

⁷http://dl.tintometer.de/cat/en/cat_checkitdirect_cod_envir.pdf

Value(s) of monitored parameter:			
	Parameter	Sep09 - Dec09	Jan10 - Aug10
	COD _{out}	0.85	0.86
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)			
	Meter	COD Vario Photometer	
	Type of meter	Spectrophotometer	
	Serial number	38397	
	Accuracy	± 3.5% ⁸	
	Calibration frequency	once every 3 years	
	Last calibration	22/05/2008	
Measuring/ Reading/ Recording frequency:	Daily measuring		
Calculation method (if applicable):	The total of COD existing UASB 1 and 2 multiplied by its influent flow. Then divided by the WW _{out}		
QA/QC procedures applied:	The spectrophotometer is calibrated at least once every 3 years		

Data / Parameter:	AM022 ID 5 Volume of biogas sent to facility heaters		
Data unit:	Nm ³ biogas		
Description:	Volume of biogas sent to facility heaters		
Measured /Calculated /Default:	Measured		
Source of data:	Biogas flow meter GM3		
Value(s) of monitored parameter:	Parameter	Sep09 - Dec09	Jan10 - Aug10
	V _{boiler} (For baseline emissions)	4,482,701	8,195,011
	V _{boiler} (For project emissions)	4,938,236	10,151,864
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation. For baseline emissions, the biogas used in boilers in side project boundary is included. For project emissions, the biogas used in all the boilers is considered for conservative estimation of project emissions.		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Meter	GM3	
	Type of meter	Thermal mass flow meter	
	Serial number	9B09BD02000	
	Accuracy	± 1.0% of reading plus ± 0.5% of full scale ⁹	

⁸http://dl.tintometer.de/cat/en/cat_checkitdirect_cod_envir.pdf

⁹ <https://wa001.endress.com/dla/50000092467/000/01/TI069DEN.pdf>

	Calibration frequency	once every 3 yrs
	Previous calibration	19/09/08
	Last calibration	06/08/10
Measuring/ Reading/ Re- cording frequency:	Continuous measuring / daily recording	
Calculation method (if appli- cable):		
QA/QC procedures applied:	The flow meter is calibrated at least once every 3 years	
Any comment	The biogas used at steam boiler no.6 and 9 is excluded in the baseline emission reduction calculation as described in Annex 1 : Deviation1. The same is included in Project emissions $E_{CH_4_IC_heat}$	

Data / Parameter:	AM0022 ID 8 F: Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility								
Data unit:	Litres per year								
Description:	Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility								
Measured /Calculated /Default:	Calculated								
Source of data:	Calculated using ID 5, ID 15, ID 19								
Value(s) of monitored parameter:	<table><tr><td>Parameter</td><td>Sep09 - Dec09</td><td>Jan10 - Aug10</td></tr><tr><td>F</td><td>2,394</td><td>4,480</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	F	2,394	4,480
Parameter	Sep09 - Dec09	Jan10 - Aug10							
F	2,394	4,480							
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation								
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Based on weighted average consumption of the boilers calculated as per operating hours. The calculation approach is explained in the deviation in Annex -1.								
Measuring/ Reading/ Recording frequency:									
Calculation method (if applicable):	Calculated base on the Net calorific value of biogas. The quantity of biogas used at boiler is multiplied by NCV of biogas. Then divided by NCV of heavy fuel oil to get the volume of heavy fuel oil.								
QA/QC procedures applied:									

Data / Parameter:	AM0022 ID 9 Biogas sent to flares (V1)
Data unit:	Nm ³ biogas
Description:	Surplus biogas sent to flare system (wet basis)
Measured /Calculated	Measured

/Default:			
Source of data:	Biogas flow meter GM4		
Value(s) of monitored parameter:	Parameter	Sep09 - Dec09	Jan10 - Aug10
	V ₁ (flare)	180,564	267,261
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Meter	GM4	
	Type of meter	Thermal mass flow meter	
	Serial number	AA083102000	
	Accuracy	± 1.0% of reading plus ± 0.5% of full scale ¹⁰	
	Previous calibration	29/11/07	
	Last calibration	04/08/10	
Measuring/ Reading/ Recording frequency:	Continuous measuring / daily recording		
Calculation method (if applicable):			
QA/QC procedures applied:	The flow meter is calibrated at least once every 3 years		

Data / Parameter:	AM0022 ID11 Biogas methane concentration		
Data unit:	%		
Description:	Methane concentration in biogas		
Measured /Calculated /Default:	Measured		
Source of data:	Biogas analyzer		
Value(s) of monitored parameter:	Parameter	Sep09 - Dec09	Jan10 - Aug10
	Methane content in Biogas	58.74%	60.14%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Meter	Gas analyzer	
	Type of meter	Infrared gas analyzer	
	Serial number	ABB EL 1020 IR 3.241376.5	
	Accuracy	± 1%	
	Calibration frequency	once every year as per manufacturer's recommendation	
	Previous calibration	10/05/10 (monthly calibration in 2009)	

¹⁰ <https://wa001.endress.com/dla/50000092467/000/01/TI069DEN.pdf>

	Last calibration	04/06/10	
Measuring/ Reading/ Re-cording frequency:	Continuous measuring / daily recording		
Calculation method (if applicable):			
QA/QC procedures applied:	The gas analyzer is calibrated at least once every year		

Data / Parameter:	AM0022 ID 12 Project emissions from flaring of the residual gas stream (PE _{flare})								
Data unit:	t CO ₂ e								
Description:	Project emissions from flaring of the residual gas stream								
Measured /Calculated /Default:	Calculated								
Source of data:	Calculated based on the flared gas amount and 0% flare efficiency.								
Value(s) of monitored parameter:	<table><tr><td>Parameter</td><td>Sep09 - Dec09</td><td>Jan10 - Aug10</td></tr><tr><td>PE_{flare}</td><td>3,394</td><td>10,599</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	PE _{flare}	3,394	10,599
Parameter	Sep09 - Dec09	Jan10 - Aug10							
PE _{flare}	3,394	10,599							
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation								
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)									
Measuring/ Reading/ Recording frequency:									
Calculation method (if applicable):	Using data measured with meter GM4. Pipe leakage is also included in the calculation.								
QA/QC procedures applied:									

Data / Parameter:	AM0022 ID 13 Amount of chemical oxidising agents entering system boundary		
Data unit:	tonnes/m ³		
Description:	Amount of chemical oxidizing agents entering system boundary		
Measured /Calculated /Default:	Default		
Source of data:			
Value(s) of monitored parameter:	0		
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)			
Monitoring equipment (type, accuracy class, serial number, calibration frequency,	No oxidizing agents are used. The waste water from last lagoon is used for balancing the pH of the waste water.		

date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	

Data / Parameter:	AM0022 ID 15 Heating system combustion efficiency
Data unit:	%
Description:	Proportion of biogas combusted by heating system facility (hot oil and steam boilers)
Measured /Calculated /Default:	Default
Source of data:	Default value as per methodology as no specification is available for this parameter.
Value(s) of monitored parameter:	98.5%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Default value is used.
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	

Data / Parameter:	AM0022 ID 16 Flow of wastewater directly to the current wastewater treatment system
Data unit:	M ³
Description:	Volume of flow of wastewater directly to the current wastewater treatment system and bypassing the new wastewater treatment facility
Measured /Calculated /Default:	Default
Source of data:	Registered VCS PDD
Value(s) of monitored parameter:	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)	

ber, calibration frequency, date of last calibration, validity)	No waste water is set directly to the current facility. Even if waste water is sent directly to any facility, it will have no affect on the emission reduction estimate as baseline emissions are equal to project emissions for such a case.
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	

Data / Parameter:	AAM0022 ID 17 Loss of biogas from pipeline		
Data unit:	%		
Description:	Loss of biogas from pipeline		
Measured /Calculated /Default:	Calculated		
Source of data:	Calculated from GM1,GM2,GM3,GM4		
Value(s) of monitored parameter:	Parameter	Sep09 - Dec09	Jan10 - Aug10
	% LOSS _{pipeline}	3.83	7.99
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)			
Measuring/ Reading/ Recording frequency:			
Calculation method (if applicable):	Calculation from the unbalance between biogas production (GM1+GM2) and utilization (GM3+GM4)		
QA/QC procedures applied:			

Data / Parameter:	AAM0022 ID 18 Organic material removed from wastewater facility		
Data unit:	t COD		
Description:	Organic material removed from wastewater facility		
Measured /Calculated /Default:	Measured by project developer		
Source of data:	Measured for all the organic matter removed.		
Value(s) of monitored parameter:	Parameter	Sep09 - Dec09	Jan10 - Aug10
	Organic material removed	0	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	No organic material is removed from the system		

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Weigh bridge available at project site.
Measuring/ Reading/ Recording frequency:	Measured when organic material is removed.
Calculation method (if applicable):	
QA/QC procedures applied:	

Data / Parameter:	AM0022 ID 19 Biogas calorific value								
Data unit:	MJ/Nm ³								
Description:	Calorific value of biogas								
Measured /Calculated /Default:	Calculated								
Source of data:	Calculated from methane content in biogas								
Value(s) of monitored parameter:	<table><tr><td>Parameter</td><td>Sep09 - Dec09</td><td>Jan10 - Aug10</td></tr><tr><td>NCV_{Biogas}</td><td>21.57</td><td>22.09</td></tr></table>			Parameter	Sep09 - Dec09	Jan10 - Aug10	NCV _{Biogas}	21.57	22.09
Parameter	Sep09 - Dec09	Jan10 - Aug10							
NCV _{Biogas}	21.57	22.09							
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation								
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)									
Measuring/ Reading/ Re- cording frequency:									
Calculation method (if applicable):	The NCV of methane (assumed as 100% of methane) is multiplied by %CH ₄ in biogas								
QA/QC procedures applied:									

3.3 Calculation methodology

Emission reductions were calculated in accordance with the formula provided in AM0022 version 4 and applied in the project PDD as an ex-ante calculation.

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.

Formula (1) AM 0022 v4

$$E_{\text{project}} = E_{\text{CH}_4_{\text{lagoons}}} + E_{\text{CH}_4_{\text{NAWTF}}} + E_{\text{CH}_4_{\text{IC+Leaks}}}$$

Where :

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

$E_{\text{CH}_4_{\text{lagoons}}}$ are the fugitive methane emissions from lagoons from equations 2 (tCO₂e)

$E_{\text{CH}_4_{\text{NAWTF}}}$ are the fugitive methane emissions from the new anaerobic wastewater treatment facility (tCO₂e)

$E_{\text{CH}_4_{\text{IC+Leaks}}}$ are the methane emissions from inefficient combustion and leaks (tCO₂e)

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
E_{project}	4,048	11,976
$E_{\text{CH}_4_{\text{lagoons}}}$	0	-
$E_{\text{CH}_4_{\text{NAWTF}}}$	0	0
$E_{\text{CH}_4_{\text{IC+Leaks}}}$	4,048	11,976

- Fugitive methane emissions from lagoons**

Formula (2 (project)) AM00 22 v4

$$E_{\text{CH}_4_{\text{lagoons}}} = M_{\text{lagoon_anaerobic}} * EF_{\text{CH}_4} * GWP_{\text{CH}_4} / 1000$$

Where:

$E_{\text{CH}_4_{\text{lagoons}}}$ is the methane emissions from the lagoons (tCO₂e)

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

EF_{CH_4} is the methane emission factor (kg CH₄ / kg COD). A default COD to methane conversion factor of 0.21 kg CH₄ / kg COD is used. If the methodology is used for wastewater containing material not akin to simple sugar as CH₄, a different emissions factor has to be applied, the developer should sent out the case for a relevant carbon emission factor.

GWP_{CH_4} is the Global Warming Potential of methane ($GWP_{\text{CH}_4} = 21$)

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$E_{\text{CH}_4_{\text{lagoons}}}$	0	-
$M_{\text{lagoon_anaerobic}}$	0	-
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.

Formula (3 (project)) AM 0022 v4

$$M_{\text{lagoon_anaerobic}} = M_{\text{lagoon_total}} - M_{\text{lagoon_aerobic}} - M_{\text{lagoon_chemical_ox}} - M_{\text{lagoon_deposit}}$$

Where :

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

M_{lagoon_total} 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 processed.

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

$M_{lagoon_chemical_ox}$ 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)

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$M_{lagoon_anaerobic}$	0	0
M_{lagoon_total}	414	872
$M_{lagoon_aerobic}$	496	988
$M_{lagoon_chemical_ox}$	0	0
$M_{lagoon_deposition}$	0	0

Registered project No. 1040 (Korat Waste to Energy)¹¹ carried out a sensitivity analysis to determine the suitability of the surface oxidation factor utilised in this project analysis. 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 quantify the amount of COD entering the lagoon system, wastewater flow is separated into two parts. In the first part the amount of COD entering the lagoon system from the new wastewater treatment facility 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. In the second part the amount of COD entering the lagoon system is equal to the amount of COD that bypasses the new wastewater treatment facility.

The first part is determined by the following equation:

Formula (4 (project)) AM 0022 v4

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

M_{lagoon_input} is the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)

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

R_{NAWTF} is the total organic material removal efficiency of the new project wastewater 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, manufacturer 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 methodol-

¹¹Project 1040 : Korat Waste To Energy available on website: <http://cdm.unfccc.int/Projects/DB/KPMG1175141470.89/view>

ogy (AM022 “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 by:

Formula (4(a) (project)) AM 0022 v4

$$M_{\text{lagoon_input_bypass}} = M_{\text{input_bypass}}$$

Where

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

Even though the AM0022 monitoring method identifies this parameter the calculation doesn't use this parameter for any of the calculations. It is 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:

Formula (5 (project)) AM 0022 v4

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

Where :

$M_{\text{lagoon_total}}$ is the 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 wastewater was bypassing the new waste water treatment facility.

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

Material deposition into the lagoon system:

Formula (6 (project)) AM 0022 v4

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

$R_{deposition}$ = 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 divided by assessing the relative ability of COD in the waste water stream, to sediment the project boundaries, through pre project analysis.

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_input}	471	992
M_{input_total}	8,608	16,960
R_{NAWTF}	94.53%	94.15%
$M_{input_lagoon_by\ pass}$	0	0

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_total}	414	872
M_{lagoon_input}	471	992
R_{lagoon}	87.88%	87.88%

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$M_{lagoon_deposition}$	0	0
M_{lagoon_input}	471	992
$R_{deposition}$	0	0

- **Methane emissions from new anaerobic wastewater 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:

Formula (7) AM 0022 v4

$$E_{CH_4_IC+Leaks} = \left(\sum_r V_r * C_{CH_4_r} * (1 - f_r) * GWP_{CH_4} \right) + PE_{flare}$$

Where :

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

V_r is the biogas combustion process volume in route r (Nm³)

C_{CH_4} is the methane concentration in biogas (tCH₄/Nm³) 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 steam (tCO₂e) 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.

Parameter	Unit	Sep 09 - Dec 09	Jan 10 - Aug 10
$E_{CH4_IC+leaks}$		4,048	11,976
$E_{CH4_IC_heat}$		654	1,377
V_{heat} (used in boiler)	Nm ³	4,938,236	10,151,864
f_{heat}	%	98.5%	98.5%
$E_{CH4_IC_elec}$		0.0	0
V_{elec}	Nm ³	0	0
f_{elec} -Not applicable in this project			
PE_{flare}		3,394	10,599
$\rho_{CH4,n}$	kg/m ³	0.716	0.716
$V1$ (flare)	Nm ³	180,564	267,261
$V1$ leakage	Nm ³	203,760	904,916
$\eta_{flare,h}$	%	0%	0%
GWP_{CH4}		21	21
Methane % - Average	%	58.74%	60.14%

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

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

For purposes of simplification, the flaring tool steps are avoided.

The summary of project emissions is shown as table below,

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$E_{project}$	4,048	11,976
$E_{CH4_lagoons}$	0	-
E_{CH4_NAWTF}	0	0
$E_{CH4_IC+Leaks}$	4,048	11,976

- Methane emissions from leaks in the biogas system**

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

The above inconsistency does not mean that the safety requirements are ignored. The UASB reactor gas collection system consists of a gas-tight-concrete-coated gas dome. The delivery pipe to the boiler site is less than 2 km in length.

The pipeline system uses High Density Polyethylene (HDPE). The piping material, therefore, is appropriate and has chemical resistance to biogas. The leakage of biogas due to the pipeline system is, therefore, negligible in the project emissions calculations.

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:

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
E_{BL}	43,258	84,283
$E_{CH4_lagoons_BL}$	35,776	70,279
$E_{CO2_heat_BL}$	7,482	14,004
$E_{CO2_power_BL}$	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

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$E_{CH4_lagoons_BL}$	35,776	70,279
$M_{lagoon_anaerobic_BL}$	7,069	13,886
EF_{CH4}	0.241	0.241
GWP_{CH4}	21	21

Formula (3 (baseline)) AM0022 version 4

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_anaerobic_BL}	7,069	13,886
M _{lagoon_total}	7,565	14,874
M _{lagoon_aerobic}	496	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

$$M_{lagoon_input_BL} = M_{input_total}$$

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_input}	8,608	16,925
M _{input_total}	8,608	16,925
R _{NAWTF}	0.00%	0.00%
M _{input_lagoon_bypass}	0	0

Formula (5 (baseline)) AM0022 version 4

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_total}	7,565	14,874
M _{lagoon_input}	8,608	16,925
R _{lagoon}	87.88%	87.88%

Formula (6 (baseline)) AM0022 version 4

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
M_{lagoon_deposition}	0	0
M _{lagoon_input}	8,608	16,925
R _{deposition}	0	0

- Baseline CO₂ emissions from heat generation**

Result from formula (9), AM0022 version 4:

On site heat generation emissions displaced by generation based on biogas collected in the anaerobic treatment facility are calculated below (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

$$E_{CO_2_{heat}} = F * NCV * EF$$

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 the specific country.

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
$E_{CO_2_{heat}}$	7,482	14,004
F	2,394	4,480
NCV	0.0404	0.0404
EF	77.3670	77.3670

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 = 1.04¹² (MJ/ft³) / 0.02832 (m³/ft³) = 36.723 MJ
- 1 m³ biogas at x % concentration of methane = 36.723 * 59.4% = 21.81 MJ
- Combustion efficiency on HFO (η_{boiler}) as well as biogas is considered to be 98.5% in the absence of the manufacturer's data.
- 1 ton of heavy fuel oil = 40,400 MJ¹³

59.4% is the average actual value of Methane concentration of biogas is used in this crediting period of monitored data.

C. Emission reductions

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
ER	39,210	72,307
E_{BL}	43,258	84,283
$E_{project}$	4,048	11,976

If the determination of conservativeness shows that deductions must be made, the data will be adjusted as shown below:

¹² Source: Oil and Thailand 2009.

<http://www.dede.go.th/dede/fileadmin/upload/nov50/sep53/Oil%20and%20Thailand%202009.pdf>

¹³ IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction, Table 1.2, value for "Residual fuel oil"

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
ER _{conservative}	39,210	72,307
ER	39,210	72,307
Conservativeness estimate	-11,231	-32,118

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

Year	Estimation of emission reductions (tCO ₂ e)	Conservative estimation of emission reductions (tCO ₂ e)
Sep 09 - Dec 09	39,210	39,210
Jan 10 - Aug 10	72,307	72,307
Total ER (tCO₂e) of verification period	111,517	111,517

As per the validated PD, the project activity is expected to achieve GHG emission reductions in the amount of 99,955 tCO₂e per year. The increase in 12% of ex-post emission reductions as compared to ex-ante values from the PDD can be explained by a higher COD load entering the UASB reactors. As compared to the ex-ante scenario in the PDD, the total COD load (on an annual basis) entering the UASB reactor is 15% higher than expected, leading to higher baseline emissions (also by 16%). The increase in overall emission reductions are slightly lower (12%) because of higher project emissions (due to biogas flaring) than expected in the PDD.

In conclusion, total emission reduction to be verified in the 4th monitoring period is 111,517 tCO₂e.

D. Determination of conservativeness

The following equation provides a conservative estimate of emission reductions. It assumes 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.

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

Parameter	Sep 09 - Dec 09	Jan 10 - Aug 10
=	-7,208	-14,423
E _{CH₄_lagoon_BL}	35,776	70,279
E _{CH₄_lagoon}	-	-
E _{CH₄_NAWTF}	0	0
E _{CH₄_Coll}	42,984	84,702

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
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 Organization for Standardization (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	Supervisory Control And Data Acquisition
tCO ₂ eq	Tonne CO ₂ equivalent
UASB	Upflow Anaerobic Sludge Blanket
VER	Voluntary Emission Reduction
VCS	Voluntary Carbon Standard

Annex 1

ADDITIONAL DEVIATION MADE FOR THIS MONITORING PERIOD

Deviation	Description of the deviation	Justification for deviation
1. The new steam boilers which were installed after the registration of the project are not included in the emission reduction calculation.	The approach is described below	In this approach the biogas used in the new boilers is excluded from the estimation of the baseline emissions.

Status in the monitoring / monitoring period:

There were 2 steam boilers, no.6 and 9, installed during the monitoring period. The biogas consumed by these 2 boilers is excluded from the total biogas combusted counted by GM3.

Followed approach:

The GM3 is the biogas flow meter for total boiler utilization at boiler. The reading for this flow meter is the total biogas consumed by hot oil and steam boilers. There is no separate biogas flow meter for each boiler.

To identify the maximum consumption for each boiler, the PP tests by running each boiler at full load and record the consumption, for each boiler at this full load. This number is used for calculating the biogas consumption during the operational hours. The operation hours for each boiler are available on daily basis from log records.

The biogas consumption for each boiler is added up and percentage of biogas consumption in each boiler can be established on daily basis. This percentage figure is used to estimate the amount of biogas consumed in each boiler using the total biogas consumption for all boilers as per GM3.

This percentage is multiplied by biogas volume from GM3, the result will be the biogas usage of each boiler from the reading of GM3.

The biogas consumption by steam boiler no.6 and 9 will be deducted from V_{boiler} which is total biogas sent to boiler for emission calculation.

Reference:

The calculation the biogas usage for each boiler is provided as an additional spreadsheet with all relevant data.