south pole

Monitoring Report

Version 3.1[1]

Date 27/08/2012

Blue Fire Bio wastewater treatment and biogas utilization project

UNFCCC Reference No: 4219

GS VER Reference No: GS778

GS VER Verification (Pre CDM)
Monitoring period 09/04/2010 - 08/04/2011 (first and last days included)

Net Emission reductions: 19,332 tCO_2e

Document prepared by:

Suwipa Rukwongtrakool
South Pole Carbon Asset Management Ltd.
s.rukvongtrakul@southpolecarbon.com

[1] Version 3.1 dated 27/08/2012: the revision of this monitoring report based on GS comments and requests for clarification/corrective action received during the issuance review period.

Table of Contents

1. Introduction

1.1. General Project Information

The project entails the installation of two sets of upflow anaerobic sludge blanket technology (UASB) biogas reactors and 1.128MW_{el} gas engines at an existing starch factory in Thailand for:

a) the extraction of methane (biogas) from the wastewater stream through the biogas reactors;
b) the reuse of biogas as fuel in existing thermal boiler within the plant for starch drying; and
c) the reuse of biogas as fuel for power generation.

Prior to the implementation of the project, the wastewater was treated by an open lagoon system, consisting of six anaerobic ponds all with a depth of over 4 meters. After the lagoons, the wastewater was reused for starch cleaning. There was no discharge. Heavy fuel oil was used in boiler for heating purposes and electricity was provided by the grid.

In phase I, the project installed two new sets of biogas reactors (hereafter called "BFR 1" and "BFR 2") with methane capture and utilization for energy purposes. As the starch factory planned to expand its starch production with the construction of a second line similar to the existing one, another biogas reactor (hereafter called "BFR 3") was then introduced; and the lagoon system was extended to 15 lagoons (Phase II). As a consequence of the new anaerobic reactors, the organic load entering the lagoon system is drastically reduced because most of the organic matter is converted to biogas in the reactor. The project activity avoids the release of methane into the atmosphere, which would occur due to the anaerobic digestion of the organic content in the open lagoon based wastewater treatment system.

Regarding the installed capacity of gas engines, according to the registered PDD the project plans to install 3.128 MW_{el} gas engines for power generation which the installation of power system for the second phase is not yet completed because the performance of the biogas system is below expectation. Therefore, the project decided to conclude only the installation of 1.128 MW_{el} gas engines for the first phase which can be observed during the onsite verification by the verification team. Although 0.128 MW gas engine is not used for normal operation during the monitoring period, it is considered as a backup system for the project operation which the validation team agreed to include it in the project boundary of the project activity.

Table 1 Technical specifications of key components of the project activity

Equipment	Capacity	Source
BFR 1 and BFR 2	2 units x 3,400 m^3/day (approx.)	Technical proposal for biogas system
BFR 3	6,800 m^3/day (approx.)	Technical proposal for biogas system
Thermal oil boilers	2 units x 4.070 MW_{th}	Technical specification of thermal oil boiler
Gas engines	1.128 MW_{el} (2 units x 0.5 MW_{el} and 1 unit of 0.128 MW_{el})	Technical specification of gas engines
Open flaring system	500 m^3/hr	Technical specification of flare system

Table 2 Relevant dates for the project activity

Event	Date
Operation start of the 1st phase	July 2007
Operation start of the 2nd phase	October 2010
First Synchronization of the power system with the grid	December 2010
Registration under UNFCCC	9 April 2011
Pre-CDM monitoring report	9 April 2010 - 8 April 2011

Total emission reductions achieved in this monitoring period are 19,332 tCO_2e.

1.2. Project Participants

Name of Party involved (*) ((host) indicates a host party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Blue Fire Bio Co.,Ltd	No
Switzerland	South Pole Carbon Asset Management Ltd.	No

1.3. Location of the project activity

The proposed project is located in Chaodee Starch factory, in Dan Khun Tot district, Nakhorn Ratchasima, Korat, Thailand. It is situated at about 250 km north of Bangkok, in the Northeast of Thailand. Most of the starch plants in Thailand are located in this province.

The exact location of the plant is 15.1303N, 101.5586E.

1.4. Status of Project Implementation

The emission reductions for the monitoring period are lower than the estimated emission reductions (ERs) in the registered PDD. Since the emission reductions in the registered PDD are estimated based on full implementation of the project activity, there are several reasons that affect the lower amount of emission reductions in the monitoring period.

- the second phase of the project activity started operating in October 2010 as mentioned in Table 2 which happened during monitoring period;
- the performance of the biogas system is below expectation, the installation of power system for the second phase is not yet concluded and
- the gas engines for the first phase started using biogas in October 2009, however the power supplied to grid is not recorded till the synchronization is certified which happens in December 2010. The PP can claim emission reductions for electricity export component only after synchronization happens; therefore, total baseline emissions are lower than expected volumes.

1.5. Project layout

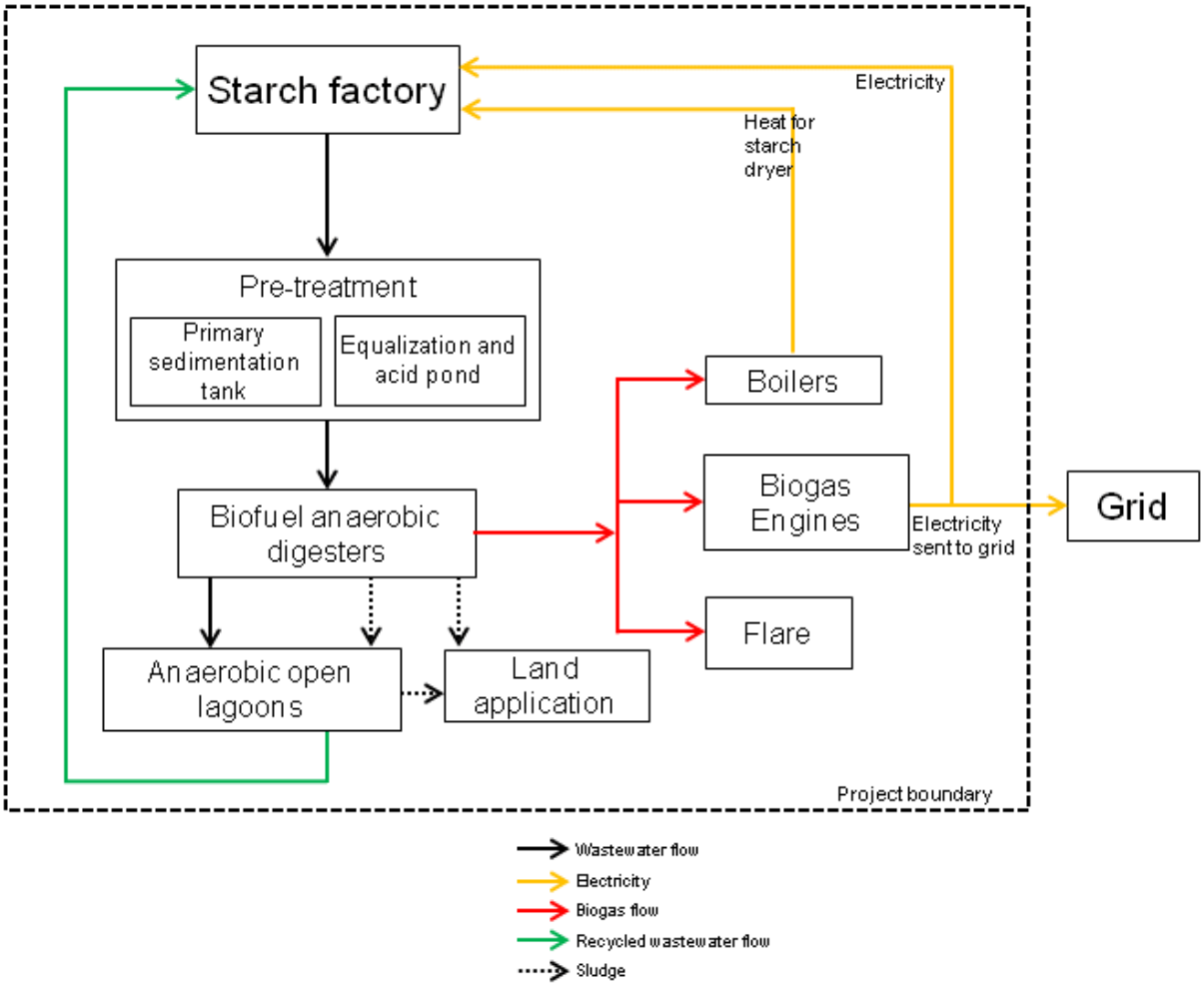

Figure 1. Project layout

2. Reference

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

The following Small-Scale methodologies are applied:

- AMS III.H "Methane recovery in wastewater treatment" version 13, for the methane avoidance and recovery aspect of the project;
- AMS I.C "Thermal energy production with or without electricity" version 16, for the heat generation;
- AMS I.D "Grid connected renewable electricity generation" version 15, for the electricity generation component.

These methodologies refer to the following tools:

- Version 02 of the tool to calculate the emission factor for an electricity system;
- Version 01 of the tool to determine project emissions from flaring gases containing methane;

- Version 02 of the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion.

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

3. Monitoring Background

3.1. Monitoring period

This is pre-CDM GS VER monitoring report of this project activity. It covers the period from 9th April 2010 to 8th April 2011 (both days included)[2]. This is in line with the GS guidelines, for verification of the emission reductions one year prior to the CDM registration.

3.2. Presentation of monitoring results

All monitoring data and calculations are made available in form of excel sheet.

The spreadsheet includes:

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

4. Parameters monitored according to the monitoring plan

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

4.1. Parameters fixed at validation for entire crediting period:

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

Data and parameters from the AMS-III.H version 13

Data / Parameter:	GWP_{CH4}
Data unit:	-
Description:	Global warming potential of methane gas
Source of data used:	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value(s) :	21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.
Additional comment:	

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

Data / Parameter:	$B_{o, ww}$
Data unit:	kg CH_4/kg COD
Description:	Methane generation capacity of COD in waste water.
Source of data used:	IPCC default value, corrected as per methodology AMS III-H page 5, is used for estimation
Value(s) :	0.21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.
Additional comment:	

Data / Parameter:	UF_{BL}
Data unit:	-
Description:	Model correction factor to account of model uncertainties
Source of data used:	AMS.III.H
Value(s) :	0.94
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Additional comment:	The original source of data is: FCCC/SBSTA/2003/Add.2, page 25

Data / Parameter:	UF_{PJ}
Data unit:	-
Description:	Model correction factor to account of model uncertainties
Source of data used:	AMS.III.H
Value(s) :	1.06
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	The original source of data is: FCCC/SBSTA/2003/Add.2, page 25

Data / Parameter:	$MCF_{ww, treatment,BL,i}$
Data unit:	Fraction
Description:	Methane correction factor for the baseline anaerobic wastewater treatment systems
Source of data used:	Table III.H.1 from AMS-III.H, Version 13 methodology
Value(s) :	0.8
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Additional comment:	The value is chosen in a conservative manner according to the table III.H.1 from AMS-III.H, version13 methodology. The baseline wastewater treatment system consists in a succession of deep lagoons, with depth more than 2 metres, so the value of 0.8 has been chosen.

Data / Parameter:	$MCF_{ww, treatment,PJ,BFR}$
Data unit:	Fraction
Description:	Methane correction factor for project wastewater treatment system equipped with biogas recovery
Source of data used:	Table III.H.1 from AMS-III.H, Version 13 methodology
Value(s) :	0.8
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	The value is chosen in a conservative manner according to the table III.H.1 from AMS-III.H, version13 methodology. The project wastewater treatment system with biogas recovery consists in a bio digester.

Data / Parameter:	$MCF_{ww, treatment,PJ,lagoon}$
Data unit:	Fraction
Description:	Methane correction factor for project wastewater treatment system not equipped with biogas recovery
Source of data used:	Table III.H.1 from AMS-III.H, Version 13 methodology
Value(s) :	0.8
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	The value is chosen in a conservative manner according to the table III.H.1 from AMS-III.H, version13 methodology. The project wastewater treatment system without biogas recovery (secondary treatment) consists in a succession of deep lagoons, with depth more than 2 meters, so the value of 0.8 has been chosen.

Data / Parameter:	CFE_{ww}
Data unit:	Fraction
Description:	Capture efficiency of the biogas recovery equipment in the wastewater treatment
Source of data used:	IPCC
Value(s) :	0.9
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	DOC_s
Data unit:	Fraction
Description:	Degradable organic content of the untreated sludge generated in the year “y”
Source of data used:	IPCC default values for industrial waste
Value(s) :	0.09
Indicate what the data are used for (Baseline/ Project/	The data is used for project emission calculations.

Leakage emission calculations)	
Additional comment:	

Data / Parameter:	DOC_F
Data unit:	Fraction
Description:	Fraction of DOC dissimilated to biogas
Source of data used:	IPCC default value
Value(s) :	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	F
Data unit:	Fraction
Description:	Fraction of CH_4 in biogas
Source of data used:	IPCC default value
Value(s) :	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	$MCF_{s, final}$
Data unit:	Fraction
Description:	Methane correction factor of the landfill that receives the final sludge.
Source of data used:	AMS III.G default values
Value(s) :	1.0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	$MCF_{s, treatment}$
Data unit:	Fraction
Description:	Methane correction factor for the sludge treatment system
Source of data used:	IPCC
Value(s) :	0.8
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	$\eta_{removed,baseline}$
Data unit:	%

Description:	COD removal efficiency of the baseline system
Source of data used:	Measured historical values
Value(s) :	89%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.
Additional comment:	

Data / Parameter:	D_{CH4}
Data unit:	kg/m^3
Description:	Density of methane at normal conditions
Source of data used:	"Tool to determine project emissions from flaring gases containing methane", page 9
Value(s) :	0.716
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	NCV_{CH4}
Data unit:	MJ/ton
Description:	NCV of methane
Source of data used:	http://www.engineeringtoolbox.com/gross-net-heating-values-d_420.html
Value(s) :	50,016
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	EC_y
Data unit:	MWh
Description:	Auxiliary electricity consumed by biogas system and gas engine
Source of data used:	Rated power capacity equipment list
Value(s) :	2691
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data / Parameter:	FE
Data unit:	%
Description:	Flare efficiency
Source of data used:	Tool to determine project emissions from flaring gases containing methane.
Value(s) :	50%

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	

Data and parameters from the AMS-I.C version 16

Data / Parameter:	$EF_{HFO,CO2}$
Data unit:	tCO_2/TJ
Description:	Emission factor of fossil fuel replaced – Residual Fuel oil
Source of data used:	IPCC 2006 default value for residual fuel oil, Volume 2, Chapter 1, 1.23
Value(s) :	77.4 tCO2/TJ
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.
Additional comment:	

Data / Parameter:	C_{oil}
Data unit:	KJ/kg. K
Description:	Specific heat of oil
Source of data used:	http://www.nirmalenergy.com/therminol_55.pdf
Value(s) :	2.87 KJ/kg.K at 293°C
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Additional comment:	

Data / Parameter:	$\eta_{BL,thermal}$
Data unit:	-
Description:	Efficiency of thermal oil boiler.
Source of data used:	Technological specification
Value(s) :	86%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Additional comment:	

Data / Parameter:	$NCV_{HFO,CO2}$
Data unit:	GJ/tonne
Description:	Net calorific value of heavy fuel oil
Source of data used:	2006 IPCC Guidelines
Value(s) :	40.4
Indicate what the data are used for (Baseline/ Project/ Leakage emission	The data is used for baseline and project emission calculations.

calculations)	
Additional comment:	

Data / Parameter:	ρ_{HFO}
Data unit:	kg/litre
Description:	Density of fossil fuel
Source of data used:	Thai local value (PTT), http://www.pttplc.com/Files/Document/Pdf/energy/nc_en_ee-01_01.pdf
Value(s) :	0.95
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Additional comment:	

Data / Parameter:	Density of thermic oil
Data unit:	Kg/m^3
Description:	Density of fluid used for heating purposes
Source of data used:	http://www.nirmalenergy.com/therminol_55.pdf
Value(s) :	677 kg/m^3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Additional comment:	This value is used to convert the flow rate of thermic fluid $Q_{oil, h}$.

Data and parameters from the AMS-I.D version 15

Data / Parameter:	EF_{CO2}
Data unit:	tCO_2/MWh
Description:	Grid emission factor of Thailand
Source of data used:	Refer to Annex 3 of the registered PDD
Value(s) :	0.530
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.
Additional comment:	

4.2. Parameters monitored during crediting period:

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

Data / Parameter:	$Q_{ww,y}$
Data unit:	m^3
Description:	Flow of wastewater treated in the year y
Measured /Calculated	Measured

<table>
<tr><td>/Default:</td><td></td></tr>
<tr><td>Source of data:</td><td>Log books</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th rowspan="2">Monitoring period</th><th colspan="3">Value</th></tr>
<tr><th>$Q_{ww,BFR1}$</th><th>$Q_{ww,BFR2}$</th><th>$Q_{ww,BFR3}$</th></tr>
<tr><td>09/04/2010 - 31/12/2010</td><td>121,487</td><td>67,188</td><td>57,605</td></tr>
<tr><td>01/01/2011 - 08/04/2011</td><td>128,198</td><td>26,021</td><td>74,067</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>The data is used for baseline and project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Tag no.</td><td>FM1 (inlet of BFR 1)</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>09/04/2010 - 09/09/2010</td></tr>
<tr><td>Equipment Type</td><td>Magnetic Flowmeter</td></tr>
<tr><td>Manufacturer</td><td>YOKOGOWA</td></tr>
<tr><td>Model</td><td>AXF100G-D1UL1S-AJ11-01B</td></tr>
<tr><td>Accuracy Level</td><td>±0.35%</td></tr>
<tr><td>Serial No.</td><td>S5F804670</td></tr>
<tr><td>Calibration Frequency</td><td>Once in three years</td></tr>
<tr><td>Date of calibration</td><td>09/08/2006</td></tr>
<tr><td>Validity</td><td>08/08/2009</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>10/09/2010 - 25/03/2011</td></tr>
<tr><td>Equipment Type</td><td>Electromagnetic flow meter</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>Water Master</td></tr>
<tr><td>Accuracy Level</td><td>±0.1%</td></tr>
<tr><td>Serial No.</td><td>3K220000010927</td></tr>
<tr><td>Calibration Frequency</td><td>Once in three years</td></tr>
<tr><td>Date of previous calibrations</td><td>29/03/2009</td></tr>
<tr><td>Date of latest calibration</td><td>01/01/2011</td></tr>
<tr><td>Validity</td><td>31/12/2014</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>26/03/2011 - 26/03/2011</td></tr>
<tr><td>Equipment Type</td><td>Electromagnetic flow meter</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>Water Master</td></tr>
<tr><td>Accuracy Level</td><td>±0.1%</td></tr>
<tr><td>Serial No.</td><td>3K220000010926</td></tr>
<tr><td>Calibration Frequency</td><td>Once in three years</td></tr>
<tr><td>Date of previous calibrations</td><td>29/03/2009</td></tr>
<tr><td>Date of latest calibration</td><td>31/12/2010</td></tr>
<tr><td>Validity</td><td>30/12/2013</td></tr>
</table>
</td></tr>
</table>

Period of use	27/03/2011 onwards
Equipment Type	Electromagnetic flow meter
Manufacturer	ABB
Model	Water Master
Accuracy Level	±0.1%
Serial No.	3K220000022330
Calibration Frequency	Once in three years
Date of previous calibrations	22/07/2009
Date of latest calibration	01/01/2011
Validity	31/12/2014

Tag no.	FM2 (inlet of BFR 2)

Period of use	09/04/2010 - 09/09/2010
Equipment Type	Magnetic Flowmeter
Manufacturer	YOKOGOWA
Model	AXF100G-D1UL1S-AJ11-01B
Accuracy Level	±0.35%
Serial No.	S5F804671
Calibration Frequency	Once in three years
Date of calibration	09/08/2006
Validity	08/08/2009

Period of use	10/09/2010 - 26/03/2011
Equipment Type	Electromagnetic flow meter
Manufacturer	ABB
Model	Water Meter
Accuracy Level	±0.1%
Serial No.	3K220000022330
Calibration Frequency	Once in three years
Date of previous calibrations	22/07/2009
Date of latest calibration	01/01/2011
Validity	31/12/2014

Period of use	27/03/2011 onwards
Equipment Type	Electromagnetic flow meter
Manufacturer	ABB
Model	Water Master
Accuracy Level	±0.1%
Serial No.	3K220000010926
Calibration Frequency	Once in three years
Date of previous calibrations	29/03/2009

	Date of latest calibration	31/12/2010
	Validity	30/12/2013
	Tag no.	FM5 (inlet of BFR 3)
	Equipment Type	Liquid flow meter
	Manufacturer	Euromag
	Model	Converter: MC308 Detector: MUT1000EL
	Accuracy Level	±0.2%[3]
	Serial No.	ZAL0214
	Calibration Frequency	Once in three years
	Date of previous calibrations	26/02/2010
	Date of latest calibration	02/01/2011
	Validity	01/01/2014
Measuring/ Reading/ Recording frequency:	The meter has continuous monitoring of the flow of wastewater. The accumulated reading is taken from the meter screen and recorded in the log sheet by the operator on a daily basis. The results from the log sheet are transferred to the excel sheet template.	
Calculation method (if applicable):	N/A	
QA/QC procedures applied:	The data recorded in log sheets is based on meter readings directly at the meter location and checked by the plant manager on regular basis. The flow meter is regularly calibrated once in every three years in line with the latest EB guidelines for small-scale project.	
Comment:	Since the equipment YOKOGAWA used as FM1 and FM2 were replaced by new meters since 10th September 2010 and the calibration was not done properly during the monitoring period, the measured values of wastewater flow for the period from 9th April - 9th September 2010 have been adjusted by applying the maximum permissible error (±0.35%) in a conservative manner.	

Data / Parameter:	$COD_{ww, untreated,y} = COD_{y, in, BFR}$
Data unit:	mg/l
Description:	Chemical oxygen demand of the wastewater entering the wastewater treatment system in the year y
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	

Monitoring period	**Value**	
	$COD_{in,BFR\ 1,2}$	**$COD_{in,BFR\ 3}$**
09/04/2010 - 31/12/2010	15,090	14,221

[3] http://www.google.co.th/url?sa=t&rct=j&q=euromag%20mut1000el&source=web&cd=2&ved=0CCwQFjAB&url=http%3A%2F%2Fwww.euromag.com%2Fen%2Fdownload%2Fcategory%2F2-brochure-eng%3Fdownload%3D20%253Asensor-mut-1000el&ei=DwNrT7aJI4rKrAfbvKWyAg&usg=AFQjCNF-YAjFh17hgZGXMxQb2D9P8WJWCw&cad=rja.

	01/01/2011 - 08/04/2011	12,434	12,999	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline and project emission calculations.			
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The COD content is analyzed using a Close Reflux Titrimetric method in the on-site laboratory. The certified chemicals are used for the analysis to meet the standard method.			
Measuring/ Reading/ Recording frequency:	Wastewater sample is collected every 2 hours and analysis for COD is done twice a day. The test results are logged manually in the plant operation report on a daily basis. The results from the log sheet are transferred to the excel sheet template.			
Calculation method (if applicable):	N/A			
QA/QC procedures applied:	The Close Reflux Titrimetric method is well documented and well accepted either by national or international standards.			

Data / Parameter:	$COD_{ww,treated,y} = COD_{y,out,BFR}$
Data unit:	mg/l
Description:	COD of water exiting the BFR treatment process.
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	

Monitoring period	**Value**		
	$COD_{out,BFR1}$	**$COD_{out,BFR2}$**	**$COD_{out,BFR3}$**
09/04/2010 - 31/12/2010	355	414	341
01/01/2011 - 08/04/2011	427	407	433

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The COD content is analyzed using a Close Reflux Titrimetric method in the on-site laboratory. The certified chemicals are used for the analysis to meet the standard method.
Measuring/ Reading/ Recording frequency:	Wastewater sample is collected every 2 hours and analysis for COD is done twice a day. The test results are logged manually in the plant operation report on a daily basis. The results from the log sheet are transferred to the excel sheet template.
Calculation method (if applicable):	
QA/QC procedures applied:	The test results are reviewed by QC supervisor before transferring to the excel sheet. The Close Reflux Titrimetric method is well documented and well accepted either by national or international standards.

Data / Parameter:	$COD_{out,lagoon,PJ,y}$
Data unit:	mg/l
Description:	COD of water after the secondary treatment process, before being reused.
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010: 175; 01/01/2011 - 08/04/2011: 192
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The COD content is analyzed using a Close Reflux Titrimetric method in the on-site laboratory. The certified chemicals are used for the analysis to meet the standard method.
Measuring/ Reading/ Recording frequency:	Wastewater sample is collected every 8 hours and analysis for COD is done once a day. The test results are logged manually in the plant operation report on a daily basis. The results from the log sheet are transferred to the excel sheet template.
Calculation method (if applicable):	
QA/QC procedures applied:	The test results are reviewed by QC supervisor before transferring to the excel sheet. The Close Reflux Titrimetric method is well documented and well accepted either by national or international standards.

Data / Parameter:	$COD_{ww,removed,PJ,BFR,y}$
Data unit:	$tones/m^3$
Description:	Chemical Oxygen Demand removed by the treatment system of the project activity equipped with biogas recovery (BFR) in the year y
Measured /Calculated /Default:	Calculated
Source of data:	Refer to the parameter $COD_{ww,untreated,y} = COD_{y,in,BFR}$ and $COD_{ww,treated,y} = COD_{y,out,BFR}$, which is measured by Close Reflux Titrimetric
Value(s) of monitored parameter:	**Monitoring period** / **Value**: **BFR 1** / **BFR 2** / **BFR 3**: 09/04/2010 - 31/12/2010: 0.0147 / 0.0147 / 0.0139; 01/01/2011 - 08/04/2011: 0.0120 / 0.0120 / 0.0126
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration	Refer to the information provided for the parameter $COD_{ww,untreated,y} = COD_{y,in,BFR}$ and $COD_{ww,treated,y} = COD_{y,out,BFR}$

frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Refer to the parameter $COD_{ww,untreated,y} = COD_{y, in, BFR}$ and $COD_{ww,treated,y} = COD_{y, out, BFR}$
Calculation method (if applicable):	Refer to the parameter $COD_{ww,untreated,y} = COD_{y, in, BFR}$ and $COD_{ww,treated,y} = COD_{y, out, BFR}$
QA/QC procedures applied:	

Data / Parameter:	$S_{y, final}$
Data unit:	Tonnes
Description:	Amount of final sludge as dry matter generated by the wastewater treatment in the year y
Measured /Calculated /Default:	Measured
Source of data:	Log records of starch plant
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010 / -; 01/01/2011 - 08/04/2011 / -
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	In case there is sludge removal, the quantity of sludge generated shall be monitored in log records before end use.
Calculation method (if applicable):	
QA/QC procedures applied:	The measurement equipment shall be calibrated on regular basis.
Any comment	There is no sludge removal during the monitoring period.

Data / Parameter:	$BG_{combusted,y}$
Data unit:	Nm^3
Description:	Quantity of biogas combusted for gainful use
Measured /Calculated /Default:	Calculation based on the values of $BG_{boiler, y}$ and $BG_{gas\ engine, y}$
Source of data:	Refer to the parameter $BG_{boiler, y}$ and $BG_{gas\ engine, y}$
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010 / 2,544,488; 01/01/2011 - 08/04/2011 / 2,377,152
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type,	Refer to the parameter $BG_{boiler, y}$ and $BG_{gas\ engine, y}$

accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Refer to the parameter $BG_{boiler, y}$ and $BG_{gas\ engine, y}$
Calculation method (if applicable):	N/A
QA/QC procedures applied:	Refer to the parameter $BG_{boiler, y}$ and $BG_{gas\ engine, y}$

Data / Parameter:	$BG_{ToFlare, y}$
Data unit:	Nm^3
Description:	Total quantity of biogas flared
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010: 18,028; 01/01/2011 - 08/04/2011: 1,286
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Tag no.**: GM1 **Equipment Type**: Mass Flow Meter **Manufacturer**: Fluid Components International LLC (FCI) **Model**: ST51 **Accuracy Level**: ±2%[4] **Serial No.**: 307520 **Calibration Frequency**: Once in three years **Date of previous calibrations**: 11/08/2009 **Date of latest calibration**: 31/12/2010 **Validity**: 30/12/2013
Measuring/ Reading/ Recording frequency:	Measurements of volume of biogas sent to flare are done continuously using gas flow meters. In recording this parameter, continuously measurement is done and cumulative reading is recorded daily. The plant's operators first manually record the monitored data onto log sheets then transfer to the computer for electronic storage.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	The gas flow meter is calibrated on regular basis, at least once every three years.
Any comment:	Since relevant parameters for calculation of the project emission from flaring were not monitored during the monitoring period, 0% of flare

[4] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

	efficiency were taken into account of project emissions for conservativeness.

Data / Parameter:	EG_y
Data unit:	kWh (converted into MWh for calculation purpose)
Description:	Net electricity generated from the biogas collected in the anaerobic treatment facility and sent to the grid
Measured /Calculated /Default:	Measured
Source of data:	Monthly report by PEA
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010: 0; 01/01/2011 - 08/04/2011: 1,940
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Equipment Type**: Electricity Meter; **Manufacturer**: EDMI; **Model**: Genius Series; **Accuracy Level**: Class 0.2s, ±0.2%; **Serial No.**: 206500546 / PEA No.20963728
Measuring/ Reading/ Recording frequency:	The measurement of this parameter is done continuously using electricity meter owned by PEA. The parameter is recorded monthly. This can be verified from the reports issued by PEA (Provincial Electricity Authority).
Calculation method (if applicable):	N/A
QA/QC procedures applied:	The reports are issued by Provincial Electricity Authority (PEA) where the monitored data is monthly recorded by the PEA officer together with plant's operator. The quantity of electricity sent to the grid can be cross-checked with invoices raised by PEA. Calibration of the meter shall be carried out on annual basis as per the internal PEA regulation[5].
Additional comment:	Since the project started exporting electricity generated to the grid in December 2010 and the electricity exported is very less amount, the baseline emissions from electricity displaced by the project activityis neglected from emission reduction calculation.

Data / Parameter:	$BG_{recovered, y}$
Data unit:	Nm^3
Description:	Amount of biogas recovered
Measured /Calculated /Default:	Measured by using the same equipment for $BG_{boiler, y}$, $BG_{ToFlare, y}$ and $BG_{gas\ engine, y}$
Source of data:	Refer to the information of $BG_{boiler, y}$, $BG_{ToFlare, y}$ and $BG_{gas\ engine, y}$
Value(s) of monitored	

[5] The document shall be provided to DOE during verification.

parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010: 2,562,516; 01/01/2011 - 08/04/2011: 2,378,438
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)	Refer to the parameter $BG_{boiler, y}$, $BG_{ToFlare, y}$ and $BG_{gas\ engine, y}$
Measuring/ Reading/ Recording frequency:	Refer to the parameter $BG_{boiler, y}$, $BG_{ToFlare, y}$ and $BG_{gas\ engine, y}$
Calculation method (if applicable):	N/A
QA/QC procedures applied:	Refer to the parameter $BG_{boiler, y}$, $BG_{ToFlare, y}$ and $BG_{gas\ engine, y}$

Data / Parameter:	$BG_{boiler, y}$
Data unit:	Nm^3
Description:	Amount of biogas fired in boiler
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	

Monitoring period	**Value**		
	$BG_{boiler\ 1,y}$	**$BG_{boiler\ 2,y}$**	**Total**
09/04/2010 - 31/12/2010	1,063,973	984,587	2,048,560
01/01/2011 - 08/04/2011	1,336,919	1,030,877	2,367,796

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	

Tag no.	GM2 (Boiler 1)
Equipment Type	Mass Flow Meter
Manufacturer	Fluid Components International LLC (FCI)
Model	ST51
Accuracy Level	±2%[6]
Serial No.	307522
Calibration Frequency	Once in three years
Date of previous calibrations	11/08/2009
Date of latest calibration	31/12/2010
Validity	30/12/2013

[6] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

	Tag no. GM3 (Boiler 2) **Equipment Type** Mass Flow Meter **Manufacturer** Fluid Components International LLC (FCI) **Model** ST51 **Accuracy Level** ±2%[7] **Serial No.** 307521 **Calibration Frequency** Once in three years **Date of previous calibrations** 11/08/2009 **Date of latest calibration** 31/12/2010 **Validity** 30/12/2013
Measuring/ Reading/ Recording frequency:	Measurements of volume of biogas sent to boilers are done continuously using gas flow meters. In recording this parameter, continuously measurement is done and cumulative reading is recorded daily. The plant's operators first manually record the monitored data onto log sheets then transfer to the computer for electronic storage.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	The gas flow meter is calibrated on regular basis, at least once every three years.

Data / Parameter:	$BG_{gas\ engine,\ y}$
Data unit:	Nm^3
Description:	Amount of biogas used for power generation in gas engine
Measured /Calculated /Default:	Measurement - flow meter
Source of data:	Log books
Value(s) of monitored parameter:	**Monitoring period** / **Value** 09/04/2010 - 31/12/2010 / 495,928 01/01/2011 - 08/04/2011 / 9,356
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Tag no.** GM4 **Period** 09/04/2010 - 24/02/2011 **Equipment Type** Mass Flow Meter **Manufacturer** Fluid Components International LLC (FCI) **Model** ST51

[7] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

	Accuracy Level ±2%[8]
	Serial No. 307523
	Calibration Frequency Once in three years
	Date of previous calibrations 11/08/2009
	Date of latest calibration 31/12/2010
	Validity 30/12/2013

Period	25/02/2011 onwards
Equipment Type	Mass Flow Meter
Manufacturer	Fluid Components International LLC (FCI)
Model	ST51
Accuracy Level	±2%[9]
Serial No.	307525
Calibration Frequency	Once in three years
Date of previous calibrations	10/08/2009
Date of latest calibration	31/12/2010
Validity	30/12/2013

Measuring/ Reading/ Recording frequency:	Measurements of volume of biogas sent to gas engines are done continuously using gas flow meters. In recording this parameter, continuously measurement is done and cumulative reading is recorded daily. The plant's operators first manually record the monitored data onto log sheets then transfer to the computer for electronic storage.
Calculation method (if applicable):	
QA/QC procedures applied:	The gas flow meter is calibrated on regular basis, at least once every three years.

Data / Parameter:	W_{CH4}
Data unit:	%
Description:	Methane content in biogas
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	

Monitoring period	**Value**	
	Lower	**Upper**
09/04/2010 - 31/12/2010	56.09	56.97
01/01/2011 - 08/04/2011	53.16	53.65

Indicate what the data are used for (Baseline/ Project/ Leakage emission	The data is used for baseline and project emission calculations.

[8] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

[9] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

<table>
<tr><td>calculations)</td><td></td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Tag no.</td><td>Gas Analyzer</td></tr>
<tr><td>Equipment Type</td><td>Gas Analyzer</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>EL3020</td></tr>
<tr><td>Accuracy Level</td><td>±1%[10]</td></tr>
<tr><td>Serial No.</td><td>3.348750.9</td></tr>
<tr><td>Calibration Frequency</td><td>Once a year</td></tr>
<tr><td>Date of latest calibration</td><td>19/08/2009</td></tr>
<tr><td>Validity</td><td>18/08/2010</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measurement is done using a continuous system. The values are logged into log books at least 6 times per day.</td></tr>
<tr><td>Calculation method (if applicable):</td><td></td></tr>
<tr><td>QA/QC procedures applied:</td><td>Gas analyzers shall be annually calibrated according to the manufacturer’s recommendation.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>T_{flare}</td></tr>
<tr><td>Data unit:</td><td>°C</td></tr>
<tr><td>Description:</td><td>Flame temperature of the flare</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured</td></tr>
<tr><td>Source of data:</td><td>Electronic file from data logger</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Monitoring period</th><th>Value</th></tr>
<tr><td>09/04/2010 - 31/12/2010</td><td>0</td></tr>
<tr><td>01/01/2011 - 08/04/2011</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>The data is used for project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Equipment Type</td><td>Thermocouple Type N</td></tr>
<tr><td>Manufacturer</td><td>PR electronics</td></tr>
<tr><td>Model</td><td>5334B</td></tr>
<tr><td>Serial No.</td><td>070125977</td></tr>
<tr><td>Accuracy Level</td><td>±0.05%</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td></td></tr>
<tr><td>Calculation method (if applicable):</td><td></td></tr>
<tr><td>QA/QC procedures applied:</td><td></td></tr>
<tr><td>Additional comment:</td><td>There is no data recorded during the monitoring period, because the measurement system is not in place.</td></tr>
</table>

10 http://www05.abb.com/global/scot/scot205.nsf/veritydisplay/7b9eb5e9db6b05f3c1257960004217c8/$file/10-24-410-09-EN.pdf

<table>
<tr><td>Data / Parameter:</td><td>$FV_{RG,h}$</td></tr>
<tr><td>Data unit:</td><td>Nm^3/hr</td></tr>
<tr><td>Description:</td><td>Biogas sent to flare (volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h)</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured using the same equipment of $BG_{ToFlare, y}$</td></tr>
<tr><td>Source of data:</td><td>Electronic file from data logger</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>There is no hourly values logged during the monitoring period</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>The data is used for project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Tag no.</td><td>GM1</td></tr>
<tr><td>Equipment Type</td><td>Mass Flow Meter</td></tr>
<tr><td>Manufacturer</td><td>Fluid Components International LLC (FCI)</td></tr>
<tr><td>Model</td><td>ST51</td></tr>
<tr><td>Accuracy Level</td><td>±2%[11]</td></tr>
<tr><td>Serial No.</td><td>307520</td></tr>
<tr><td>Calibration Frequency</td><td>Once in three years</td></tr>
<tr><td>Date of previous calibration</td><td>11/08/2009</td></tr>
<tr><td>Date of latest calibration</td><td>31/10/2010</td></tr>
<tr><td>Validity</td><td>30/10/2013</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measurements of volume of biogas sent to flare are done continuously using gas flow meters.</td></tr>
<tr><td>Calculation method (if applicable):</td><td></td></tr>
<tr><td>QA/QC procedures applied:</td><td>The gas flow meter is calibrated on regular basis, at least once every three years.</td></tr>
<tr><td>Additional comment:</td><td>Since relevant parameters for calculation of the project emission from flaring were not monitored during the monitoring period, 0% efficiency is assumed for the biogas flared and project emissions are estimated in conservative manner.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$\eta_{flare-h}$</td></tr>
<tr><td>Data unit:</td><td>%</td></tr>
<tr><td>Description:</td><td>Flare efficiency of the open flare</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Calculated based on tool to determine project emissions from flaring gases containing methane, EB28, Annex 13</td></tr>
<tr><td>Source of data:</td><td>Calculation</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Monitoring period</th><th>Value</th></tr>
<tr><td>09/04/2010 - 31/12/2010</td><td>0</td></tr>
</table>
</td></tr>
</table>

[11] http://www.fluidcomponents.com/Industrial/Products/MassFlowMeters/ProdST50.asp.

	01/01/2011 - 08/04/2011 | 0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	Under normal operation, continuous measurement of the temperature of the exhaust gases of the flare would have been done. However, during this monitoring period, the flare temperature was not monitored properly and 0% flare efficiency is taken.
Calculation method (if applicable):	Based on tool to determine project emissions from flaring gases containing methane, EB28, Annex 13
QA/QC procedures applied:	N/A
Additional comment:	The temperature of the exhaust gases of the flare used for estimation the flare efficiency was not monitored properly. Therefore a conservative value of 0% flare efficiency was taken.

Data / Parameter:	$T_{out.h}$
Data unit:	Deg C
Description:	Temperature of thermic fluid leaving the boiler for starch drying.
Measured /Calculated /Default:	Measured
Source of data:	Electronic file from data logger
Value(s) of monitored parameter:	**Monitoring period** | **Value** 09/04/2010 - 31/12/2010 | 0 01/01/2011 - 08/04/2011 | 0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Equipment Type** | Resistance thermometer **Model** | PT 100 **Accuracy Level** | 0.05%[12]
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	
Additional comment:	Since this parameter used for the calculation of baseline emission for heat produced was not recorded properly during the monitoring period, a deviation has been made to the approach specified in the registered PDD, which is provided in Annex 2.

[12] The document shall be provided to DOE during verification.

Data / Parameter:	$T_{in,h}$
Data unit:	Deg C
Description:	Temperature of thermic fluid entering the boiler for starch drying.
Measured /Calculated /Default:	Measured
Source of data:	Electronic file from data logger
Value(s) of monitored parameter:	**Monitoring period** / **Value** 09/04/2010 - 31/12/2010 / 0 01/01/2011 - 08/04/2011 / 0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Equipment Type**: Resistance thermometer **Model**: PT 100 **Accuracy Level**: 0.05%[13]
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	
Additional comment:	Since this parameter used for the calculation of baseline emission for heat produced was not recorded properly during the monitoring period, a deviation has been made to the approach specified in the registered PDD, which is provided in Annex 2.

Data / Parameter:	$Q_{oil,h}$
Data unit:	m^3/hr
Description:	Flow of the thermic fluid in the boiler.
Measured /Calculated /Default:	Measured using flow meter However, there is no meter available for the project activity.
Source of data:	Electronic file from data logger
Value(s) of monitored parameter:	**Monitoring period** / **Value** 09/04/2010 - 31/12/2010 / 0 01/01/2011 - 08/04/2011 / 0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration	No equipment installed.

[13] The document shall be provided to DOE during verification.

frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	In case there is equipment available, continuous measurement shall be done and logged in data logger or hourly recorded by the operators.
Calculation method (if applicable):	
QA/QC procedures applied:	There is no meter available.
Additional comment:	Since the flow meter used for monitoring this parameter was not available, a deviation has been made to the approach specified in the registered PDD which is provided in Annex 2.

Data / Parameter:	$Q_{HFO, y}$
Data unit:	Tonnes
Description:	Fuel oil burnt in the hot oil boiler along with biogas.
Measured /Calculated /Default:	Measured
Source of data:	Log books
Value(s) of monitored parameter:	**Monitoring period** / **Value**: 09/04/2010 - 31/12/2010: 432,950; 01/01/2011 - 08/04/2011: 500,359
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used for project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Boiler 1: **Equipment Type**: Oil meter; **Manufacturer**: Aquametro; **Model**: VZO 20 FL; **Accuracy Level**: ±1%; **Serial no.**: 4643681; **Calibration Frequency**: Once in ten years; **Date of previous calibration**: 13/10/2006; **Validity**: 12/10/2016 Boiler 2: **Equipment Type**: Oil meter; **Manufacturer**: Aquametro; **Model**: VZO 20 RC; **Accuracy Level**: ±1%; **Serial no.**: 4801239; **Calibration Frequency**: Once in ten years; **Date of previous calibration**: 22/05/2008; **Validity**: 21/05/2018
Measuring/ Reading/ Recording frequency:	The measurement of this parameter is done continuously using flow meter. Daily recording is done and the aggregate data in monthly is then transferred to electronic file.

Calculation method (if applicable):	N/A
QA/QC procedures applied:	The installed meters at the starch factory are calibrated in line with the manufacturer's recommendation which is every ten years.

5. Emission reduction calculation

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

- The Emission reduction based on ex-ante formulas, using the ex-post monitored values of the COD, biogas usage, power consumption etc.
- The Emission Reductions based on the amount of biogas collected, used and destructed by the project activity. This is a more direct approach. In this case the project emissions are from the power usage.

5.1. Baseline emissions

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS III.H- Version 13), the emissions due to the displacement of electricity from the grid (calculated according to AMS I.D- Version 15) and the emissions due to fossil fuel replacement for heating calculated according to AMS I.C- Version 16):

$$\mathbf{BE_{y} = BE_{elec,y} + BE_{thermal,CO2,y} + BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}} \quad \mathbf{(1)}$$

Where:

BE_y	Baseline emissions in the year y (tCO_2e).
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO_2e).
$BE_{thermal,CO2,y}$ year y	Baseline emissions from steam/heat displaced by the project activity during the in tCO_2e.
$BE_{elec,y}$ year y	Baseline emissions from electricity displaced by the project activity during the in tCO_2e.
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e).
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e).
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharge into sea/river/lake in year y (tCO_2e). The value of this term is zero for the case 1 (ii).
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.

AMS III H

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 paragraph 20 of AMS III.H version 13:

$$\mathbf{BE_{ww,treatment,y} = \sum Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH4}} \quad \mathbf{(2)}$$

Where:

$Q_{ww,i,y}$	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 baseline wastewater treatment system i (MCF value as per table III.H.l).
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)[14]
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[15]
GWP_{CH4}	Global Warming Potential for methane (value of 21).

In the baseline situation, there is no sludge treatment and in the baseline situation and the treated wastewater is not discharged into sea/lake/river.

Therefore:

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

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

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

Baseline emissions from electricity consumption ($BE_{power,y}$) are neglected. This is conservative.

As per AMS III.H, paragraph 3, since the recovered biogas is used for thermal and electricity generation, type I methodologies are used. As per AMS III.H, paragraph19 and AMS I.C, paragraph 14, baseline emissions for supply of electricity to and/or displacement electricity from a grid shall be calculated as per the procedures described in AMS-I.D. For emissions from fossil fuel consumption, the emission factor for the fossil fuel shall be used (tCO2/tonne).

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:

$$\mathbf{BE_{thermal,CO2,y} = (EG_{thermal,y} / \eta_{BL,thermal})* EF_{FF,CO2}} \quad \mathbf{(4)}$$

Where:

$BE_{thermal,CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year y in tCO_2e.
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year y in TJ.
$EF_{FF,CO2}$	The CO2 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.

[14] The IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties. For domestic waste water, a COD based value of $B_{o,ww}$ can be converted to BOD_5 based value by dividing it by 2.4 i.e. a default value of 0.504 kg CH_4/kg COD can be used.

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

$\eta_{BL,thermal}$ The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity.

The net quantity of steam/heat supplied by the project activity is calculated as follows:

$$\mathbf{EG_{thermal,y} = \sum_{h}[Q_{oil,h} X(T_{out,h} - T_{in,h})]XC_{oil}}$$

Where:

$T_{out,h}$ Temperature of heating medium (thermal oil) coming out of boiler during hour h (Deg C)

$T_{in,h}$ Temperature of heating medium (thermal oil) going into the boiler during hour h (Deg C)

$Q_{oil,h}$ Thermal oil flow rate during hour (kg/h)

C_{oil} Specific heat of oil - Standard (KJ/kg.K)

Due to incompleteness of the monitoring equipment and data collection, a deviation has been applied to estimate the baseline emissions in a conservative approach. The information for the deviation has been provided in Annex 2 of the monitoring report.

AMS-I.D

As per paragraph 10 of AMS I.D, for the electricity displaced by the project activity, the baseline emissions are calculated as follows:

$$\mathbf{BE_{elec,y} = EG_y * EF_{CO2}} \quad \mathbf{(5)}$$

Where:

$BE_{elec,y}$ the baseline emissions from electricity displaced by the project activity during the year y in tCO_2e.

EG_y the net quantity of electricity generated by the project activity during the year y in MWh.

EF_{CO2} Grid emission factor of Thailand, calculated with the tool to calculate the emission factor of an electricity system, in tCO_2/MWh

Due to less electricity was generated and supplied to the grid during the monitoring period, the baseline emissions from the electricity displaced has been neglected for conservativeness.

Baseline Emissions

		09/04 - 31/12/2010		01/01 - 08/04/2011	
		BFR1,2	BFR3	BFR1,2	BFR3
$Q_{ww, i, y}$	m^3	188,385	57,605	154,219	74,067
$COD_{removed, i, y}$	$tonnes/m^3$	0.0134	0.0127	0.0111	0.0116
$B_{o, ww}$		0.21	0.21	0.21	0.21
$MCF_{ww, treatment, BL, i}$		0.8	0.8	0.8	0.8
GWP_{CH4}		21	21	21	21
UF_{BL}		0.94	0.94	0.94	0.94
$BE_{ww, treatment, y}$ (COD)	**tCO_2**	**8,390**	**2,418**	**5,660**	**2,842**
$BE_{ww, treatment, y}$ (COD) - Total	**tCO_2**	**10,808**		**8,501**	

		09/04 - 31/12/2010	01/01 - 08/04/2011
$BG_{combusted, y (boiler1,2)}$	Nm^3	2,048,560	2,367,796
$BG_{combusted, y (gas engines)}$	Nm^3	495,928	9,356
$BG_{ToFlare, y}$	Nm^3	18,028	1,286
$W_{CH4, y (95\% lower)}$	%	0.56	0.53
D_{CH4}	kg/m^3	0.716	0.716
FE		0%	0%
MD_y	**tCO_2**	**21,458**	**19,000**

		09/04 - 31/12/2010	01/01 - 08/04/2011
$Q_{starch, y}$	kg	46,798,187	46,209,720
$q_{HFO, starch}$	l/kg	0.026	0.026
ρ_{HFO}	kg/litre	0.95	0.95
$NCV_{HFO, CO2}$	GJ/tonne	40.4	40.4
$EF_{HFO, CO2}$	tCO_2/TJ	77.4	77.4
$Q_{HFO, y}$	litres	432,950	500,359
NCV_{CH4}	MJ/ton	0.050	0.050
$EG_{thermal, y - Fuel energy input}$	TJ	57.8	64.3
$EG_{thermal, y - Historical data basis}$	TJ	46.5	45.9
$BE_{thermal, CO2, y}$	**tCO_2**	**3,601**	**3,555**

		09/04 - 31/12/2010	01/01 - 08/04/2011
EG_y	MWh	0	0
EF_{CO2}	tCO_2/MWh	0.53	0.53
$BE_{elec, y}$	**tCO_2**	**0**	**0**

5.2. Project emissions

AMS III H

Project emissions are the sum of emissions from the wastewater treatment systems affected by the project and not equipped with biogas recovery, methane fugitive emissions on account of inefficiencies in capture systems, methane emissions due to incomplete flaring, CO_2 emissions on

account of power and fuel used by the project activity facilities (calculated according to AMS III.H-Version 13, paragraph 26).
The project activity emissions are calculated as follows:

$$\mathbf{PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y}} \quad \mathbf{(6)}$$

Where:

PE_y	Project activity emissions in the year y (tCO_2e)
$PE_{power,y}$	Emissions from electricity or fossil fuel consumption in the year y
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems not equipped with biogas recovery in year y
$PE_{s,treatment,y}$	Emissions from sludge treatment systems not equipped with biogas recovery in year y
$PE_{ww,discharge,y}$	Emissions from degradable organic carbon in treated wastewater in year y
$PE_{s,final,y}$	Emissions from anaerobic decay of the final sludge produced in the year y
$PE_{fugitive,y}$	Emissions from biogas release in capture systems in year y
$PE_{biomass,y}$	Emissions from biomass stored under anaerobic condition
$PE_{flaring,y}$	Emissions from incomplete flaring in year y

- **$PE_{power,y}$:** These emissions are calculated as per paragraphs 19 and 26 of AMS III.H. All the equipments that are involved in operation of biogas generation and consumption are to be included in estimation of power consumption.

$$\mathbf{PE_{power,y} = EC_y * EF_{CO2}} \quad \mathbf{(7)}$$

Where:

$PE_{power,y}$	Project emissions from electricity consumption by the project activity during the year y in tCO_2e.
EC_y	Net quantity of electricity imported by the project activity during the year y in TJ.
EF_{CO2}	Grid emission factor of Thailand, calculated with the tool to calculate the emission factor of an electricity system, in tCO_2/MWh

- **$PE_{ww,treatment,y}$:** These accounts for project emissions in wastewater not equipped with biogas recovery system and are calculated as per paragraph 20, using an uncertainty factor of 1.06, as follows:

$$\mathbf{PE_{ww,treatment,y} = \sum Q_{ww,k,y} * COD_{removed,PJ,ky} * MCF_{ww,treatment,PJ,k} * B_{o,ww} * UF_{PJ} * GWP_{CH4}} \quad \mathbf{(8)}$$

Where:

$Q_{ww,k,y}$	Volume of wastewater treated in project wastewater treatment system k without biogas recovery in the year "y" (m3/yr)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH4/kg COD)[16]

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

$COD_{removed,PJ,k,y}$	Chemical oxygen demand removed by project wastewater treatment system k without biogas recovery in the year "y" (tonnes/m3); measured as the difference between inflow COD and the outflow COD in system k.
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for project wastewater treatment system k without biogas recovery.
UF_{PJ}	Model correction for uncertainties (1.06)

- **$PE_{s,\ treatment,y}$** : These emissions account for methane emissions from sludge treatment system affected by the project activity, and not equipped with biogas recovery in the project situation. However, the project activity does not include sludge treatment system, therefore the emission from sludge treatment system is null:

  $PE_{s,treatment,\ y} = 0$

- **$PE_{ww,\ discharge,\ y}$**: These emissions account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater. Not applicable to the project activity, since the treated wastewater is not discharged in river, sea or lake.

  $PE_{ww,\ discharge,\ y} = 0$

- **$PE_{s,\ final,\ y}$** : These emissions account for methane emissions from anaerobic decay of the final sludge produced in year *y* and are calculated as follows:

$$\mathbf{PE_{s,\ final,\ y} = S_{final,PJ,y} * DOC_{s} * UF_{PJ} * MCF_{s,\ PJ,final} * DOC_{F} * F * 16/12 * GWP_{CH4}} \quad \mathbf{(9)}$$

Where:

$S_{final,PJ,y}$	Amount of dry matter in final sludge generated by the project wastewater treatment systems in year *y* (tonnes)
DOC_S	Degradable organic content of the untreated sludge generated in the year "y" (fraction, dry basis). Default value of 0.5 for domestic sludge and 0.257 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
UF_{PJ}	Model correction for factor to account for model uncertainties (1.06)
$MCF_{s,PJ,final}$	Methane correction factor of the disposal site that receives the final sludge in the project situation, estimated as per the procedures described in AMS-III.G
DOC_F	Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
F	Fraction of CH_4 in biogas (IPCC default of 0.5)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

There is no sludge removal during the monitoring period. Therefore the emission from anaerobic decay from the final sludge produced is zero.

- **$PE_{fugitive,y}$:** These emissions account methane release in capture system. They are determined as per paragraph 27 of AMS III.H:

$$\mathbf{PE_{fugitive,y} = PE_{fugitive,\ ww,\ y} + PE_{fugitive,\ s,y}} \quad \mathbf{(10)}$$

Where:

$PE_{fugitive,\ ww,\ y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater

treatment systems equipped with biogas recovery in year "y" (tCO2e);

$PE_{fugitive, s,y}$ Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment in the year "y" (tCO2e)

$$\mathbf{PE_{fugitive, ww,y} = (1 - CFE_{ww}) * MEP_{ww, treatment,y} * GWP_{CH4}} \quad \textbf{(11)}$$

Where:

CFE_{ww} Capture efficiency of the biogas recovery equipment in the wastewater treatment (a default value of 0.9 shall be used, given no other appropriate value)

$MEP_{ww, treatment,y}$ Methane emission potential of wastewater treatment system equipped with biogas recovery in the year "y" (tonnes)

$$\mathbf{MEP_{ww, treatment,y} = Q_{ww,y} * B_{o, ww} * UF_{PJ} * \sum COD_{removed,PJ,k,y} * MCF_{ww, treatment,PJ,k}} \quad \textbf{(12)}$$

Where:

$COD_{removed,PJ,k,y}$ 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 wastewater treatment system k equipped with methane biogas equipment

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

UF_{PJ} Model correction factor to account for model uncertainties (1.06)

$$\mathbf{PE_{fugitive, s,y} = (1 - CFE_{s}) * MEP_{s, treatment,y} * GWP_{CH4}} \quad \textbf{(13)}$$

Where:

CFE_{s} Capture efficiency of the biogas recovery equipment in the sludge treatment (a default value of 0.9 shall be used, given no other appropriate value)

$MEP_{s, treatment,y}$ Methane emission potential of sludge treatment system equipped with biogas recovery in the year "y" (tonnes)

$$\mathbf{MEP_{s, treatment,y} = \sum(S_{l,PJ,y} * MCF_{s, treatment,PJl}) * DOC_{s} * UF_{PJ} * DOC_{F} * F * 16/12} \quad \textbf{(14)}$$

Where:

$S_{l,PJ,y}$ Amount of sludge treated in the project sludge treatment system, equipped with biogas recovery system (on dry basis) in year y (tonnes)

DOC_{F} Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used

$MCF_{s, treatment,PJ,l}$ Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion/utilization/flare equipment (MCF Higher value of 1.0 as per table III.H.1)

UF_{PJ} Model correction for factor to account for model uncertainties (1.06)

In the project activity, sludge is kept in suspension by the upward flow of wastewater. Excess of sludge will be withdrawn and used to start-up new reactors elsewhere or used as fertilizer inside the project boundary. However, the quantity of excess sludge is expected to be negligible for ex-ante calculation. Therefore, emissions from sludge treatment are not considered.

- **$PE_{biomass,\ y}$**: Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation. Not applicable to the project activity, since no biomass storage is envisaged in the project activity.

- **$PE_{flaring,y}$:** Methane emission due to incomplete flaring in year y as per "Tool to determine project emissions from flaring gases containing methane" (tCO_2e).

The calculation steps for project emissions are as follows:

STEP 1: Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour h, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

As per the guidance of the tool, a simplified approach will be used and only the volumetric fraction of methane will be measured, the difference is considered to be 100% Nitrogen.

STEP 2 though STEP 4 are not applicable for this project.

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH\ 4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis). Considering that the gas is cooler than 60 degrees Celsius, the reported density is expressed on dry basis already.

$$\mathbf{TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH\ 4,n}} \qquad \mathbf{(15)}$$

Where:

$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (Nm^3/h)
$fv_{CH4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h
$\rho_{CH4,n}$	Density of methane at normal condition (kg/m3)

STEP 6: Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of the flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

In case of open flares, the default value for flare efficiency ($\eta_{flare,h}$) in the hour h is:

- 0%, if the flame is not detected for more than 20 minutes during the hour h;
- 50%, if the flame is detected for more than 20 minutes during the hour h.

During the monitoring period there is no data for the operation time of the flare available, hence, the hourly flare efficiency is assumed to be zero for conservativeness.

STEP 7: Calculation of annual project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$\mathbf{PE_{flare,y} = \Sigma\ TM_{RG,h} * (1- \eta_{flare,h}) * GWP_{CH4}/1000} \quad \mathbf{(16)}$$

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in hour h
$\eta_{flare,h}$	Flare efficiency in hour h
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period

AMS.I.C

According to paragraph 26 of AMS-I.C, CO_2 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 CO_2 emissions from fossil fuel combustion".

$$\mathbf{PE_{FC} = FC_{HFO,\,y} * NCV_{HFO} * EF_{HFO,CO2}} \quad \mathbf{(17)}$$

Where :

$FC_{HFO,\,y}$	Amount of fossil used in the boiler in tonne/yr
NCV_{HFO}	NCV of fossil fuel used in the process i.e. Fuel oil – 40.4 GJ/tonne
$EF_{HFO,CO2}$	Emission factor of Heavy fuel oil as per IPCC – 77.4 tCO2/TJ

Project Emissions

		09/04 - 31/12/2010	01/01 - 08/04/2011
EC_y	MWh	1,346	897
EF_{CO2}	tCO_2/MWh	0.53	0.53
$PE_{power, y}$	**tCO_2**	**713**	**475**

		09/04 - 31/12/2010			01/01 - 08/04/2011		
		BFR1	BFR2	BFR3	BFR1	BFR2	BFR3
$Q_{ww, k, y}$	m^3	121,641	67,324	57,605	128,198	26,021	74,067
$COD_{removed, PJ, i, y}$	mg/l	0.00032	0.00037	0.00030	0.00038	0.00036	0.00039
Bo, ww	kg CH_4/kg COD	0.21	0.21	0.21	0.21	0.21	0.21
$MCF_{ww, treatment, PJ, lagoon}$		0.8	0.8	0.8	0.8	0.8	0.8
GWP_{CH4}		21	21	21	21	21	21
UF_{PJ}		1.06	1.06	1.06	1.06	1.06	1.06
$PE_{ww, treatment, y}$	**tCO_2**	**144**	**93**	**65**	**182**	**35**	**107**
$PE_{ww, treatment, y - Total}$	**tCO_2**	**302**			**324**		

		09/04 - 31/12/2010	01/01 - 08/04/2011
$PE_{s, treatment, y}$	**tCO_2**	**0**	**0**
$PE_{ww, discharge, y}$	**tCO_2**	**0**	**0**
$PE_{s, final, y}$	**tCO_2**	**0**	**0**
$PE_{biomass, y}$	**tCO_2**	**0**	**0**

		09/04 - 31/12/2010			01/01 - 08/04/2011		
		BFR1	BFR2	BFR3	BFR1	BFR2	BFR3
$MCF_{ww, treatment, PJ, BFR}$		0.8	0.8	0.8	0.8	0.8	0.8
$COD_{removed, PJ, BFR, y}$	mg/l	0.0147	0.0147	0.0139	0.0120	0.0120	0.0126
$MEP_{ww, treatment, y}$	tonnes	319	176	142	274	56	166
$PE_{fugitive, ww, y}$	**tCO_2**	**670**	**369**	**299**	**576**	**117**	**348**
$PE_{fugitive, s, y}$	**tCO_2**	**0**	**0**	**0**	**0**	**0**	**0**
$PE_{fugitive, y}$	**tCO_2**	**1,339**			**1,041**		

		09/04 - 31/12/2010	01/01 - 08/04/2011
$Q_{biogas, flare, y}$	Nm^3	18,028	1,286
$W_{CH4, y (95\% upper)}$	%	0.57	0.54
$PE_{flaring, y}$	**tCO_2**	**154**	**10**

		09/04 - 31/12/2010	01/01 - 08/04/2011
$NCV_{HFO, CO2}$	GJ/tonne	40.4	40.4
$EF_{HFO, CO2}$	tCO_2/TJ	77.4	77.4
$Q_{HFO, y}$	litres	432,950	500,359
ρ_{HFO}	kg/litre	0.95	0.95
$FC_{HFO, y}$	tonne	411	475
PE_{FC}	**tCO_2**	**1,286**	**1,486**

5.3. Leakage emissions

The equipment used are not transferred from another activity, therefore according to the AMS.III.H, there is no leakage to be considered.

All the equipment used in the project activity for power and heat generation is either brought for purpose of project activity and no shifting of old equipment takes place. No energy equipment currently being utilised is transferred from outside the boundary to the project activity. Therefore, there is no leakage as per AMS.I.C and AMS.I.D.

5.4. Emission reductions

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:

(i) The amount of biogas captured and destroyed or gainfully used by the project activity, that is monitored ex post;

(ii) Ex post calculated baseline, project and leakage emissions base on actual monitored data for the project activity.

$$\mathbf{ER_{y,expost} = min(BE_{y,expost} - PE_{y,\,expost} - LE_{y\,expost}),(MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,\,expost})} \quad \mathbf{(19)}$$

Where:

$ER_{y,ex\text{-}post}$	*Ex post* emission reductions in year *y* (tCO2e)
$BE_{y,ex\text{-}post}$	*Ex post* baseline emissions in year *y* (tCO2e)
$PE_{y,ex\text{-}post}$	*Ex post* project emissions in year *y* (tCO2e)
$LE_{y,ex\text{-}post}$	*Ex post* leakage emissions in year *y* (tCO2e)
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year y

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*:

$$\mathbf{MD_y = BG_{burnt,\,y} * w_{CH4,\,y} * D_{CH4} * FE * GWP_{CH4}} \quad \mathbf{(20)}$$

Where:

$BG_{burnt,\,y}$	Biogas flared/combusted in year *y* (m^3)
W_{CH4}	Methane content in the biogas in the year *y* (mass fraction)
D_{CH4}	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)

Emission Reduction

		09/04 - 31/12/2010	01/01 - 08/04/2011
ER (COD Approach)	tCO_2	8,300	6,651
ER (Biogas Approach)	tCO_2	20,745	18,524
$ER_{y,\,expost}$	**tCO_2**	**8,299**	**6,650**
$ER_{y,\,tol}$	**tCO_2**	**19,332**	

6. QA/QC aspects of Monitoring

6.1. Monitoring Management

1. Monitoring Management

The project hires people to operate the biogas plant. The required monitoring equipment is installed in consultation with the equipment supplier under supervision of operation manager and QC manager.

Data acquisition for the flow meters and laboratory analysis is executed according to the measurement method described in section 4.

The plant is operated by trained operators who also collect data under the supervision of qualified managers.

Further information can be referred to Figure 2 and Table 3.

2. Quality Assurance and Quality Control

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

3. On-site Procedures

Since the installation of the operations software creating daily logs of plant performance is incomplete, there is no data printed out and recorded electronically for periodic download onsite or remote transfer for further processing. However, the monitoring data is recorded and verified according to the monitoring management.

The operation manager and QC manager are responsible to execute timely calibration as per the specification from equipment supplier or at least once in three years.

4. Data Storage and Filing – Electric Workbook

All relevant data from log sheet is input in excel sheet stored electronically with the process control computer unit, external storage media and transferred.

5. Emergency preparedness

The project activity does not result in any unidentified activity that can result in substantial emissions from the project activity.

However, the leakages, if any, in the piping or digester shall come under notice of plant operator either instantly on the control screens else at the time of data logging, due to mismatch between expected biogas generation from wastewater quantities processed or other way around.

6. Safety protocol

The project provides operators with the training courses regarding safety both in theory and practical part. The operator, who is responsible for safety conditions at work, will ensure that the project activity complies with regulations and documentations relating to safety condition, such as use of safety equipment, participating in evacuation fire drill, details for safety in biogas area.

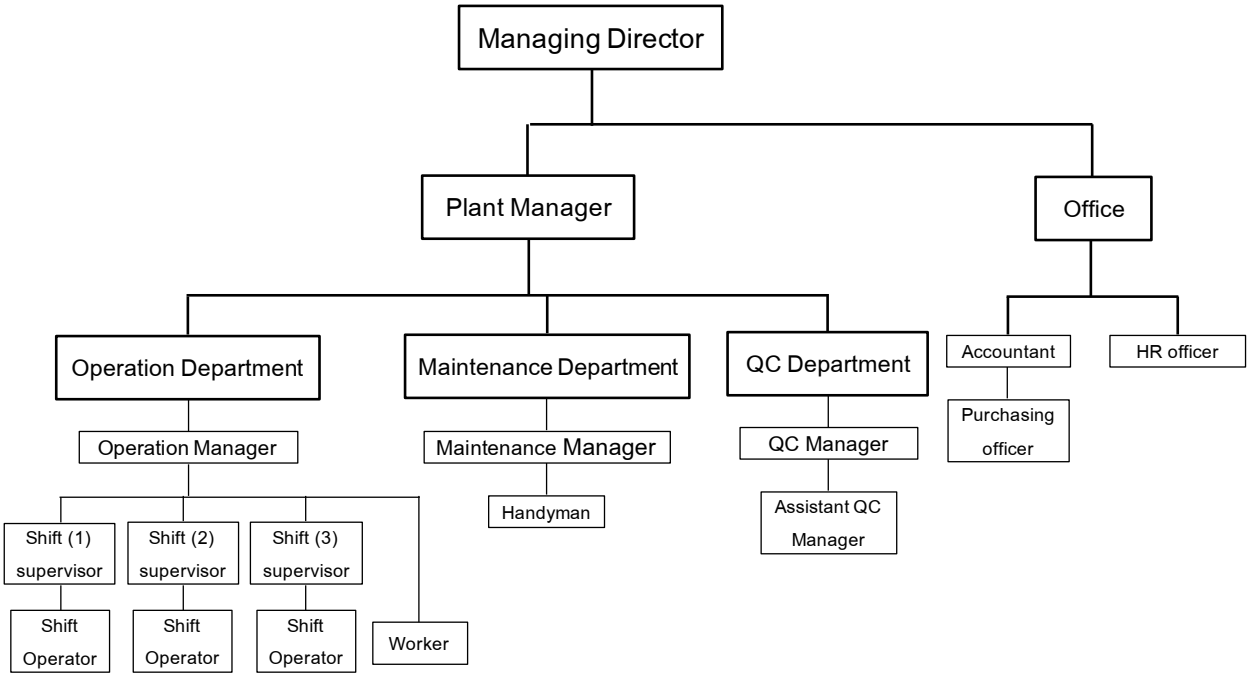

Figure 2 Organization chart

Table 3 Responsibilities

Managing Director	- Review the performance report
	- Approve for hiring new staff
Office	- Employment
	- Input the data from all of log books into electronic sheets
	- Collect all electronic sheets
Plant Manager	- Plan for biogas production
	- Approve for purchasing new equipment
	- Review performance report and submit to MD
Operation Manager / QC Manager	- Conduct calibration of equipment (QC Manager)
	- Quality check for log books
	- Quality check for electronic sheets
	- Request for installation new equipment
	- Report performance to plant manager
Shift supervisor/ Shift operator	- Record the data into log books
	- Support QC team for wastewater analysis
Assistant QC Manager	- Wastewater analysis
	- Analysis report to QC manager
Maintenance Manager	- Provide maintenance plan
	- Approve for delivering equipment to in-house fixing
Handyman	- Take responsibilities for the electricity and control system
	- Check capability of all equipment and machine

7. Summary of results

7.1. Monitoring Data

Parameter	Unit	2010	2011
$Q_{ww, BFR1}$	m^3	121,487	128,198
$Q_{ww, BFR1 - Higher}$	m^3	121,641	0
$Q_{ww, BFR1 - Lower}$	m^3	121,333	0
$Q_{ww, BFR2}$	m^3	67,188	26,021
$Q_{ww, BFR2 - Higher}$	m^3	67,324	0
$Q_{ww, BFR2 - Lower}$	m^3	67,052	0
$Q_{ww, BFR3}$	m^3	57,605	74,067
$COD_{in, BFR1,2}$	tonnes/m^3	0.0151	0.0124
$COD_{in, BFR3}$	tonnes/m^3	0.0142	0.0130
$COD_{out, BFR1}$	tonnes/m^3	0.0004	0.0004
$COD_{out, BFR2}$	tonnes/m^3	0.0004	0.0004
$COD_{out, BFR3}$	tonnes/m^3	0.0003	0.0004
$BG_{recovered, y}$	Nm^3	2,562,516	2,378,438
$BG_{ToFlare, y}$	Nm^3	18,028	1,286
$BG_{boiler1, y}$	Nm^3	1,063,973	1,336,919
$BG_{boiler2, y}$	Nm^3	984,587	1,030,877
$BG_{gas\ engine, y}$	Nm^3	495,928	9,356
$W_{CH4-2\ (95\%\ lower)}$	%	56.09	53.16
$W_{CH4-2\ (95\%\ upper)}$	%	56.97	53.65
EG_y	MWh	0	0

7.2. Comparison of actual emission reductions with estimates in the CDM-PDD

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	51,817	19,332

Emission reductions in 2010 (09/04/2010 - 31/12/2010): 10,613 tCO_2e
Emission reductions in 2011 (01/01/2011 - 08/04/2011): 8,719 tCO_2e
Total emission reductions during the monitoring period: 19,332 tCO_2e

7.3. Remarks on difference from estimated value in the PDD

The project activity achieves 19,332 tCO_2 Emission Reductions during the monitoring period from April 9th, 2010 to April 8th, 2011.

The estimated value for emission reductions in the registered PDD was provided based on the operation for 2 phases. However, during this monitoring period, the operation of the biogas system for the 2nd phase was started in October 2010 and the installation of gas engines was completely done for 1.128 MW_{el}. Therefore, the actual values for this monitoring period is lower than the values applied in the PDD. More details about the project implementation during this monitoring period are also provided in section 1.2 of the monitoring report.

Annex 1
Gold Standard Monitoring Parameters

No		1
Indicator		Air quality: *Odour*
Chosen parameter		biogas consumption
Way of monitoring	How	Monitoring biogas consumption in the gas engine and thermal boiler to demonstrate a reduction in odour emission **Details** $BG_{gas\ engine,\ y}$ (Amount of biogas used for power generation in gas engine) Measurements of volume of biogas sent to the gas engines are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually archive the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily. $BG_{boiler,\ y}$ (Amount of biogas fired in boiler) Measurements of volume of biogas sent to boilers are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually archive the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily. $BG_{ToFlare,\ y}$ (Total quantity of biogas flared) Measurements of volume of biogas sent to flare are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually achieve the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily.
	When	Refer to how to monitor above
	By who	Biogas plant operator
QA/QC procedures to be applied		Refer to QA/QC procedures applied for each parameters in section 4.2
Monitored Value & Frequency		2010 (9 Nov - 31 Dec): 2,544,488 Nm^3 (Biogas utilized) 2011 (1 Jan – 8 Nov): 2,377,152 Nm^3(Biogas utilized)

No		2
Indicator		Quality of employment
Chosen parameter		Training records
Way of monitoring	How	Review of training plan for 2010 and training records shall be archived at the end of each training
	When	Periodical (depending on the frequency of training)
	By who	Monitored by BFB
QA/QC procedures to be applied		The training record for each training course as per the plan
Monitored Value & Frequency		Details of the target audience and training courses are included in the annual training plan as the table below.

The following information are included in the training record form:
- training course title
- place
- trainer
- assessment & criteria
- list of trainees including position, signature
- assessment result

COURSE TITLE	TARGET
Core Development Course	
1. Basic ISO 9001	Supervisor, Office
2. INTERNAL AUDITOR (ISO 9001)	Internal monitoring team
3. Company rule and productive working (Orientation)	New staff
Skill Development Course	
4. Calibration	Quality control staff
5. Used forklift correctly and safely	Forklift driver
Law & Safety Course	
6. Safety Officer – Foreman level	Pre-Supervisor
7. Safety Officer – Management level	Manager
8. Basic Fire Fighting (Work Shop)	All staff
9. Fire Evacuation plan	All staff
10. Technical Fire Fighting	Fire Fighting team
11. Hazardous Chemical safety	Production staff and Supervisor
12. Emergency plan for chemical spill	Emergency team
13. Emergency plan for LPG leak	Emergency team
14. Emergency plan for fire	Emergency team
15. Emergency plan for explosion of hot oil boiler	Emergency team
16. Emergency plan for electrical short	Emergency team
Special Course	
17. Motivation and Conscious creation in organization	Supervisor, Office
18. Organizational Structure and Human Resources Management	Supervisor, Office
19. 5 S for Productivity Improvement	All staff
20. Art of Management for production lines supervisor	Supervisor, Office, Executive
21. Human relationship with teamwork	Supervisor, Office
22. Effective communication, Assignment, Control and Monitoring	Supervisor, Office
23. Company Policy Deployment by BSC&KPIs Indicators	Supervisor, Office
24. Efficiency of biogas system, UASB.	Operation staff
25. Checking quality of biogas system by monitored parameters	Quality control staff
26. Operation and Control biogas system	Operation staff

No	3
Indicator	Quantitative employment and income generation
Chosen parameter	Number of employed staffs and the level of income generation

Way of monitoring	How	Number of employees and the level of income generation will be demonstrated through HR records
	When	Monthly
	By who	BFB
QA/QC procedures to be applied		-
Monitoring Value and Frequency		There are about 22 employees recruited by the end of the monitoring period.

No		4
Indicator		Project eligibility criteria
Chosen parameter		Biogas utilisation (%)
Way of monitoring	How	**Measure** Biogas consumption in the electricity generators ($BG_{gas\ engine,\ y}$) Biogas consumption instead of fuel oil in thermal oil boilers ($BG_{boiler,\ y}$) Biogas flared ($BG_{ToFlare,\ y}$) **Details** $BG_{gas\ engine,\ y}$ (Amount of biogas used for power generation in gas engine) Measurements of volume of biogas sent to the gas engines are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually archive the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily. $BG_{boiler,\ y}$ (Amount of biogas fired in boiler) Measurements of volume of biogas sent to boilers are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually archive the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily. $BG_{ToFlare,\ y}$ (Total quantity of biogas flared) Measurements of volume of biogas sent to flare are done continuously using gas flow meters. In recording these parameters, plant's operators shall first manually achieve the monitored data onto log sheets then transfer to the computer for electronic storage. Continuously measurements will be done and cumulative reading will be recorded daily. **Calculation to determine biogas utilisation (%)** Biogas utilisation (%) is the calculation for the ratio of total biogas consumption in the electricity generators/gas engines ($BG_{gas\ engine,\ y}$) and in thermal oil boilers ($BG_{boiler,\ y}$) to the total gas generation, which is calculated from $BG_{gas\ engine,\ y}$, $BG_{boiler,\ y}$ and $BG_{ToFlare,\ y}$.
	When	Refer to how to monitor above

	By who	Biogas plant operator
QA/QC procedures to be applied		Refer to QA/QC procedures applied for each parameters in section 4.2
Monitored Value & Frequency		09/04/2010 - 31/12/2010: 99.3% 01/01/2011 - 08/04/2011: 99.9%

No		5
Indicator		Soil condition
Chosen parameter		Sludge application
Way of monitoring	How	Refer to section B.7.1 in the registered PDD Details S y,final (Amount of final sludge as dry matter generated by the wastewater treatment in the year y) The sludge will be weighed and used as soil fertilizer. The end use of sludge generated is monitored in log records in form of soil application site and quantity of sludge generated.
	When	Refer to how to monitor above
	By who	Biogas plant operator
QA/QC procedures to be applied		Refer to QA/QC procedures applied for each parameters in section 4.2
Monitored Value & Frequency		There is no sludge removal during the monitoring period.

Annex 2
Explanation of conservative approach for deviations in monitoring period

Approach in PDD	Approach in Monitoring Period – Deviated approach.	Explanation of Conservativeness
Baseline emissions for estimating the fossil fuel replaced. The methodology AMS I.C., version 16 (paragraph 15), the baseline emissions are estimated based on the amount of heat/steam delivered by the equipment.	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 registered PDD. 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.

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 $BE_{thermal, CO2, y} = (EG_{thermal, y} / \eta_{BL, thermal})* EF_{FF, CO2}$. 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 or from market information available for the fossil fuel consumption in starch production. This provides an estimate of $EG_{thermal,y}$. This approach is mentioned in the methodology AMS-I.C version 16 as per 31(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 on conservative of approach:

The historical data is based on amount of dry starch produced in during year 2006 - 2007 and amount of fossil fuel consumed. The biogas plant is commissioned in July 2007; thereby the biogas usage starts in boiler in month of July. If compared, the amount of fossil fuel (fuel oil) used in the project activity in 2006 - 2007 is approximately 0.034 liter per kg of dry starch produced. After the biogas is used in July 2007 the amount of fossil fuel consumed reduces and a lower value is reported as annual average of fuel oil used per kg of dry starch produced.

When compared to industrial average, as per published data at Thai Tapioca Starch Association website based on the market research, the value assumed in project activity is conservative. Source: http://www.thaitapiocastarch.org/article05.asp

Indicator	Unit per Ton of Starch	Min. - Max. Value	Average Value
1. Water Usage	Cubic Metre/Ton	7.4 - 36.3	18.0
2. Electricity Usage	Kilowatt-Hour/Ton	117.7 - 221.0	169.4
3. Fuel Oil Usage	Litre/Ton	25.9 - 39.4	33.6
4. Loss of Starch	Kilogram/Ton	25.3 - 41.9	33.3
5. Sulfur Usage	Kilogram/Ton	0.34 - 1.03	0.70

To be on conservative side, the project proponent has chosen the lowest available value from the above table i.e. 25.9 liters of fuel oil per kg of starch as the basis to estimate the baseline emission for the project activity.