

WASTEWATER TREATMENT WITH BIOGAS PRODUCTION (UASB) AND HEAT UTILIZATION AT GENERAL STARCH CO., LTD.



Document Prepared By South Pole Carbon Asset Management Ltd.

Project Title	Wastewater Treatment with Biogas Production (UASB) and Heat Utilization at General Starch Co., Ltd
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Table of Contents

1	Project Details	3
1.1	Summary Description of Project	3
1.2	Sectoral Scope and Project Type	3
1.3	Project Proponent	3
1.4	Other Entities Involved in the Project	4
1.5	Project Start Date	4
1.6	Project Crediting Period	4
1.7	Project Location	4
1.8	Title and Reference of Methodology	5
2	Implementation Status	5
2.1	Implementation Status of the Project Activity	5
2.2	Deviations from the Monitoring Plan	6
2.3	Grouped Project	6
3	Data and Parameters	7
3.1	Data and Parameters Available at Validation	7
3.2	Data and Parameters Monitored	10
3.3	Description of the Monitoring Plan	19
4	Quantification of GHG Emission Reductions and Removals	21
4.1	Baseline Emissions	21
4.2	Project Emissions	22
4.3	Leakage	22
4.4	Summary of GHG Emission Reductions and Removals	23
5	Additional Information	24

1 PROJECT DETAILS

1.1 Summary Description of Project

The project activity involves the installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) technology, at a starch manufacturing plant that has been in operation since 1995. Prior to project implementation, the wastewater was treated using an open lagoon system.

The first phase of the project (UASB 1) was implemented at General Starch Co., Ltd. in 2003 with start up of operations in January 2004, and the second phase of the project (UASB 2) began in 2005 with start up of operations in January of 2006. The biogas produced from anaerobic digestion is captured and then used as fuel for heat generation.

As per the VCS's guideline, the project is verified against the VCS version 3. Further background information on the project activity can be found in the VCS Project Design Document (PDD), which has been registered and available on the V-C-S under project number 82 as well as the combined Voluntary Validation and Verification:

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

This is the 5th verification of the project. Details of previous monitoring periods are listed below. All monitoring and verification reports are available on the VCS registry.

- 1st monitoring period : 01-04-04 to 31-05-07 ; verification report issued 31-08-07
- 2nd monitoring period : 01-06-07 to 31-03-08 ; verification report issued 22-08-08
- 3rd monitoring period : 01-04-08 to 31-08-09 ; verification report issued 09-02-10
- 4th monitoring period : 01-09-09 to 31-08-10 ; verification report issued 06-05-11

1.2 Sectoral Scope and Project Type

The project sectoral scope, as defined by the UNFCCC, is: 13 – Waste handling and disposal.

1.3 Project Proponent

Role	Project owner (Responsible for implementation and operation of the project activity)
Organization:	Papop Renewable Co.,Ltd.
Street/P.O.Box:	Prasert Manukij
City:	Bangkok
Postfix/ZIP:	10230
Country:	Thailand
E-Mail:	likit@papop.com
URL:	www.papop.com
Represented by:	Likit Nimtrakul
Title:	Mr.
Salutation:	Director
Telephone:	+ 66 2 570 5580

Role	Carbon consultant (responsible for development of emission reductions through the Voluntary Carbon Standard)
Organization:	South Pole Carbon Asset Management Ltd.
Street/P.O.Box:	Technoparkstrasse 1
City:	Zurich
Postfix/ZIP:	8005
Country:	Switzerland
E-Mail:	i.puhl@southpolecarbon.com
URL:	www.southpolecarbon.com
Represented by:	Ingo Puhl
Title:	Mr.
Salutation:	Managing Partner.
Telephone:	+ 66 2 678 8979

1.4 Other Entities Involved in the Project

1.5 Project Start Date

The commissioning date of the first UASB reactor was 1st Jan 2004.

1.6 Project Crediting Period

The initial crediting period was 7 years and then extended to 10 years. The subsequent renewals of the crediting time might be considered according to the status of the project activity and baseline revision at that time.

1.7 Project Location

The proposed project site is located on Ratchasima-Chokchai Road, Amphur Kornburi in Nakorn Ratchasima Province, which is in the northeast of Thailand. Nakorn Ratchasima, about 250 km away from Bangkok, is one of the five biggest cities in Thailand. Most of the tapioca starch plants in Thailand are located in this province. The closest Railway station is Jira Station, and the closest airport is Nakorn Ratchasima.

Address : No. 99, Chok Chai – Kornburi Road, Amphur Kornburi, Nakhorn Ratchasima

GPS coordinates : 14.580219,102.186799



Figure 1 : Project location

1.8 Title and Reference of Methodology

Avoided wastewater and on-site energy use emissions in the industrial sector – version 04 (AM0022, version 04), hereafter referred to as the “baseline methodology”.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

In this monitoring period , the operation of biogas plant is fully handled by General Starch team. Due to the improvement of the operation skill and knowledge of staffs. The capacity of the UASB has been raised up , can receive higher COD loadings , and the performance in term of COD reduction and biogas generation tend to increase in this monitoring period.

- Since the biogas generated was higher than the expected levels and more than the utilization capacity of boilers, new boilers were installed. The deviation applied due to these additional boilers is described in the following section.
- There is no changing or modification in biogas system.

2.2 Deviations from the Monitoring Plan

Deviation 1

The new steam boilers which were installed after the registration of the project are not included in the emission reduction calculation.

Description of deviation

Status in this monitoring period

There were two steam boilers, no.6 and 9, installed during the monitoring period , after the registration of this project activity. The biogas consumed by these two boilers is excluded from the total biogas combusted, monitored as per GM3.

Followed approach

The GM3 is the biogas flow meter installed at the main biogas supply line to boilers. There is no separate biogas flow meter for each boiler. The biogas usage by each boiler is calculated as described below.

- a) PP conducted a test to identify the maximum biogas consumption for each boiler at full load stage. During the test one boiler is running at 100% of its capacity, and the biogas totalized flow at biogas flow meter is recorded when boiler is started and stopped. The resulting figures are used to calculate biogas consumption during operational hours. The operation hours for each boiler are available on a daily basis from log records. The running hour of each boiler multiplied by its maximum biogas consumption is the biogas amount consumed. Then the percentage of biogas amount consumed by each boiler is calculated.
- b) The above percentage is multiplied with the actual biogas consumption counted by GM3 to identify the biogas amount sent to each boiler on monthly basis.

The result of biogas consumed by boilers is presented in Table 7. The biogas consumption of steam boiler no.6 and 9 is deducted from V_{boiler} , which is total biogas sent to boilers for emission calculation.

Justification for deviation

In this approach the biogas used in the new boilers is excluded from the estimation of the baseline emissions

2.3 Grouped Project

This project is not a grouped project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data Unit / Parameter:	EF _{CH4}
Data unit:	kg CH ₄ / kg COD
Description:	Methane emission factor
Source of data:	Expert selection based on AM0013 v4 guidance
Value applied:	0.241
Purpose of the data:	Project emission calculation
Any comment:	Details of the calculation and data used are provided in Annex 3 of registered VCS PD.

Data Unit / Parameter:	R _{lagoon}
Data unit:	%
Description:	Organic material removal ratio
Source of data:	Applied from registered project no 1040 "Korat Waste to Energy"
Value applied:	87.88
Purpose of the data:	Baseline and project emission calculation
Any comment:	The project developer did not carry out biochemical tests prior to project implementation. For this reason, comparable test results were used.

Data Unit / Parameter:	R _{deposition}
Data unit:	%
Description:	Organic material deposition ratio
Source of data:	Estimated by project developer on basis of experience
Value applied:	0 (project scenario), 0 (baseline scenario)
Purpose of the data:	Baseline and project emission calculation
Any comment:	This corresponds to the assumptions made for the

	Korat Waste to Energy project, a registered AM0022 project in Thailand.
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Data Unit / Parameter:	ECH4_NAWTF
Data unit:	tCO ₂ e
Description:	Methane emitted from UASB digesters
Source of data:	IPCC default value
Value applied:	0
Purpose of the data:	Baseline emission calculation
Any comment:	-

Data Unit / Parameter:	R _{NAWTF}
Data unit:	Fraction
Description:	Total organic material removal efficiency of the new project wastewater facility.
Source of data:	Calculated using COD concentration entering the project treatment facility and COD concentration leaving the treatment facility.
Value applied:	95.92%
Purpose of the data:	Project emission calculation
Any comment:	-

Data Unit / Parameter:	EF
Data unit:	tCO ₂ /TJ
Description:	Carbon emission factor of fuel oil
Source of data:	IPCC 2006
Value applied:	77.367
Purpose of the data:	Baseline emission calculation
Any comment:	

Data Unit / Parameter:	NCV
Data unit:	TJ/t
Description:	Net calorific value of fuel oil
Source of data:	IPCC 2006 P.1.18
Value applied:	0.0404
Purpose of the data:	Baseline emission calculation
Any comment:	-

Data Unit / Parameter:	Density of CH ₄
Data unit:	kgCH ₄ / Nm ³ CH ₄
Description:	Density of methane at standard condition (0 degree Celsius, 1,013 bar)
Source of data:	UNFCCC Methodological tool to determine project emissions from flaring gases containing methane, Table 1, page 12
Value applied:	0.716
Purpose of the data:	Project emission calculation
Any comment:	-

Data Unit / Parameter:	Lagoon surface area
Data unit:	Hectare
Description:	Total lagoon area
Source of data:	Project developer
Value applied:	16
Purpose of the data:	Baseline emission calculation
Any comment:	-

Data Unit / Parameter:	Flare efficiency
Data unit:	%

Description:	Flare efficiency for open flare
Source of data:	Tool to determine project emissions from flaring gases containing methane
Value applied:	50
Purpose of the data:	Project emission calculation
Any comment:	When the flare is active, a flame can be visibly observed.

3.2 Data and Parameters Monitored

Data Unit / Parameter:	AM0022 ID 1 Wastewater flows entering the project treatment facility				
Data unit:	m ³ /year				
Description:	The volume of wastewater flows entering into the new anaerobic digestion system				
Source of data:	Wastewater flow meter FM3, FM5				
Description of measurement methods and procedures to be applied:	The volumetric flow meters are installed with totalized flow transmitter.				
Frequency of monitoring/recording:	The wastewater flow is continuously monitored and recorded in log sheet on daily basis.				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>448,552</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>1,173,627</td></tr> </table>	Sep'10 – Dec'10	448,552	Jan'11 - Dec'11	1,173,627
Sep'10 – Dec'10	448,552				
Jan'11 - Dec'11	1,173,627				
Monitoring equipment:	FM3 and FM5, as per detail in Table 6				
QA/QC procedures to be applied:	The flow meters are calibrated at least once every 3 years.				
Calculation method:	Summation of FM3 and FM5				
Any comment:	-				

Data Unit / Parameter:	AM0022 ID 2 Wastewater flows leaving the project treatment
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	facility				
Data unit:	m ³ /year				
Description:	The volume of wastewater flows leaving the new anaerobic digestion system				
Source of data:	Established using ID 1 and assuming hydrological balance				
Description of measurement methods and procedures to be applied:	Assumed hydrological balance and using metered data from ID 1.				
Frequency of monitoring/recording:	The wastewater flow is continuously monitored and recorded in log sheet on daily basis.				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>448,552</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>1,173,627</td></tr> </table>	Sep'10 – Dec'10	448,552	Jan'11 - Dec'11	1,173,627
Sep'10 – Dec'10	448,552				
Jan'11 - Dec'11	1,173,627				
Monitoring equipment:	FM3 and FM5, as per detail in Table 6				
QA/QC procedures to be applied:	The flow meters are calibrated at least once every 3 years.				
Calculation method:	Summation of FM3 and FM5				
Any comment:	-				

Data Unit / Parameter:	AM0022 ID 3 Wastewater organic material concentration entering the project treatment facility				
Data unit:	kg COD/m ³				
Description:	COD concentration of the wastewater entering the new anaerobic digestion system				
Source of data:	Wastewater analysis result				
Description of measurement methods and procedures to be applied:	The COD content in wastewater is analyzed using a colorimetric method by the on-site laboratory.				
Frequency of monitoring/recording:	The analysis is carried out at least once a day for every operational day.				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>16.60</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>16.49</td></tr> </table>	Sep'10 – Dec'10	16.60	Jan'11 - Dec'11	16.49
Sep'10 – Dec'10	16.60				
Jan'11 - Dec'11	16.49				

Monitoring equipment:	Spectrophotometer, as per detail in Table 6
QA/QC procedures to be applied:	The spectrophotometer is calibrated at least once every 3 years.
Calculation method:	The total of COD entering UASB 1 and 2 multiplied by its influent flow, and then divided by the WW_{input}
Any comment:	-

Data Unit / Parameter:	AM0022 ID 4 Wastewater organic material concentration leaving the project treatment facility				
Data unit:	kg COD/m ³				
Description:	COD concentration of the wastewater leaving the new anaerobic digestion system				
Source of data:	Wastewater analysis result				
Description of measurement methods and procedures to be applied:	The COD content in wastewater is analyzed using a colorimetric method by the on-site laboratory.				
Frequency of monitoring/recording:	The analysis is carried out at least once a day for every operational day.				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>0.74</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>0.88</td></tr> </table>	Sep'10 – Dec'10	0.74	Jan'11 - Dec'11	0.88
Sep'10 – Dec'10	0.74				
Jan'11 - Dec'11	0.88				
Monitoring equipment:	Spectrophotometer as per detail in Table 6				
QA/QC procedures to be applied:	The spectrophotometer is calibrated at least once every 3 years.				
Calculation method:	The total of COD existing UASB 1 and 2 multiplied by its influent flow, and then divided by the WW_{out} .				
Any comment:	-				

Data Unit / Parameter:	AM0022 ID 5 Volume of biogas sent to facility heaters
Data unit:	Nm ³
Description:	Volume of biogas sent to facility heaters
Source of data:	Biogas flow meter, GM3

Description of measurement methods and procedures to be applied:	The biogas flow meter is installed with totalized flow transmitter.				
Frequency of monitoring/recording:	The biogas flow is continuously monitored and recorded in log sheet on daily basis.				
Value monitored:	<table> <tr> <td>Sep'10 – Dec'10</td><td>4,057,418</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>12,603,198</td></tr> </table>	Sep'10 – Dec'10	4,057,418	Jan'11 - Dec'11	12,603,198
Sep'10 – Dec'10	4,057,418				
Jan'11 - Dec'11	12,603,198				
Monitoring equipment:	GM3 as per detail in Table 6				
QA/QC procedures to be applied:	The flow meter is calibrated at least once every 3 years.				
Calculation method:	-				
Any comment:	The biogas used at steam boiler no.6 and 9 is excluded in the baseline emission reduction calculation as described in Deviation 1. The same is included in Project emissions $E_{CH_4, IC, heat}$				

Data Unit / Parameter:	AM0022 ID 8 F: Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility				
Data unit:	ton				
Description:	Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility				
Source of data:	Calculated using ID5 , ID15 , ID19				
Description of measurement methods and procedures to be applied:	-				
Frequency of monitoring/recording:	-				
Value monitored:	<table> <tr> <td>Sep'10 – Dec'10</td><td>2,067</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>6,307</td></tr> </table>	Sep'10 – Dec'10	2,067	Jan'11 - Dec'11	6,307
Sep'10 – Dec'10	2,067				
Jan'11 - Dec'11	6,307				
Monitoring equipment:	-				
QA/QC procedures to be applied:	-				
Calculation method:	Calculated based on the net calorific value (NCV) of biogas.				

	The quantity of biogas used by the boiler is multiplied by NCV of biogas, and then divided by NCV of heavy fuel oil to get the volume of heavy fuel oil.
Any comment:	-

Data Unit / Parameter:	AM0022 ID 9 Biogas sent to flares (V1)				
Data unit:	Nm ³ biogas				
Description:	Surplus biogas sent to flare system (wet basis)				
Source of data:	Biogas flow meter, GM4				
Description of measurement methods and procedures to be applied:	The biogas flow meter is installed with totalized flow transmitter.				
Frequency of monitoring/recording:	The biogas flow is continuously monitored and recorded in log sheet on daily basis.				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>103,704</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>223,491</td></tr> </table>	Sep'10 – Dec'10	103,704	Jan'11 - Dec'11	223,491
Sep'10 – Dec'10	103,704				
Jan'11 - Dec'11	223,491				
Monitoring equipment:	GM4 as per detail in Table 6				
QA/QC procedures to be applied:	The biogas flow meter is calibrated at least once every 3 years.				
Calculation method:	-				
Any comment:	-				

Data Unit / Parameter:	AM0022 ID11 Biogas methane concentration
Data unit:	%
Description:	Methane concentration in biogas
Source of data:	Biogas analyzer
Description of measurement methods and procedures to be applied:	The inline gas analyzers are installed for continuous measurement of the methane content in the biogas. The daily average value is used for reporting.
Frequency of monitoring/recording:	The gas analyzers are continuously monitored and summarized on daily basis.

Value monitored:	<table> <tr> <td>Sep'10 – Dec'10</td><td>56.04</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>55.05</td></tr> </table>	Sep'10 – Dec'10	56.04	Jan'11 - Dec'11	55.05
Sep'10 – Dec'10	56.04				
Jan'11 - Dec'11	55.05				
Monitoring equipment:	Inline gas analyzer as per detail in Table 6				
QA/QC procedures to be applied:	The gas analyzer is calibrated at least once every 3 years.				
Calculation method:	-				
Any comment:	There are two inline gas analyzers installed at site , ABB (installed by Papop) and VISIT (installed by GSL) meters. The major source of monitored data is from ABB meter. But when summation of methane and CO₂ value measured by this meter is over 100%. The operator will switch to use the results from another meter , VISIT. And the ABB meter will be crosschecked with standard gas to adjust the error..				

Data Unit / Parameter:	AM0022 ID 12 Project emissions from flaring of the residual gas stream (PEflare)				
Data unit:	t CO ₂ e				
Description:	Project emissions from flaring of the residual gas stream				
Source of data:	Calculated based on the flared gas amount and 0% flare efficiency.				
Description of measurement methods and procedures to be applied:	The PEflare is calculated as per "Tool to determine project emissions from flaring gases containing methane"				
Frequency of monitoring/recording:	-				
Value monitored:	<table> <tr> <td>Sep'10 – Dec'10</td><td>874</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>1,850</td></tr> </table>	Sep'10 – Dec'10	874	Jan'11 - Dec'11	1,850
Sep'10 – Dec'10	874				
Jan'11 - Dec'11	1,850				
Monitoring equipment:	-				

QA/QC procedures to be applied:	-
Calculation method:	Using data measured with meter GM4. Pipe leakage is also included in the calculation when the biogas produced quantities are higher than usage quantities.
Any comment:	-

Data Unit / Parameter:	AM0022 ID 13 Amount of chemical oxidizing agents entering system boundary
Data unit:	Tons / m ³
Description:	Amount of chemical oxidizing agents entering system boundary
Source of data:	Default value
Description of measurement methods and procedures to be applied:	-
Frequency of monitoring/recording:	-
Value monitored:	0
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	No oxidizing agents are used. The wastewater from the last lagoon is used for balancing the pH of the wastewater.

Data Unit / Parameter:	AM0022 ID 15 Heating system combustion efficiency
Data unit:	%
Description:	Proportion of biogas combusted by heating system facility (hot oil and steam boiler)
Source of data:	Assumed due to lack of manufacturing data
Description of measurement methods and procedures to be applied:	-

Frequency of monitoring/recording:	-
Value monitored:	98.5 %
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	-

Data Unit / Parameter:	AM0022 ID 16 Flow of wastewater directly to the current wastewater treatment system
Data unit:	m ³
Description:	Volume of wastewater directly to the current wastewater treatment system and bypassing the new wastewater facilities
Source of data:	Default value from registered PD
Description of measurement methods and procedures to be applied:	No wastewater is sent directly to the current facility. Even if wastewater is sent directly to any facility, it will have no affect on the emission reduction estimate as baseline emissions are equal to project emissions for such a case.
Frequency of monitoring/recording:	-
Value monitored:	0
Monitoring equipment:	-
QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	No wastewater is sent directly to the current facilities. Even if wastewater is sent directly to any facilities, it will have no effect on the estimated emission reduction because baseline emissions are equal to project emissions for such a case.

Data Unit / Parameter:	AM0022 ID 17 Loss of biogas from pipeline				
Data unit:	%				
Description:	Loss of biogas from pipeline				
Source of data:	Calculated from GM1, GM2 , GM3 and GM4				
Description of measurement methods and procedures to be applied:	-				
Frequency of monitoring/recording:	-				
Value monitored:	<table border="1"> <tr> <td>Sep'10 – Dec'10</td><td>0</td></tr> <tr> <td>Jan'11 - Dec'11</td><td>0</td></tr> </table>	Sep'10 – Dec'10	0	Jan'11 - Dec'11	0
Sep'10 – Dec'10	0				
Jan'11 - Dec'11	0				
Monitoring equipment:	-				
QA/QC procedures to be applied:	-				
Calculation method:	Calculated from the unbalance between biogas production (GM1+GM2) and utilization (GM3+GM4)				
Any comment:	In case of the leakage is negative, which means the biogas produced quantity is less than biogas usage, the loss is considered as 0 for conservativeness.				

Data Unit / Parameter:	AM0022 ID 18 Organic material removed from wastewater facility
Data unit:	t COD
Description:	Organic material removed from wastewater facility
Source of data:	The record of excess sludge removed from truck scale at starch factory.
Description of measurement methods and procedures to be applied:	The amount of excess sludge removed is weighed every time before leaving the project site.
Frequency of monitoring/recording:	-
Value monitored:	0
Monitoring equipment:	-

QA/QC procedures to be applied:	-
Calculation method:	-
Any comment:	No excess sludge is removed from UASB system.

Data Unit / Parameter:	AM0022 ID 19 Biogas calorific value of biogas					
Data unit:	MJ/Nm ³					
Description:	Calorific value of biogas					
Source of data:	Calculated from methane content in biogas					
Description of measurement methods and procedures to be applied:	-					
Frequency of monitoring/recording:	-					
Value monitored:	<table><tr><td>Sep'10 – Dec'10</td><td>20.58</td></tr><tr><td>Jan'11 - Dec'11</td><td>20.22</td></tr></table>		Sep'10 – Dec'10	20.58	Jan'11 - Dec'11	20.22
Sep'10 – Dec'10	20.58					
Jan'11 - Dec'11	20.22					
Monitoring equipment:	-					
QA/QC procedures to be applied:	-					
Calculation method:	The NCV of methane is multiplied by %CH ₄ in biogas.					
Any comment:	-					

3.3 Description of the Monitoring Plan

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

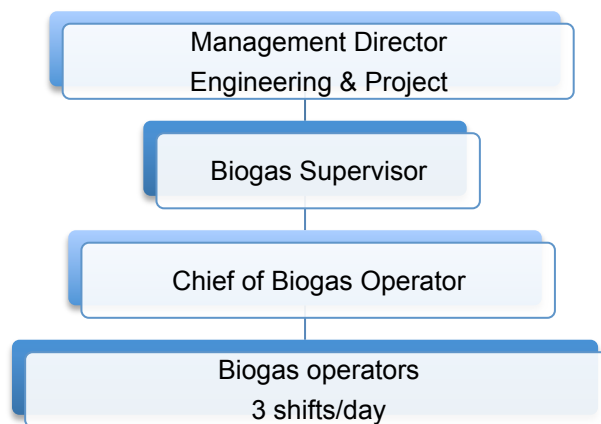
The operation of the wastewater treatment system has been transferred from Papop to General Starch (GSL) since May 2010 due to the expiration of the BOT contract. The wastewater treatment system operational and management systems have been certified under ISO 14001 version 2004 by UKAS. This certificate is valid from 16th Dec 2008 to 15th Dec 2011. This certificate ensures that requirements and procedures for parameter

monitoring, data recording and data archiving for environmental management system of biogas section are well managed according to ISO14001 requirements¹.

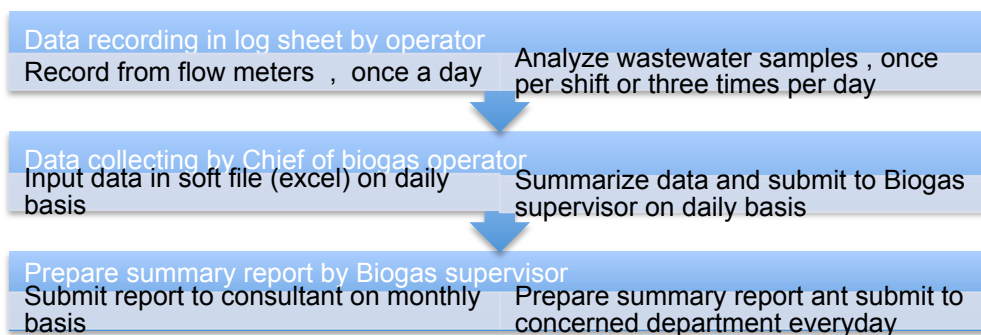
The plant operator carries out the daily operation recording and laboratory analysis. The monitored data is collected and recorded in the excel spreadsheet by chief of biogas operator. The report will be checked and approved by the plant supervisor. The summary reports are submitted to management on daily basis.

All equipment calibrations are controlled by the biogas plant supervisor. All documents are managed according to the requirements of ISO14001.

Organization structure



Data Collection and management system



¹ http://www.fs.fed.us/ems/includes/sum_ems_elements.pdf

Data storage and backup

- The original log sheets are collected and stored at biogas plant office by Chief of biogas operator.
- The data in excel format is stored at two computers at biogas plant. The backup of harddisks are done by IT department on monthly basis.
- The data submitted to consultant is stored and backup via consultant's internal server on monthly basis.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

$$E_{BL} = E_{CH4_lagoons_BL} + E_{CO2_heat_BL} + E_{CO2_power_BL} \quad \text{Formula (8)}$$

Where ,

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

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

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

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

Table 1 : Summary of baseline emission calculation

Parameter	Sep10 - Dec10	Jan11 - Dec11
E_{BL}	37,063	98,287
$E_{CH4_lagoons_BL}$	30,603	78,572
$E_{CO2_heat_BL}$	6,461	19,714
$E_{CO2_power_BL}$	0	0

4.2 Project Emissions

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

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

$$E_{project} = E_{CH4_lagoons} + E_{CH4_NAWTF} + E_{CH4_IC+Leaks} \quad \text{Formula (1)}$$

Where :

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

$E_{CH4_lagoons}$ are the fugitive methane emissions from lagoons from equations 2 (tCO₂e)

E_{CH4_NAWTF} are the fugitive methane emissions from the new anaerobic wastewater treatment facility (tCO₂e)

$E_{CH4_IC+Leaks}$ are the methane emissions from inefficient combustion and leaks (tCO₂e)

Table 2 : Summary of project emission calculation

Parameter	Sep10 - Dec10	Jan11 - Dec11
$E_{project}$	1,548	3,914
$E_{CH4_lagoons}$	0	-
E_{CH4_NAWTF}	0	0
$E_{CH4_IC+Leaks}$	1,548	3,914

4.3 Leakage

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

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

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

The unbalance between produced and burnt amount of biogas is considered as leakage. However, in case of the burnt biogas quantity is higher than produced quantity, the zero leakage is applied for conservativeness.

Table 3 : Summary of leakage information

Parameter	Unit	Sep'10 - Dec'10	Jan'11 - Dec'11
V1 _{leakage}	Nm ³	-	-

4.4 Summary of GHG Emission Reductions and Removals

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

Formula (12)

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

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

Formula (13)

Any positive difference between emissions of CH₄ from the lagoon and emissions from the digester and the lagoons in the project situation are to be deducted from the emission reduction estimate.

Table 4 : Summary of emission reduction calculation

Period	Sep'10 - Dec'10	Jan'11 - Dec'11	Unit
E _{project}	1,548	3,914	tCO ₂ e
E _{BL}	37,063	98,287	tCO ₂ e
Estimated ER	35,515	94,373	tCO ₂ e
Conservative ER	35,515	94,373	tCO ₂ e
Emission reductions	35,515	94,373	tCO ₂ e
Total emission reductions		129,888	tCO₂e

5 ADDITIONAL INFORMATION

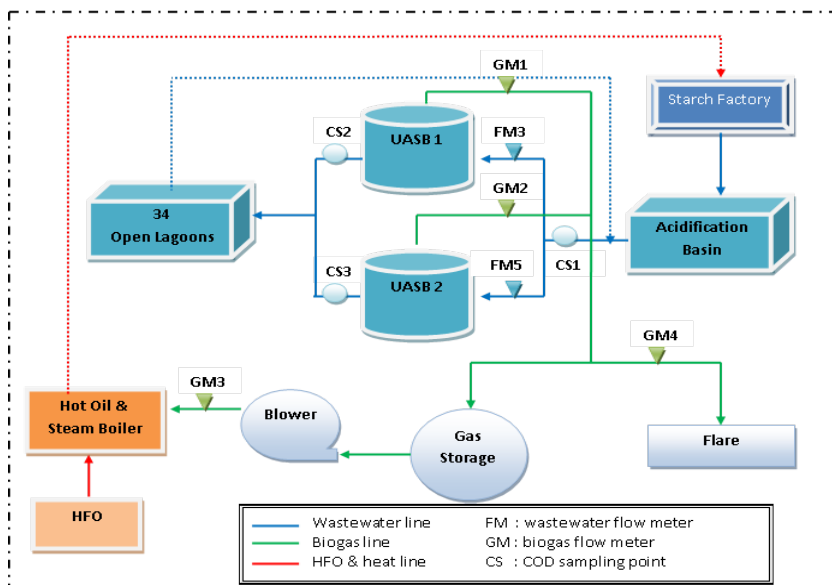


Figure 2 : Monitoring diagram

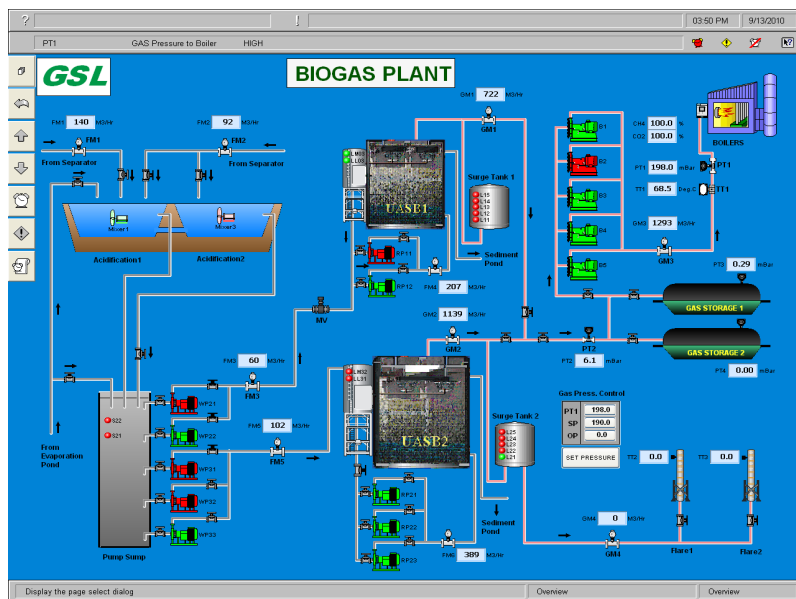


Figure 3 : Process flow diagram from SCADA screen

Table 5 : Summary of monitored data

ID no	Parameter	Ex-post values	Ex-post values	Unit
		Sep10 - Dec10	Jan11 - Dec11	
1	WW _{input}	448,552	1,173,627	m3
	UASB 1 = FM3	184,557	458,993	m3
	UASB 2 = FM5	263,995	714,634	m3
2	WW _{out}	448,552	1,173,627	m3
	UASB 1 = FM3	184,557	458,993	m3
	UASB 2 = FM5	263,995	714,634	m3
3	MCOD _{in}	7,444,858	19,354,173	kgCOD
		16.60	16.49	kgCOD/m3
4	MCOD _{out}	330,477	1,030,076	kgCOD
		0.74	0.88	kgCOD/m3
5	V _{boiler}	4,057,418	12,603,198	Nm3
6	EL	-	-	MWh
7	F	2,067	6,307	ton
8	V _{1 (flare)}	103,704	223,491	Nm3
9	C _{CH4}	0.000401	0.000394	tCH4/Nm3
10	PE _{flare}	874	1,850	tCO2
11	M _{ox agent}	0	0	kgCOD
12	E _{ta boiler}	98.5%	98.5%	
13	WW _{bypass}	0	0	m3
14	Loss _{pipeline}	0	0	%
15	M _{removed}	7,114,380	18,324,097	kgCOD
16	NCV _{biogas}	20.58	20.22	MJ/Nm3

Table 6 : Information of monitoring equipment

Meter	Brand	Model	S/N	Accuracy	Calibration Date		
					Bef. 2009	2010	2011
FM3	E+H	Promag 10 DN200	6B00EB20000	0.5% OR	2-Jul-09	26-Oct-10	14-Oct-11
FM5	E+H	Promag 10W DN200	6B00E920000	0.5% OR	2-Jul-09	26-Oct-10	14-Oct-11
GM1	E+H	Proline T-mass 65I	C3010D02000	1.5%		4-Aug-10	24-Jun-11
GM2	E+H	Proline T-mass 65I	A9059602000	1.5%		5-Aug-10	24-Jun-11
GM3	E+H	Proline T-mass 65I	9B09BD02000	1.5%		6-Aug-10	24-Jun-11
GM4	E+H	Proline T-mass 65I	AA083102000	1.5%	29-Nov-07	4-Aug-10	23-Jun-11
MS	ABB	EL 1020	3.241376.5	2%	4-Jun-10	19-Nov-10	21-Dec-11
MS	VISIT	VISIT 04	0505	2%		4-Nov-10	21-Dec-11
CS	Lovibond	Tintometer	38397	3.5%	22-May-08	1-Nov-10	

Table 7 : Biogas consumption at boilers

Year 2010	Biogas consumption at each boiler (Nm3)								
	Hot oil 1	Hot oil 2	Hot oil 3	Hot oil 4	Steam 5	Steam 6	Steam 9	Hot oil 7	Hot oil 8
1	184,021	186,361	113,392	101,841	94,781	65,338	165,338	228,038	290,216
2	208,450	237,330	112,807	108,657	709	148,271	150,994	280,480	271,714
3	212,590	231,851	132,048	131,355	12,356	151,706	177,937	307,274	237,380
4	213,818	198,094	86,549	73,492	33,802	121,574	99,933	326,594	153,495
5	196,514	227,189	125,705	73,338	61,882	154,132	112,626	243,072	164,725
6	146,273	135,760	109,342	18,849	0	105,053	74,107	103,086	158,009
7	159,035	153,837	91,337	83,968	533	113,157	104,740	203,682	160,792
8	138,250	112,821	85,619	60,458	3,443	84,901	127,046	228,291	177,330
9	251,431	176,073	125,195	121,328	0	152,148	159,414	0	0
10	230,843	216,814	134,547	77,856	0	154,257	149,621	54,488	129,364
11	215,080	230,857	109,888	112,926	18,482	162,290	164,845	269,530	209,552
12	261,344	264,670	113,739	124,844	42,003	160,206	173,762	260,937	305,625
Total	2,417,650	2,371,657	1,340,167	1,088,911	267,991	1,573,034	1,660,362	2,505,473	2,258,201

Year 2011	Biogas consumption at each boiler (Nm3)								
	Hot oil 1	Hot oil 2	Hot oil 3	Hot oil 4	Steam 5	Steam 6	Steam 9	Hot oil 7	Hot oil 8
1	248,007	234,539	114,016	117,432	62,806	157,173	175,353	297,295	207,357
2	256,607	230,965	127,736	125,036	86,673	158,367	167,686	347,409	253,094
3	236,309	287,212	139,186	146,071	143,639	189,395	192,265	339,735	276,571
4	242,970	224,656	115,165	116,017	86,175	163,575	168,797	328,236	328,049
5	183,376	232,796	118,320	121,137	53,871	152,901	165,867	96,783	215,539
6	0	201,090	117,573	109,730	3,563	148,842	152,490	0	180,448
7	0	72,912	43,680	22,467	10,836	148,166	107,148	0	35,021
8	5,957	226,802	119,718	113,560	1,432	153,205	180,982	0	245,054
9	86,874	105,165	98,547	96,169	0	150,199	175,920	0	215,764
10	179,494	75,335	111,043	105,585	0	148,046	154,887	143,853	286,092
11	295,162	276,973	135,656	140,544	10,245	196,228	196,874	0	330,708
12	273,706	282,050	148,798	142,197	88,858	206,594	211,746	288,691	426,032
Total	2,008,463	2,450,494	1,389,439	1,355,946	548,100	1,972,692	2,050,014	1,842,003	2,999,730