Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	Bangna Starch Wastewater Treatment and Biogas Utilization Project	
UNFCCC reference number of the project activity	2556	
Version number of the PDD applicable to this monitoring report	4.1	
Version number of this monitoring report	1	
Completion date of this monitoring report	01/08/2017	
Monitoring period number	3rd monitoring period	
Duration of this monitoring period	01/08/2013 – 09/11/2016 (first and last days included)	
Monitoring report number for this monitoring report	n/a	
Project participants	P & Papop Renewable Co., Ltd. South Pole Carbon Asset Management Ltd.	
Host Party	Thailand	
Sectoral scopes	Sectoral scope: 13 Waste handling and disposal	
Applied methodologies and standardized baselines	Applied methodologies: 1) AMS-III.H "Methane Recovery in Wastewater Treatment" (Version 09) 2) AMS-I.D "Grid connected renewable electricity generation (Version 13) There is no standardized baseline applicable for the project.	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	Not applicable	159,614
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	136,871	

SECTION A. Description of project activity

A.1. General description of project activity

The proposed project activity consists of the installation of an upflow anaerobic sludge blanket technology (UASB) biogas reactor and power generation (2.85 MW_{el} gas engine (3 x 0.95 MW) at an existing starch manufacturing plant for:

a) extraction of methane (biogas) from the wastewater stream through the biogas reactor, and
b) reuse of biogas as fuel for power generation (installed capacity of 2.85 MW_{el} gas engines)

The implementation of the project activity helps in the avoidance of methane (a GHG) emissions, which would have occurred from the anaerobic decay of wastewater in the baseline. Furthermore, biogas is used as a fuel in gas engines. The use of biogas (renewable fuel) reduces GHG emissions related to fossil fuel use for power generation in the grid in the absence of the project activity.

Brief description of the installed technology and equipment
The following equipment have been installed in the project activity:

Equipment	Manufacturer / Technology provider	Type/Model	Specifications
Wastewater treatment system	Papop Co.,Ltd	Upflow Anaerobic Sludge Blanket (UASB)	Upflow Anaerobic Sludge Blanket has a designed COD reduction efficiency of 90%. The UASB is designed with a total volumetric capacity of 6,581 m^3.
Gas engine	Guascor	SFGLD 560	There are three electricity generation sets with total installed capacity of 2.85 MW_{el}.
Flare	BKE Flare system	Closed flare	Closed flare has a maximum capacity of 1,250 Nm^3/hr.

Relevant dates for the project activity

Event	Date	Reference
Construction of UASB	20/07/2006	Purchase order
Commissioning of UASB	October 2007	Commissioning certificate by Papop Co.,Ltd
Commissioning of gas engines	21/12/2007	Commissioning test report
Registration under UNFCCC	10/11/2009	UNFCCC website
1st monitoring period	10/11/2009 - 31/12/2010	UNFCCC website
Approval of revision of monitoring plan	23/09/2011	UNFCCC website
Approval of notification for changes in the registered PDD	23/09/2011	UNFCCC website
2nd monitoring period	01/01/2011 – 31/07/2013	UNFCCC website

Total GHG emission reductions achieved during this monitoring period are 159,614 tCO_2e.

Further background information on the project activity can be found in the registered Project Design Document under the following link: http://cdm.unfccc.int/Projects/DB/RWTUV1241593452.75/view

A.2. Location of project activity

The project site is located next to Rimmaenamparn in Tombol Um Mao, Amphur Yangthalat, Kalasin Province, Thailand (Host country).

The coordinates of the project are Latitude 16°23'7.71"N (16.385475) and Longitude 103°28'21.28"E (103.472578).

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	P & Papop Renewable Co.,Ltd. (Private entity)	No
Switzerland	South Pole Carbon Asset Management Ltd. (Private entity)	No

A.4. Reference to applied methodologies and standardized baselines

a) The applied methodology
AMS-III.H version 9 – Methane recovery in wastewater treatment
(https://cdm.unfccc.int/methodologies/DB/4ND00PCGC7WXR3L0LOJTS6SVZP4NSU)
AMS-I.D version 13 - Grid connected renewable electricity generation
(https://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X)

b) Within AMS-III.H and AMS-I.D following tools are used for this project activity:
- "Tool to determine project emissions from flaring gases containing methane" (EB 28 annex 13) is used to calculate project emissions from flaring of a residual gas stream containing methane (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf)
- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" (version 2) is used to refer methane correction factor (MCF) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v2.pdf)

A.5. Crediting period type and duration

Type: Renewable crediting period
Start date and end date of the crediting period: 10/11/2009 – 09/11/2016
Current monitoring period: 01/08/2013 – 09/11/2016
Length of the current monitoring period: 3 years 1 month and 9 days

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project replaces the existing wastewater treatment practice (open lagoon system) and thus avoids the release of methane into the atmosphere that results from the anaerobic digestion of the organic content in the wastewater treated in the lagoon system.

The biogas reactor produces biogas to fuel gas engines for the production electricity grid, thus displacing fossil sources in the grid. Therefore, the project activity reduces greenhouse gases due to avoidance of methane emissions from the existing lagoon system and displacement of fossil fuel based electricity from the grid.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

No temporary deviations from registered monitoring plan or applied methodology during the monitoring period.

B.2.2. Corrections

No corrections to project information or parameters fixed at validation during the monitoring period.

B.2.3. Changes to the start date of the crediting period

There are no changes to the start date of crediting period.

B.2.4. Inclusion of monitoring plan

Not applicable

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

Changes from the registered monitoring plan were requested and approved during previous monitoring as follows.

The approval date of the revised PDD: 23/09/2011

The version and completion date of the revised PDD: version 4 and dated 11/08/2011

(http://cdm.unfccc.int/Projects/DB/RWTUV1241593452.75/view)

There is no change in monitoring plan during the current monitoring period.

B.2.6. Changes to project design

The gas storage was installed in 2010 which was not part of the initial design of the project activity.

The approval date of the revised PDD: 16/03/2012

The version and completion date of the revised PDD: version 4.1 and dated 31/01/2012

There is no change in project design during the current monitoring period.

SECTION C. Description of monitoring system

1. Monitoring Management

The monitoring system is based on meter readings recorded directly at the meter location and regular records of data measured in the laboratory at the project site.

The log sheets are prepared as follows:

- The operator records meter readings into log sheets and the plant manager checks the data on daily basis-. The readings are then inserted in an excel file, where from the values from the log sheet are rechecked. This reduces the scope of errors during data transfer.
- Since the totalizer readings are reported in log sheets; any doubtful readings can be cross-checked against the running total of the meter. This ensures a high level of accuracy.

For more details about the QA/QC procedures for each monitoring parameter, please refer to the monitoring parameter tables provided in D.2.

2. Data Storage and Filing – Electric Workbook

The data collection

- Meter readings are recorded into log sheets by the plant operators on daily basis and transferred to electronic log files (excel files).

- The parameters monitored in the laboratory by the lab operator are entered into log sheets, which are later transferred to the electronic log file (excel files).

The data checking

The reporting of monitored parameters is done on daily basis by the plant operator in log sheets. The data is compiled and inserted by the responsible staff into an excel template (electronic log file). The consistency of the data in both log sheets and excel files is checked by the supervisor on daily basis as well as reported to the plant manager during daily morning meeting of the next day. The compiled excel report is further sent to the project consultant for detailed emission reduction analysis. The plant manager and project consultant interact on regular basis to discuss emission reduction reporting. The details of the reporting procedure are explained in more detail in the table, which summarizes the responsibility of the staff at the project site.

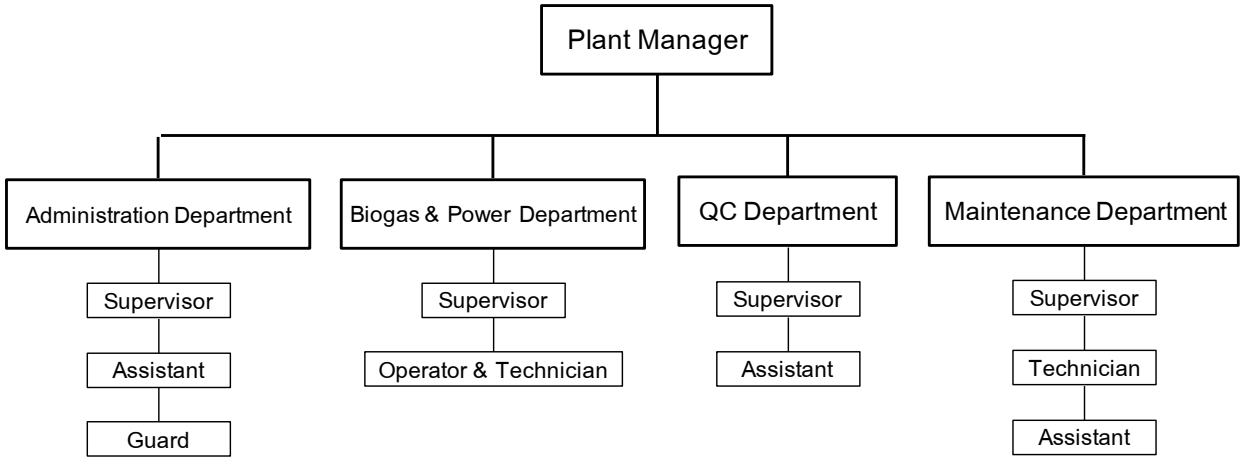

Figure 1: Organization chart

3. Roles and responsibilities

Roles	Responsibilities
Plant Manager	- Supervises the reports in form of log sheets and electronic log files - Approves the calibration plan - Assigns and approves the training plan - Approves the employment - Approves the purchase for equipment - Sends aggregated reports via email to the project consultant on a regular basis
Biogas and Power department - Supervisor	- Checks the completeness of the parameters monitored in log sheets (i.e. Biogas Plant Log Sheet)

Roles	Responsibilities
Biogas and Power department - Operator & Technician	- Logs the data monitored for biogas and power systems from the meter reading on the Biogas Plant Log Sheet on a daily basis
QC department - Supervisor	- Checks the completeness of the parameters monitored in log sheets (i.e. Lab Data Sheet) and - Fills in the electronic log file (excel file) - Regularly backs up the electronic log files
QC department - Assistant	- Takes samples and analyzes characteristics of wastewater, recording all test results in the Lab Data Sheet on regularly basis
Maintenance department - Supervisor	- Takes care of the installation of equipment - Ensures the preventive and corrective maintenance
Maintenance department - Technician & Assistant	- Assists the supervisor
Administration department	Manages & supports - for the general documentation - for the office supplies

4. Emergency procedures for the monitoring system

The staff of next shift is made aware of any event from the previous day or previous shift and plan to promptly handle the situation. In case of problem in any equipment or machine, the staff shall inform the project owner or the technical consultants to project for quick rectification of the problem.

5. Uncertainty in data

Some uncertainties may result due to malfunction of meters, calibration issues and wrong data collection (gaps in manual log sheets, human errors by plant operators). The operator is expected to put best efforts to prevent such errors, however internal audits based on daily morning meeting and monthly reports rectify any such uncertainty in the monitored data.

Monitoring equipment of the project activity

Data / Parameter as in PDD	Short description	Equipment	Tag no.	Serial no.
$Q_{y, ww}$	Wastewater treated	Electromagnetic flowmeter	FM1	93120819000[1] J905D120000[2]
$COD_{y, inflow, j}$	COD inlet of UASB	Colorimeter	-	070290C62433
$COD_{y, outflow, j}$	COD outlet of UASB			
$COD_{y, removed, j}$	COD removed by UASB			
$COD_{y, ww, treated}$	COD outlet of lagoon			
$S_{y, final}$	Amount of sludge generated	Weighbridge, which belongs to the starch factory	-	E07512-0201
$\%CH_4$	Methane content in biogas	Biogas Check	-	BM11452
$Q_{biogas, total, y}$	Amount of biogas generated	Thermal mass flowmeter	GM1/1	9502C002000
			GM1/2	A9059702000
$Q_{biogas, flare, y}$	Amount of biogas flared	Thermal mass flowmeter	GM3	9A070502000
$Q_{biogas, generator, y}$	Amount of biogas used in generators	Thermal mass flowmeter	GM2	9502C102000
T_{flare}	Temperature of the exhaust gases of the	Thermocouple	TT	SP08071880025

[1] Period of use: beginning – 26/11/2014

[2] Period of use: 27/11/2014 - present

Data / Parameter as in PDD	Short description	Equipment	Tag no.	Serial no.
	flare in stack			
Time of biogas sent to flare	Amount of minutes per hour where biogas is sent to flare	Thermal mass flowmeter	GM3	9A070502000
EC_y	Electricity imported	Electricity Meter	PM (PEA)	212054801
EG_y	Electricity exported	Electricity Meter	PM (PEA)	205055798

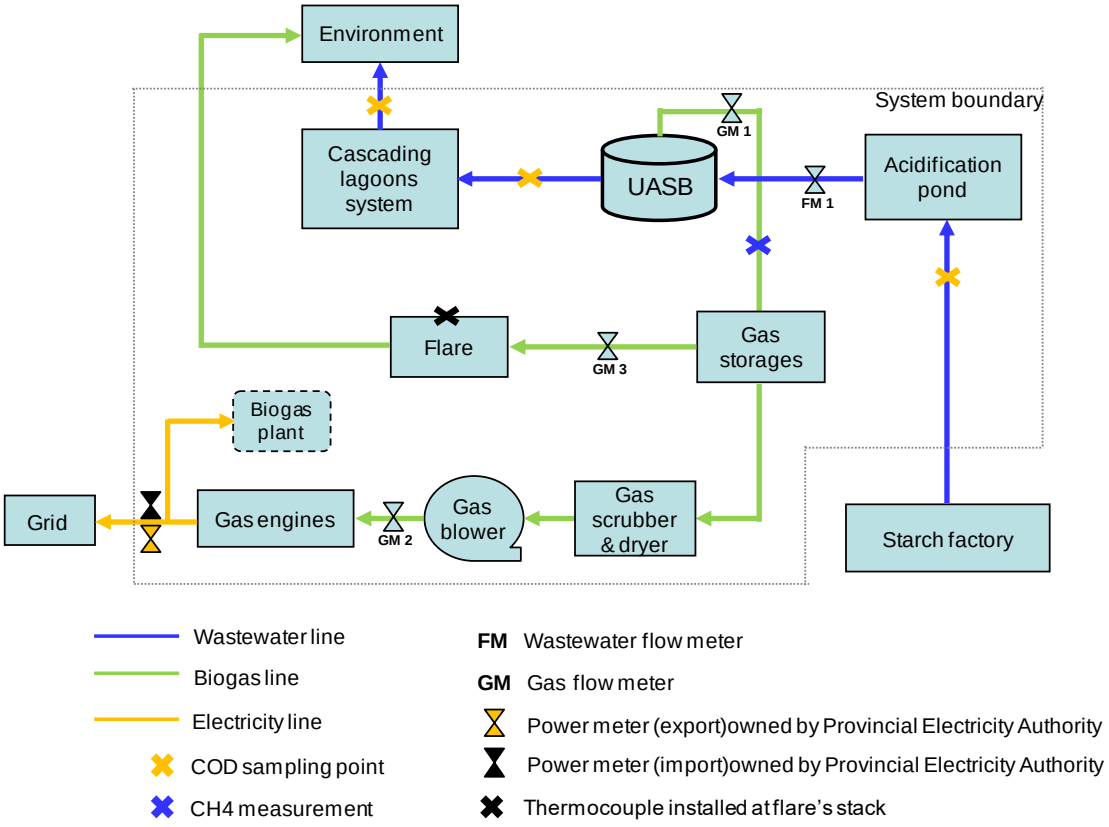

Figure 2: Flow diagram of the project activity

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	GWP_{CH4}
Unit	
Description	Global warming potential
Source of data	According EB 69 - Annex 3, the second commitment period GWP shall be effective from 01/01/2013
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	n/a

Data/Parameter	$B_{o,ww}$
Unit	kg CH_4/ kg COD
Description	IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation
Source of data	IPCC default value
Value(s) applied	0.21
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	As per AMS.III.H Version 09, the IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties.

Data/Parameter	MCF
Unit	Fraction
Description	Methane correction factor
Source of data	Table III.H.1 from AMS-III.H, Version 09 methodology and "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site (version 02)"
Value(s) applied	$MCF_{ww, treatment, i}$ = 0.8 (for baseline emissions) $MCF_{ww,l}$ = 1.0 (for project emissions from lagoon system) $MCF_{ww, final}$ = 0.2 (for wastewater released into river)
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	The original source of data can be checked for IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions. All MCF values have been chosen in a conservative manner (highest values for project and lower for baseline) according to table III.H.1 from AMS-III.H, Version 09 methodology.

Data/Parameter	CFE_{ww}
Unit	Fraction
Description	Capture and flare efficiency of the methane recovery and combustion efficiency
Source of data	Default value specified in AMS-III.H, Version 09 methodology
Value(s) applied	0.9
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	n/a

Data/Parameter	$EF_{grid, y} = EF_y$
Unit	tCO_2/MWh
Description	CO2 emission factor of the Thailand grid

Source of data	Validated as part of registered PDD pdf version submitted.
Value(s) applied	0.5057
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions.
Additional comments	n/a

Data/Parameter	**[CH4] $_{y, ww, treated}$**
Unit	Tonnes/m^3
Description	Dissolved methane content in the treated wastewater
Source of data	Methodology AMS-III.H
Value(s) applied	0.0001
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	n/a

D.2. Data and parameters monitored

Data/Parameter	**Q $_{y, ww}$**
Unit	m^3
Description	Volume of wastewater treated in the year y
Measured/calculated/ default	Measured continuously by the flow meter
Source of data	Log sheet
Value(s) of monitored parameter	

Monitoring period	**Total value (m^3)**
01/08/2013 – 31/12/2013	328,271
01/01/2014 – 31/12/2014	721,328
01/01/2015 – 31/12/2015	674,753
01/01/2016 – 09/11/2016	664,979

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag no.</td><td>FM1</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>Beginning – 26/11/2014</td></tr>
<tr><td>Equipment Type</td><td>Electromagnetic flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>PROMAG 10w</td></tr>
<tr><td>Maximum permissible error</td><td>±0.5%[3]</td></tr>
<tr><td>Serial No.</td><td>93120819000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>19/06/2013
21/05/2014</td></tr>
<tr><td>Validity</td><td>20/05/2015</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>27/11/2014 – present</td></tr>
<tr><td>Equipment Type</td><td>Electromagnetic flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>PROMAG 10L</td></tr>
<tr><td>Maximum permissible error</td><td>±0.5%[4]</td></tr>
<tr><td>Serial No.</td><td>J905D120000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>26/05/2015
18/05/2016</td></tr>
<tr><td>Validity</td><td>17/05/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>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.</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>n/a</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Additional comments</td><td>n/a</td></tr>
</table>

Data/Parameter	**$COD_{y, inflow, j}$**
Unit	mg/l or tonnes/m^3
Description	The COD (chemical oxygen demand) of wastewater entering the project system j. This can be either represented as concentration (mg/l) or be represented as tonnes/m^3
Measured/calculated/ default	Measured
Source of data	Measured by on-site laboratory and recorded in log sheets The COD content is analyzed using a colorimetric method in the on-site laboratory. The COD test results are logged manually in the plant operation report on a daily basis.

[3] https://portal.endress.com/wa001/dla/50000000584/000/03/TI093DEN_1109.pdf

[4] https://portal.endress.com/wa001/dla/50000000584/000/03/TI093DEN_1109.pdf

Value(s) of monitored parameter	

Monitoring period	Average value	
	mg/l	tonnes/m^3
01/08/2013 – 31/12/2013	17,599	0.017599
01/01/2014 – 31/12/2014	17,151	0.017151
01/01/2015 – 31/12/2015	18,727	0.018727
01/01/2016 – 09/11/2016	19,800	0.019800

Monitoring equipment	

Equipment Type	Portable Colorimeter
Manufacturer	Hach
Model	DR/890
Maximum permissible error	±0.24%[5]
Serial No.	070290C62433
Calibration Frequency	Annually
Date of calibrations	08/05/2013 29/04/2014 22/04/2015 19/02/2016
Validity	18/02/2017

Measuring/reading/recording frequency	Wastewater samples are collected at the inlet of the anaerobic treatment system (project system). The COD content is analyzed using a colorimetric method in the on-site laboratory. The COD test results are logged manually in the plant operation report on a daily basis. Samples collection and analysis for COD are done at least once per day. The results from the plant operation report are transferred to an electronic file i.e. excel sheet template.
Calculation method (if applicable)	n/a
QA/QC procedures	The data recorded in log sheets is based on the data measured in the laboratory at the project site and checked by the plant manager on regular basis.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The parameter is used to calculate COD $_{y, removed, j}$

Data/Parameter	**COD $_{y, outflow, j}$**
Unit	mg/l or tonnes/m^3
Description	The COD (chemical oxygen demand) of wastewater exiting the project system j. This can be either represented as concentration (mg/) or be represented as tonnes/m^3
Measured/calculated/ default	Measured
Source of data	Measured by on-site laboratory and recorded in log sheets The COD content is analyzed using a colorimetric method in the on-site laboratory. The COD test results are logged manually in the plant operation report on a daily basis.
Value(s) of monitored parameter	

Monitoring period	Average value	
	mg/l	tonnes/m^3
01/08/2013 – 31/12/2013	1,238	0.001230
01/01/2014 – 31/12/2014	1,043	0.001043
01/01/2015 – 31/12/2015	1,046	0.001046
01/01/2016 – 09/11/2016	1,043	0.001043

[5] http://www.hach.com/fmmimghach?/CODE:SPECCOLCOMPARE-2008-16038|1

Monitoring equipment	<table><tr><td>Equipment Type</td><td>Portable Colorimeter</td></tr><tr><td>Manufacturer</td><td>Hach</td></tr><tr><td>Model</td><td>DR/890</td></tr><tr><td>Maximum permissible error</td><td>±0.24%[6]</td></tr><tr><td>Serial No.</td><td>070290C62433</td></tr><tr><td>Calibration Frequency</td><td>Annually</td></tr><tr><td>Date of calibrations</td><td>08/05/2013 29/04/2014 22/04/2015 19/02/2016</td></tr><tr><td>Validity</td><td>18/02/2017</td></tr></table>
Measuring/reading/recording frequency	Wastewater samples are collected at the outlet of the anaerobic treatment system (project system). The COD content is analyzed using a colorimetric method in the on-site laboratory. The COD test results are logged manually in the plant operation report on a daily basis. Samples collection and analysis for COD are done at least once per day. The results from the plant operation report are transferred to an electronic file i.e. excel sheet template.
Calculation method (if applicable)	n/a
QA/QC procedures	The data recorded in log sheets is based on the data measured in the laboratory at the project site and checked by the plant manager on regular basis.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The parameter is used to calculate $COD_{y, removed, j}$

Data/Parameter	**$COD_{y, removed, j}$**
Unit	mg/l or tonnes/m^3
Description	The chemical oxygen demand removed by the treatment system “j”. Here j is the project system.
Measured/calculated/ default	Calculated
Source of data	Calculated from $COD_{y, inflow, j}$ and $COD_{y, outflow, j}$
Value(s) of monitored parameter	<table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Average value</th></tr><tr><th>mg/l</th><th>tonnes/m^3</th></tr><tr><td>01/08/2013 – 31/12/2013</td><td>16,789</td><td>0.016789</td></tr><tr><td>01/01/2014 – 31/12/2014</td><td>17,520</td><td>0.017520</td></tr><tr><td>01/01/2015 – 31/12/2015</td><td>18,510</td><td>0.018510</td></tr><tr><td>01/01/2016 – 09/11/2016</td><td>20,235</td><td>0.020235</td></tr></table>
Monitoring equipment	n/a
Measuring/reading/recording frequency	n/a
Calculation method (if applicable)	Calculated from $COD_{y, inflow, j}$ and $COD_{y, outflow, j}$ $COD_{y, removed, j} = COD_{y, inflow, j} - COD_{y, outflow, j}$
QA/QC procedures	n/a
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	n/a

[6] http://www.hach.com/fmmimghach?/CODE:SPECCOLCOMPARE-2008-16038|1

Data/Parameter	$COD_{y, ww, treated}$
Unit	mg/l or tonnes/m^3
Description	Chemical oxygen demand of the wastewater prior to discharge. This can be either represented as concentration (mg/l) or be represented as tonnes/m^3
Measured/calculated/ default	Measured by external laboratory
Source of data	External laboratory test report
Value(s) of monitored parameter	

Monitoring period	Maximum value	
	mg/l	tonnes/m^3
01/08/2013 – 31/12/2013	116.02	0.000116
01/01/2014 – 31/12/2014	99.40	0.000099
01/01/2015 – 31/12/2015	134.08	0.000134
01/01/2016 – 09/11/2016	83.36	0.000083

Monitoring equipment	n/a
Measuring/reading/recording frequency	Wastewater samples are collected at the last open anaerobic lagoon prior to discharge. The COD content is analyzed using a standard method in an external laboratory on a monthly basis.
Calculation method (if applicable)	Third party test report.
QA/QC procedures	The wastewater samples are collected by plant's operator and sent to the external laboratory for analysis of the COD content. 90/10 confidence / precision level approach is used for the collected data and conservative value is used for calculation of project emissions.
Purpose of data/parameter	Calculation of project emissions
Additional comments	n/a

Data/Parameter	$S_{y, final}$
Unit	Tonnes
Description	Amount of final sludge generated by the wastewater treatment system in the year "y"
Measured/calculated/ default	Measured
Source of data	Measured – all the sludge quantity produced during a monitoring period is measured. The end use of this sludge is also monitored
Value(s) of monitored parameter	

Monitoring period	Total value (tonnes)
01/08/2013 – 31/12/2013	0
01/01/2014 – 31/12/2014	0
01/01/2015 – 31/12/2015	0
01/01/2016 – 09/11/2016	0

Monitoring equipment

Equipment Type	Weighing machine
Manufacturer	Cardinal
Model	205
Maximum permissible error	±20 kg
Serial No.	E07512-0201
Calibration Frequency	Once in two years
Date of calibration	12/06/2012
Validity	11/06/2014

Measuring/reading/recording frequency	The sludge shall be monitored (for e.g. using weighbridge) when the sludge is removed from the wastewater treatment system. The end-use application of sludge, i.e. destination, shall be recorded in the log sheet.

Calculation method (if applicable)	n/a
QA/QC procedures	The measurement equipment is tested / calibrated once every 3 years. The same equipment as used by starch plant for tapioca procuring is used for monitoring the amount of sludge.
Purpose of data/parameter	Calculation of project emissions
Additional comments	n/a

Data/Parameter	**$\%CH_4$**
Unit	%
Description	Methane content in biogas
Measured/calculated/ default	Measured – Online system to monitor % of methane in biogas. However, during the monitoring period there was malfunction of the online system, the parameter was monitored by portable biogas analyzer which the detail of equipment and the conservative approach for calculation of emission reductions are provided.
Source of data	Log sheet
Value(s) of monitored parameter	**Monitoring period** / **Average value (%)** 01/08/2013 – 31/12/2013 / 58.59 01/01/2014 – 31/12/2014 / 58.38 01/01/2015 – 31/12/2015 / 56.91 01/01/2016 – 09/11/2016 / 58.07
Monitoring equipment	Equipment Type: Portable biogas analyzer Manufacturer: Geotechnical Instruments Model: Biogas Check Maximum permissible error: ±3%[7] Serial No.: BM 11452 Calibration Frequency: Annually Date of calibrations: 15/06/2011, 30/08/2012 Validity: 29/08/2013
Measuring/reading/recording frequency	The methane content is measured by portable biogas analyzer at least twice a day. Data is logged manually in the log sheets.
Calculation method (if applicable)	Simple average is estimated on daily basis.
QA/QC procedures	For this monitoring period, since the online system was not working, the portable gas analyzer is used to monitor the CH4 content at least twice a day. The monitored data is manually recorded onto log sheets, checked by the plant manager on regular basis, and transferred to excel file.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	As per the Monitoring plan, there should be an online methane monitoring. However during the period the methane analyzer is not working and portable methane analyzer is used to estimate methane in biogas and recorded in the log book. The biogas sample is analyzed at least twice a day and averaged for daily value.

[7] http://www.geotech.co.uk/Downloads/Portable_Biogas_Datasheet.pdf

<table>
<tr><td>Data/Parameter</td><td>$Q_{biogas, total, y}$</td></tr>
<tr><td>Unit</td><td>Nm^3</td></tr>
<tr><td>Description</td><td>Amount of biogas that is generated using the project activity in year y</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured – Gas Flow meter provided at the outlet of UASB. Denoted as GM1</td></tr>
<tr><td>Source of data</td><td>Log sheet</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Monitoring period</th><th>Total value (Nm^3)</th></tr>
<tr><td>01/08/2013 – 31/12/2013</td><td>2,417,389</td></tr>
<tr><td>01/01/2014 – 31/12/2014</td><td>5,484,678</td></tr>
<tr><td>01/01/2015 – 31/12/2015</td><td>5,400,911</td></tr>
<tr><td>01/01/2016 – 09/11/2016</td><td>5,932,912</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag no.</td><td>GM1</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>Beginning - present</td></tr>
<tr><td>Equipment Type</td><td>Thermal mass flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>t-mass 65I</td></tr>
<tr><td>Maximum permissible error</td><td>±1% of reading[8]</td></tr>
<tr><td>Serial No.</td><td>9502C002000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>19/06/2013
21/05/2014
26/05/2015
18/05/2016</td></tr>
<tr><td>Validity</td><td>17/05/2017</td></tr>
</table>
<table>
<tr><td>Period of use</td><td>01/02/2015 – present</td></tr>
<tr><td>Equipment Type</td><td>Thermal mass flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>t-mass 65I</td></tr>
<tr><td>Maximum permissible error</td><td>±1% of reading[9]</td></tr>
<tr><td>Serial No.</td><td>A9059702000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>26/05/2015
18/05/2016</td></tr>
<tr><td>Validity</td><td>17/05/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The amount of biogas generated is continuously measured by means of a cumulative flow meter installed after UASB. Data is logged manually in the log sheet and transferred to the excel sheet template on daily basis.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n/a</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>n/a</td></tr>
</table>

[8] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

[9] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

<table>
<tr><td>Data/Parameter</td><td>Q _{biogas, flare, y}</td></tr>
<tr><td>Unit</td><td>Nm^3</td></tr>
<tr><td>Description</td><td>Amount of biogas that is flared</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured – Gas Flow meter provided at the inlet of flare system. Denoted as GM3</td></tr>
<tr><td>Source of data</td><td>Log sheet</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Monitoring period</th><th>Total value (Nm^3)</th></tr>
<tr><td>01/08/2013 – 31/12/2013</td><td>54</td></tr>
<tr><td>01/01/2014 – 31/12/2014</td><td>820,817</td></tr>
<tr><td>01/01/2015 – 31/12/2015</td><td>409,455</td></tr>
<tr><td>01/01/2016 – 09/11/2016</td><td>101,142</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th>Tag no.</th><th>GM3</th></tr>
<tr><td>Equipment Type</td><td>Thermal mass flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>t-mass 65I</td></tr>
<tr><td>Maximum permissible error</td><td>±1% of reading[10]</td></tr>
<tr><td>Serial No.</td><td>9A070502000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>20/06/2013
21/05/2014
25/05/2015
18/05/2016</td></tr>
<tr><td>Validity</td><td>17/05/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The amount of biogas sent to the flare is continuously measured by means of a cumulative flow meter installed after the blower and before the flare. Data is logged manually in the log sheet and transferred to the excel sheet template on daily basis.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n/a</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td>As per the calibration details, there was a delay during the monitoring period from 21/05/2015 – 24/05/2015. However, since no biogas was flared during the period, the approach for applying an error in a conservative manner as per the latest version of the VVS is not applicable.</td></tr>
</table>

Data/Parameter	**Q $_{biogas, generator, y}$**
Unit	Nm^3
Description	Amount of biogas that is used in electricity generators.
Measured/calculated/ default	Measured – Gas Flow meter provided at the inlet of electricity generators system. Denoted as GM2
Source of data	Log sheet

[10] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

<table>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Monitoring period</th><th>Total value (Nm^3)</th></tr>
<tr><td>01/08/2013 – 31/12/2013</td><td>2,668,487</td></tr>
<tr><td>01/01/2014 – 31/12/2014</td><td>5,235,481</td></tr>
<tr><td>01/01/2015 – 31/12/2015</td><td>5,551,988</td></tr>
<tr><td>01/01/2016 – 09/11/2016</td><td>6,464,220</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th>Tag no.</th><th>GM2</th></tr>
<tr><td>Equipment Type</td><td>Thermal mass flowmeter</td></tr>
<tr><td>Manufacturer</td><td>Endress Hauser Flowtec AG</td></tr>
<tr><td>Model</td><td>t-mass 65I</td></tr>
<tr><td>Maximum permissible error</td><td>±1% of reading[11]</td></tr>
<tr><td>Serial No.</td><td>9502C102000</td></tr>
<tr><td>Calibration Frequency</td><td>Annually (based on the internal procedure of the project activity)</td></tr>
<tr><td>Date of calibrations</td><td>19/06/2013
21/05/2014
26/05/2015
18/05/2016</td></tr>
<tr><td>Validity</td><td>17/05/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The amount of biogas sent to the electricity generators is continuously measured by means of a cumulative flow meter installed at the inlet of the generators. Data is logged manually in the log sheet and transferred to the excel sheet template on daily basis.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n/a</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td>n/a</td></tr>
</table>

<table>
<tr><th>Data/Parameter</th><td>T_{flare}</td></tr>
<tr><td>Unit</td><td>˚C</td></tr>
<tr><td>Description</td><td>Temperature of the exhaust gases of the flare in stack (N type thermocouple). Data is recorded automatically on SCADA system.</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measurement by project participant</td></tr>
<tr><td>Source of data</td><td>Report from SCADA</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Since the parameter was not logged completely for the entire monitoring period when there was biogas flared, zero is assumed for the flare efficiency.
<table>
<tr><th>Monitoring period</th><th>Total value (˚C)</th></tr>
<tr><td>01/08/2013 – 31/12/2013</td><td>0</td></tr>
<tr><td>01/01/2014 – 31/12/2014</td><td>0</td></tr>
<tr><td>01/01/2015 – 31/12/2015</td><td>0</td></tr>
<tr><td>01/01/2016 – 09/11/2016</td><td>0</td></tr>
</table>
</td></tr>
</table>

[11] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

Monitoring equipment	<table><tr><td>Equipment Type</td><td>Thermocouple Type N</td></tr><tr><td>Manufacturer</td><td>Taie / WR&W</td></tr><tr><td>Model</td><td>FY800</td></tr><tr><td>Serial No.</td><td>SP08071880025</td></tr><tr><td>Calibration Frequency</td><td>Annually</td></tr><tr><td>Date of calibration</td><td>26/08/2013</td></tr><tr><td>Validity</td><td>25/08/2014</td></tr></table>
Measuring/reading/recording frequency	Since the parameter was not logged completely for the entire period of 2012 when there was biogas flared, zero is assumed for the flare efficiency.
Calculation method (if applicable)	n/a
QA/QC procedures	The calibration was not carried out on regular basis as per manufacturer's recommendation or at least once a year. However, the flare efficiency is assumed to be zero since no temperature readings were available for this monitoring period.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Since the parameter was not logged completely for the entire period when there was biogas flared, the value is assumed to be zero.

Data/Parameter	**Time of biogas sent to flare**
Unit	minutes
Description	Amount of minutes per hour where biogas is sent to the flare
Measured/calculated/ default	Measured / calculated based on SCADA record of biogas flow meter
Source of data	Report from SCADA
Value(s) of monitored parameter	<table><tr><th>Monitoring period</th><th>Value (minutes)</th></tr><tr><td>01/08/2013 – 31/12/2013</td><td>0</td></tr><tr><td>01/01/2014 – 31/12/2014</td><td>0</td></tr><tr><td>01/01/2015 – 31/12/2015</td><td>0</td></tr><tr><td>01/01/2016 – 09/11/2016</td><td>0</td></tr></table>
Monitoring equipment	The flare system is an automated system and makes sure that the biogas is not sent to the flare, if the flame is not detected. The details of the biogas going to the flare system and flame detection are available as part of the automated monitoring system at project site.
Measuring/reading/recording frequency	Whenever biogas flow is registered by the SCADA system of the biogas plant, the time is also recorded, which allows for a calculation of the time period of biogas being sent to the flare.
Calculation method (if applicable)	n/a
QA/QC procedures	n/a
Purpose of data/parameter	Calculation of project emissions
Additional comments	Since the parameter was not recorded completely for the entire monitoring period based on SCADA record, the value is assumed to be zero.

Data/Parameter	**EC_y**
Unit	MWh/y
Description	Electricity consumed by waste water treatment facility over the year.
Measured/calculated/ default	Measured – Electricity meter, maintained by PEA
Source of data	Report by PEA

Value(s) of monitored parameter	<table><tr><th>Monitoring period</th><th>Value (kWh)</th></tr><tr><td>01/08/2013 – 31/12/2013</td><td>31,500</td></tr><tr><td>01/01/2014 – 31/12/2014</td><td>201,120</td></tr><tr><td>01/01/2015 – 31/12/2015</td><td>96,060</td></tr><tr><td>01/01/2016 – 09/11/2016</td><td>90,420</td></tr></table>
Monitoring equipment	<table><tr><td>Equipment Type</td><td>Electricity Meter</td></tr><tr><td>Manufacturer</td><td>EDMI</td></tr><tr><td>Model</td><td>Genius Series Mk10E</td></tr><tr><td>Maximum permissible error</td><td>Class 0.5s, ±0.5%</td></tr><tr><td>Serial No.</td><td>212054801 (PEA No.27664781)</td></tr><tr><td>Calibration Frequency</td><td>Annually (based on PEA procedure)</td></tr><tr><td>Date of calibrations</td><td>21/06/2013 08/07/2014 24/06/2015 11/07/2016</td></tr><tr><td>Validity</td><td>10/07/2017</td></tr></table>
Measuring/reading/recording frequency	The measurement of this parameter is done continuously using electricity meter, owned by PEA. Monthly monitoring of the power meter is done. This can be verified from the reports issued by PEA (Provincial Electricity Authority).
Calculation method (if applicable)	n/a
QA/QC procedures	The reports are issued by Provincial Electricity Authority (PEA) which the monitored data is monthly recorded by the PEA officer together with plant's operator.
Purpose of data/parameter	Calculation of project emissions
Additional comments	n/a

Data/Parameter	**EG_y**
Unit	MWh/y
Description	Electricity exported to the grid during year y by power generation facility
Measured/calculated/ default	Measured – Electricity meter, maintained by PEA
Source of data	Report by PEA
Value(s) of monitored parameter	<table><tr><th>Monitoring period</th><th>Value (kWh)</th></tr><tr><td>01/08/2013 – 31/12/2013</td><td>4,421,940</td></tr><tr><td>01/01/2014 – 31/12/2014</td><td>8,827,260</td></tr><tr><td>01/01/2015 – 31/12/2015</td><td>9,637,620</td></tr><tr><td>01/01/2016 – 09/11/2016</td><td>10,305,960</td></tr></table>

Monitoring equipment	<table><tr><td>Equipment Type</td><td>Electricity Meter</td></tr><tr><td>Manufacturer</td><td>EDMI</td></tr><tr><td>Model</td><td>Genius Series Mk6</td></tr><tr><td>Maximum permissible error</td><td>Class 0.5s, ±0.5%</td></tr><tr><td>Serial No.</td><td>205055798 (PEA no.20963040)</td></tr><tr><td>Calibration Frequency</td><td>Based on PEA procedure</td></tr><tr><td>Date of calibrations</td><td>21/06/2013 08/07/2014 24/06/2015 11/07/2016</td></tr><tr><td>Validity</td><td>10/07/2017</td></tr></table>
Measuring/reading/recording frequency	The measurement of this parameter is done continuously using electricity meter, owned by PEA. Monthly monitoring of the power meter is done. This can be verified from the reports issued by PEA (Provincial Electricity Authority).
Calculation method (if applicable)	n/a
QA/QC procedures	The reports are issued by Provincial Electricity Authority (PEA) which the monitored data is monthly recorded by the PEA officer together with plant's operator.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	n/a

Data/Parameter	**FE or $\eta_{flare-h}$**
Unit	%
Description	Flare efficiency
Measured/calculated/ default	Calculated based on tool to determine project emissions from flaring gases containing methane, EB28, Annex 13
Source of data	SCADA record
Value(s) of monitored parameter	<table><tr><th>Monitoring period</th><th>Value (%)</th></tr><tr><td>01/08/2013 – 31/12/2013</td><td>0</td></tr><tr><td>01/01/2014 – 31/12/2014</td><td>0</td></tr><tr><td>01/01/2015 – 31/12/2015</td><td>0</td></tr><tr><td>01/01/2016 – 09/11/2016</td><td>0</td></tr></table>
Monitoring equipment	n/a
Measuring/reading/recording frequency	Biogas flow is registered by the SCADA system of the biogas plant, the time is also recorded, which allows for a calculation of the time period of biogas being sent to the flare.
Calculation method (if applicable)	n/a
QA/QC procedures	Maintenance of the flare system is conducted periodically as per supplier's specifications to ensure optimal operation.
Purpose of data/parameter	Calculation of project emissions
ditional comments	The parameters, which are the temperature of the exhaust gases of the flare and the time of biogas sent to flare, used for estimation the flare efficiency are not recorded completely for the entire monitoring period, thereby resulting the efficiency is zero.

D.3. Implementation of sampling plan

This section is not applicable since there is no sampling plan applied in this project activity.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS-III.H version 9) and the emission due to the displacement of electricity from the grid (calculated according to AMS-I.D version 13).

$$\mathbf{BE_y = BE_{y,el} + BE_{y,ww}} \quad \mathbf{(1)}$$

Where:

BE_y	Baseline emissions in the year "y" (tCO_2e)
$BE_{y,el}$	Baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e
$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y"

$$\mathbf{BE_{y,el} = EF_y * EG_y} \quad \mathbf{(2)}$$

Where:

$BE_{y,el}$	The baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e/MWh.
EF_y	Emission factor from the electricity displaced by the project activity during year "y". As electricity is exported to the grid, the emission factor of the national grid will be chosen: $EF_y = EF_{grid,y}$. (Calculated – Fixed ex-ante)
EG_y	Electricity generated during year y by power generation facility (MWh)

For the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery (option (vi) according to AMS-III.H), Paragraph 24 of AMS-III.H. Version 09, applies to baseline emissions as follows:

$$\mathbf{BE_{y,ww} = Q_{y,ww} * \sum_j (COD_{y,removed,j} * B_{o,ww} * MCF_{ww,treatment,j} * GWP_{CH4})} \quad \mathbf{(3)}$$

Where:

$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2/yr)
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,removed,j}$	Chemical oxygen demand removed by the anaerobic wastewater treatment systems "j" in the baseline situation in the year "y" to which the sequential anaerobic treatment step is being introduced in tonnes/m^3 (COD content of in the inlet and outlet of the lagoon system has been monitored for determination of the COD removed) As electricity is exported to the grid, the emission factor of the national grid will be chosen: $EF_y = EF_{grid,y}$. (Calculated – Fixed ex-ante)
$B_{o,ww}$	Methane producing capacity of the wastewater (The IPCC default value for domestic wastewater of 0.21 kg CH_4/kg COD)[12]
$MCF_{ww,treatment,j}$	Methane correction factor for the existing anaerobic wastewater treatment systems "j" to which the sequential anaerobic treatment step is being introduced (MCF lower value in

[12] As per AMS.III.H, the IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties.

Table III.H.1.)

GWP_{CH4} Global Warming Potential for methane (value of 21 is used)[13]

Baseline emissions

		01/08 - 31/12/2013	01/01 - 31/12/2014	01/01 - 31/12/2015	01/01 - 09/11/2016
$Q_{y, ww}$	m^3	328,271	721,328	674,753	664,979
$COD_{y, removed, j}$	mg/l	17,599	17,520	18,510	20,235
$Q_{biogas, total, y}$	Nm^3	2,417,389	5,484,678	5,400,911	5,932,912
$Q_{biogas, generator, y}$	Nm^3	2,668,487	5,235,481	5,551,988	6,464,220
$\%CH_4$ - lower	%	58.5%	58.31%	55.98%	57.91%

$BE_{y, power}$	**tCO_2**	**2,236**	**4,464**	**4,874**	**5,212**
$BE_{y, ww}$ (COD)	**tCO_2**	**24,265**	**53,079**	**52,458**	**56,514**
$BE_{y, ww}$ (biogas)	**tCO_2**	**27,931**	**54,646**	**55,636**	**67,007**

E.2. Calculation of project emissions or actual net removals

The project activity emissions are calculated as follows:

$$PE_y = PE_{y, power} + PE_{y, ww, treated} + PE_{y, s, final} + PE_{y, fugitive} + PE_{y, dissolved} + PE_{y, upgrading} + PE_{y, leakage, pipeline} \quad (4)$$

Where:

PE_y Project activity emissions in the year "y" (tCO_2e)

$PE_{y, power}$ Emissions from electricity or fossil fuel consumption in the year "y"

$PE_{y, ww, treated}$ Emissions from degradable organic carbon in treated wastewater in year "y"

$PE_{y, s, final}$ Emissions from anaerobic decay of the final sludge produced in the year "y"

$PE_{y, fugitive}$ Emissions from methane release in capture and utilization/combustion/flare systems in year "y"

$PE_{y, dissolved}$ Emissions from dissolved methane in treated wastewater in year "y"

$PE_{y, upgrading}$ Emissions related to the upgrading and compression of biogas in year "y"

$PE_{y, leakage, pipeline}$ Emissions due to physical leakage from the dedicated piped network in year "y"

Project activity emissions from degradable organic carbon in the treated wastewater ($PE_{y, ww, treated}$)

$$PE_{y, ww, treated} = Q_{y, ww} * COD_{y, ww, treated} * B_{o, ww} * MCF_{ww, final} * GWP_{CH4} \quad (5)$$

Where:

$PE_{y, ww, treated}$ Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2e)

$Q_{y, ww}$ Volume of wastewater treated in the year "y" (m^3/yr)

$COD_{y, ww, treated}$ Chemical oxygen demand of the treated wastewater in the year "y" ($tonnes/m^3$)

[13] The value of 25 is effective from 01/01/2013.

$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH_4/kg COD)[14]
$MCF_{ww, final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (as per AMS.III.H a value of 0.2 shall be used for wastewater discharge to sea, river or lake)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)[15]

The sludge removed from project activity is used for starting new anaerobic digesters or restarting other digesters by the same technology provider and is not dumped on a landfill site. Thereby no emissions from sludge removal take place in project activity.

Project activity emissions from anaerobic decay of the final sludge ($PE_{y, s, final}$)

$$PE_{y, s, final} = S_{y, final} * DOC_{y, s, final} * 16/12 * MCF_{s, final} * DOC_F * F * GWP_{CH4} \quad (6)$$

Where:

$PE_{y, s, final}$	Methane emissions from the anaerobic decay of the final sludge generated in the wastewater system in the year "y" (tCO_2e)
$S_{y, final}$	Amount of final sludge generated by the wastewater treatment in the year "y" (tonnes)
$DOC_{y, s, final}$	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.
$MCF_{s, final}$	Methane correction factor of the landfill that receives the final sludge, estimated as described in category AMS III.G. A default conservative value of 1 will be used.
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in landfill gas (IPCC default of 0.5)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)[11]

The sludge removed from project activity is used for starting new anaerobic digesters or restarting other digesters by the same technology provider and is not dumped on a landfill site. Thereby no emissions from sludge removal take place in project activity.

Fugitive emissions from methane release in capture and flare systems ($PE_{y, fugitive}$)

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

Where:

$PE_{y, fugitive, ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in year "y" (tCO_2e)
$PE_{y, fugitive, s}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic sludge treatment in the year "y" (tCO_2e)

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

[15] The value of 25 is effective from 01/01/2013.

The second term of the equation above is not applicable because the project activity does not comprise an anaerobic treatment system for sludge; it consists of an anaerobic treatment system for wastewater only. Hence, the term $PE_{y, fugitive, s}$ is neglected.

The first term of the equation above is calculated as follows:

$$PE_{y, fugitive, ww} = (1-CFE_{ww}) * MEP_{y, ww, treatment} * GWP_{CH4} \quad (8)$$

Where:

CFE_{ww}	Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment (a default value of 0.9 is used)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)[16]
$MEP_{y, ww, treatment}$	Methane emission potential of the wastewater treatment plant in the year "y" (tonnes), which is calculated according to the equation below

$$MEP_{y, ww, treatment} = Q_{y, ww} * B_{o, ww} * \sum_j COD_{y, removed, j} * MCF_{ww, j} \quad (9)$$

Where:

$Q_{y, ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y, removed, j}$	The chemical oxygen demand removed by the treatment system "j" of the project activity equipped with methane recovery in the year "y" (tonnes/m^3)
$MCF_{ww, j}$	Methane correction factor for the wastewater treatment system "j" equipped with methane recovery and combustion/flare/utilization equipment (MCF higher values in table III.H.1)
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH_4/kg COD)[17]

For this project, we only consider one treatment system j:

- The treatment system is the UASB digester. $COD_{y, removed, j}$ is estimated as the difference of the COD values between the inlet and outlet of the digester.

Emissions from dissolved methane in treated wastewater ($PE_{y, dissolved}$)

$$PE_{y, dissolved} = Q_{y, ww} * [CH4]_{y, ww, treated} * GWP_{CH4} \quad (10)$$

Where:

$PE_{y, dissolved}$	Emissions from dissolved methane in treated wastewater in year "y" (tCO_2e)
$Q_{y, ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$[CH4]_{y, ww, treated}$	Dissolved methane content in the treated wastewater (tonnes/m^3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of $10e^{-4}$ tonnes/m^3 can be used.
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)[18]

[16] The value of 25 is effective from 01/01/2013.

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

Here is the default value for the dissolved methane in anaerobic treatment has been applied: $[CH4]_{y, ww, treated} = 10^{-4}$ tonnes/m^3

Emissions from flaring of biogas ($PE_{y, flare}$)

The project emissions from flaring are incorporated into the emission reduction calculations as per the clarifications to the version 09 of the methodology[19].

$$PE_{y,flare} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000} \quad \textbf{(11)}$$

Where:

$TM_{RG, h}$	Mass flow rate of methane in the residual gas in hour h (kg/h)
$\eta_{flare, h}$	Flare efficiency in hour h

If the flare efficiency is constant / proved to be default value over the whole monitoring period. The formula can be rewritten as follows:

$$\sum_{h=1}^{8760} TM_{RG,h} = Q_{biogas, flare, y} * \%CH_4 * D_{CH4}$$

Where:

$Q_{biogas, flare, y}$	The biogas quantity flared by the project activity (Nm^3)
$\%CH_4$	Methane % in biogas, based on 95% confidence limit, for conservative estimation
D_{CH4}	Density of methane at normal conditions

Emission from upgrading and use of bottled biogas $PE_{y, upgrading}$ and from pipeline leakage $PE_{y, leakage, pipeline}$

No production, upgrading, pipeline transportation and use of bottled biogas is planned in this project, thus:

$PE_{y, leakage, pipeline} = 0$

$PE_{y, upgradining} = 0$

Project activity emissions from electricity or fossil fuel consumption ($PE_{y, power}$)

All the equipment that are involved in operation of biogas generation and consumption are to be included in estimation of power consumption. The power consumption (MWh) is multiplied with the national grid emission factor of electricity (tCO_2e/MWh).

$$\mathbf{PE_{y, power} = EF_y * EC_y} \quad \textbf{(12)}$$

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[18] The value of 25 is effective from 01/01/2013.

[19] http://cdm.unfccc.int/UserManagement/FileStorage/AM_CLAR_7MXW3CMZV4OVLA7J2QFUJ0MAMUKBVA

Where:

$PE_{y, power}$	Emissions from electricity or fossil fuel consumption in the year "y" (tCO_2e)
EC_y	Electricity consumed during year y from the national grid (MWh)
EF_y	Emission factor from the national grid electricity consumed by the project activity during year "y" (tCO_2e/MWh)

No fossil fuel is used for the operation of the project activity. Only electricity is contributed to $PE_{y, power}$. $EF_{grid, y}$ is calculated ex-ante and remains fixed during the whole crediting period.

Project emissions

		01/08 - 31/12/2013	01/01 - 31/12/2014	01/01 - 31/12/2015	01/01 - 09/11/2016
$Q_{y, ww}$	m^3	328,271	721,328	674,753	664,979
$COD_{y, ww, treated}$	t/m^3	0.000116	0.000099	0.000134	0.000083
$PE_{y, ww, treated}$	tCO_2	**40**	**75**	**95**	**58**
$PE_{y, s, final}$	tCO_2	**0**	**0**	**0**	**0**
$MEP_{y, ww, treatement}$		1,157	2,654	2,623	2,826
$Q_{biogas, flare, y}$	Nm^3	54	820,637	409,455	101,142
Flare Efficiency		0%	0%	0%	0%
$\%CH_4$ - upper	%	58.70%	58.45%	57.85%	58.22%
$PE_{y, flare}$	tCO_2	**1**	**8,586**	**4,240**	**1,054**
$PE_{y, fugutive, ww}$	tCO_2	**2,893**	**6,635**	**6,557**	**7,064**
$PE_{y, dissolved}$	tCO_2	**821**	**1,803**	**1,687**	**1,662**
EC_y	MWh	32	201	96	90
$PE_{y, power}$	tCO_2	**16**	**102**	**49**	**46**

E.3. Calculation of leakage emissions

For AMS IIIH, there is no bottling unit thereby nil leakages on account of bottling activity.

No equipment transfer takes place as an effect of project activity. All the equipment are purchased first hand and thereby no leakage considerations.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals ($t CO_2e$)	Project GHG emissions or actual net GHG removals ($t CO_2e$)	Leakage GHG emissions ($t CO_2e$)	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	203,099	43,485	0	-	159,614	159,614

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
136,871	159,614

E.6. Remarks on increase in achieved emission reductions

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