Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	CYY Biopower Wastewater treatment plant including biogas reuse for thermal oil replacement and electricity generation Project, Thailand
Reference number of the project activity	2141
Version number of the monitoring report	1
Completion date of the monitoring report	30/08/2013
Registration date of the project activity	25/03/2009
Monitoring period number and duration of this monitoring period	4th monitoring period 01/01/2013 – 20/08/2013 (first and last days included)
Project participant(s)	CYY Bio Power Co.,Ltd. South Pole Carbon Asset Management Ltd. Kommunalkredit Public Consulting GmbH
Host Party(ies)	Thailand
Sectoral scope(s) and applied methodology(ies)	Sectoral scope: 13 Waste handling and disposal Applied methodology: AM0022 ver.4 - Avoided Wastewater and On-site Energy Use Emissions in the industrial Sector
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	64,979 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	40,055 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The project activity involves the installation of an upflow anaerobic sludge blanket technology (UASB) and two gas engines at an existing starch factory for:

a) The extraction of methane (biogas) from the wastewater stream through the biogas reactor;

b) The reuse of biogas as fuel in existing thermal oil boiler within the starch plant for starch drying;

c) The reuse of biogas as fuel for power generation (using two gas engines each of 1.36 MW_{el} capacity).

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 the thermal oil boiler and in a gas engine. The use of biogas reduces GHG emissions related to fossil fuel use in the baseline in the boiler and in the grid.

Brief description of the installed technology and equipment

The following equipments have been installed in the project activity:

Component	Manufacturer	Type/Model	Brief description
Biogas reactor / Wastewater treatment system	Global Water Engineering (GWE) Ltd.,Hongkong.	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 6,000 m^3. The hydraulic retention time is approximate 2.5 days on total capacity as per design proposal provided by technology supplier.
Gas engine	DEUTZ	Biogas engine TBG 620 V16K	There are two electricity generation sets with total installed capacity of 2.72 MW_{el}.
Flare	DWS	Elevated biogas flare	An open flare has a maximum capacity of 1,600 Nm^3/hr as per the technology description by the supplier.

Relevant dates for the project activity

Event	Date	Reference
Construction of UASB	04/08/2006	Purchase order for civil works
Commissioning of UASB	03/11/2007	Certificate of Civil Mechanical and Electrical Completion
Commissioning of gas engines	02-08/12/2008	Minutes of Commissioning by Pro2 (technology provider)
Registration under UNFCCC	25/03/2009	UNFCCC website
1st monitoring period	25/03/2009 – 02/08/2009	UNFCCC website
Approval of Revision of monitoring plan	12/08/2010	UNFCCC website
Approval of Notification for changes in the registered PDD	16/03/2012	UNFCCC website
2nd monitoring period	03/08/2009 – 31/12/2010	UNFCCC website
3rd monitoring period	01/01/2011 – 31/12/2012	UNFCCC website

Total GHG emission reductions achieved in this monitoring period are 40,055 tCO2e.

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/RWTUV1218617500.62/view

A.2. Location of project activity

>> The project site is located in Tombol Pongdaeng, Amphur Khamtalesor, Nakorn Ratchasima Province, Thailand (Host country).

The coordinates of the project are Latitude 14°59'55"N (14.9986 N) and Longitude 101°54'42"E (101.9117 E).

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	CYY Bio Power Co.,Ltd. (Private entity)	No

Switzerland	South Pole Carbon Asset Management Ltd. (Private entity)	No
Austria	Kommunalkredit Public Consulting GmbH (Private entity)	No

A.4. Reference of applied methodology

>>

(a) The applied methodology

AM0022 version 04 – Avoided Wastewater and On-site Energy Use Emission in the Industrial Sector (https://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_6YUZFP6D04KGQUCLY8NNMXBCE868MA/EB28_repan08_AM0022_ver04.pdf?t=dFJ8bW1xZ3B1fDAMYMKgdkBV58p5_HmUw7re)

(b) Within AM0022 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 calculate the emission factor for an electricity system" (Version 01) is used to calculate the Carbon Emission Factor (CEF) of the electricity grid, required for determination of baseline emissions due to displacement of grid electricity.

(https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.pdf)

A.5. Crediting period of project activity

>>

Type: Fixed crediting period (10 years)

Start date and end date of the crediting period: 25/03/2009 – 24/03/2019

Current monitoring period: 01/01/2013 – 20/08/2013

Length of the current monitoring period: 7 months

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

>>The project activity involves the installation of an up-flow anaerobic sludge blanket technology (UASB) to generate biogas that is used to replace fuel usage in an existing boiler within the starch plant and generate renewable electricity.

The wastewater flows from the factory into a storage lagoon. The influent first passes through a screen extractor, in order to remove coarse particles. After the screening the wastewater flows into an equalization pond.

The wastewater is then pumped into the reactors through an influent distribution system at the bottom of the reactor. The methane reactors are of the UASB type. In the UASB, the wastewater rises through an expanded bed of anaerobic active methanogenic sludge (the so called "sludge blanket") and an internal

device at the top of the reactor, which results in a separation of the mixed liquor into clarified wastewater, biogas and sludge. The absence of any mechanical agitation allows a natural selection towards heavy flocs of active methanogenic sludge.

Excess sludge can eventually, from time to time, be withdrawn from the bottom of the reactor. This excess sludge is extremely thick (5-10% Dissolved Solids), stable, and can be dumped without problems, but it is widely sought after to start-up new reactors elsewhere. The effluent of the anaerobic treatment is further treated in some of the existing lagoons, receiving only 2% to maximum 10% of the original COD load.

A gas storage is installed[1] at the project site in order to optimize the biogas utilization ratio by ensuring a better match between biogas generation and energy demand at the thermal oil boiler and gas engines, thus avoiding unnecessary flaring of biogas. Part of the resulting biogas is used in the factory as fuel in an existing thermal oil boiler for starch drying. A dual fuel burner able to fire oil and gas is employed to burn only biogas or both fuels mixed together. The biogas meter is equipped to record the biogas consumption of the burner.

The rest of the biogas is used as fuel in two power generators (gensets) with a total installed capacity of 2.72 MWel. Before use in the power generators, the biogas has to be treated to reduce the sulphur content of the biogas from tapioca starch factory effluent using a biogas “sweetening” plant, based on a proprietary sulphur removal system, which does not use chemicals (except for pH control in the oxidation phase). In practice min. 90% removal is obtained. The scrubber is placed on top of the aeration basin, so as to allow gravitational flow of the washing water back into the inlet of the aeration basin. From the aeration basin, water is continuously pumped into the scrubber tower.

The flare system is installed on the top of the reactors. The rest of the biogas apart from utilization and collection in the gas storage is destroyed in the flare system, which is also required as part of safety procedures of the wastewater treatment plant.

The UASB system was commissioned in 2007 and the installation of two gas engines occurred later in 2008. The project activity started operation in full capacity on 29th November 2008, which is the commissioning date of the gas engines.

Implementation of the project during the monitoring period.

During the monitoring period, there were no significant events occurred which affected the project activity as describe above. The calibration of the equipment was conducted as per the plan of the project activity.

The plant was shut down for a few periods as follows.

Period	Event
01/01/2013 – 03/01/2013	New Year holiday
11/04/2013 – 19/04/2013	Songkran Festival holiday

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

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

B.2.2. Corrections

[1] The gas storage was constructed on 27/02/2010 during the second CDM monitoring period and was not part of the initial design of the project activity. The PDD was revised during the 2nd verification and was approved on 16/03/2012.

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

B.2.3. Permanent changes from registered monitoring plan or applied methodology

>>

The following changes from the registered monitoring plan were requested and approved during the previous monitoring period.

AM0022 ID 16: volume of flow of wastewater directly to the current wastewater treatment system and bypassing the new wastewater treatment facility

This parameter was removed from the registered monitoring plan since it had no direct or indirect impact on the estimation of emission reductions.

The revision of the monitoring plan was approved on 12/08/2010.
(https://cdm.unfccc.int/Projects/DB/RWTUV1218617500.62/view)

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

B.2.4. Changes to project design of registered project activity

>> 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.

B.2.5. Changes to start date of crediting period

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

B.2.6. Types of changes specific to afforestation or reforestation project activity

>> The section is left blank intentionally.

SECTION C. Description of monitoring system

>>

Data Management and Emission Reduction Reporting:

The data management is done in the following manner.

- Data acquisition from gas meters of flare and gas engines and waste water flow meter is executed through the process control unit on daily basis and the values are input manually into the CDM monitoring sheets by the plant staff and electronic format by the head of QC.
- Data acquisition from gas meter at boiler is recorded on daily basis by the staff of starch factory. The

copied data is submitted to and kept by the head of QC. The values are transferred to electronic log sheet by the head of QC.

- Electricity generation is recorded manually in daily operation sheets on daily basis at the control unit of the gas engines and transferred to electronic log sheet.
- Methane concentration is executed through the process control unit. The average values are done and input manually into the operation log book and transferred to electronic log sheet.
- For laboratory monitored parameters, the records are written into the log sheets on daily basis and transferred to electronic log sheet.
- The values from electronic log sheet are used for calculation of emission reductions estimation.
- The data is backed up in the form of excel sheet formats on a different computer and also on a portable storage system such as compact disc every 4 months by the head of QC.
- The data is archived for a period of 2 years after the crediting period.

The reporting of monitored parameters is done on a daily basis by the plant staff in form of daily log reports. The data is compiled and inserted by the responsible staff into excel report templates, which are used for calculation of emission reductions and monthly reporting respectively. The head of QC team sends the printout of summary monthly report to the plant manager and the managing director. The compiled excel report is further sent to the project consultant for detailed emission reduction analysis. The managing director and project consultant interact at least once in three months 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. The table can be referred to in the section below.

QA/QC Procedures:

- The calibrations for all the monitoring devices are available, relevant to the monitoring period.
- The head of QC ensures the timely calibrations of the monitoring devices, data acquisition and storage of data.
- The roles and responsibilities of the project's staff are briefly tabulated below.

Roles	**Responsibilities**
Head of Quality Control	- Checks the completeness of the parameters monitored - Calculates and inserts the data of methane concentration into the log book - Provides the monthly report - Sends the monthly report in print format to the plant manager and managing director - Sends aggregated reports via email to the project consultant monthly basis - Transfers all of the parameters monitored in log books into the electronic log file (excel report) on daily basis - Cooperates with the head of instrumentation to ensure the timely calibrations of the monitoring equipment - Backs up the data from the excel reports every 4 months - Follows and collects the copied log book for the monitored parameter at the boiler of the starch plant on daily basis
Quality Control Staff	- Takes samples and analyzes characteristics of wastewater - Fills in the analysis result to the log book

Biogas system controller	- Fills in the data monitored for biogas system from the process control unit to the log book
Power system controller	- Fills in the data monitored for power system from the process control unit to the log book
Plant Manager	- Supervises and signs off the monthly report
Head of Instrumentation (Technician)	- Supports the operation of biogas and power system - Maintains and repairs the equipment and machines - Cooperates with the head of quality control to ensure the timely calibrations of the monitoring equipment

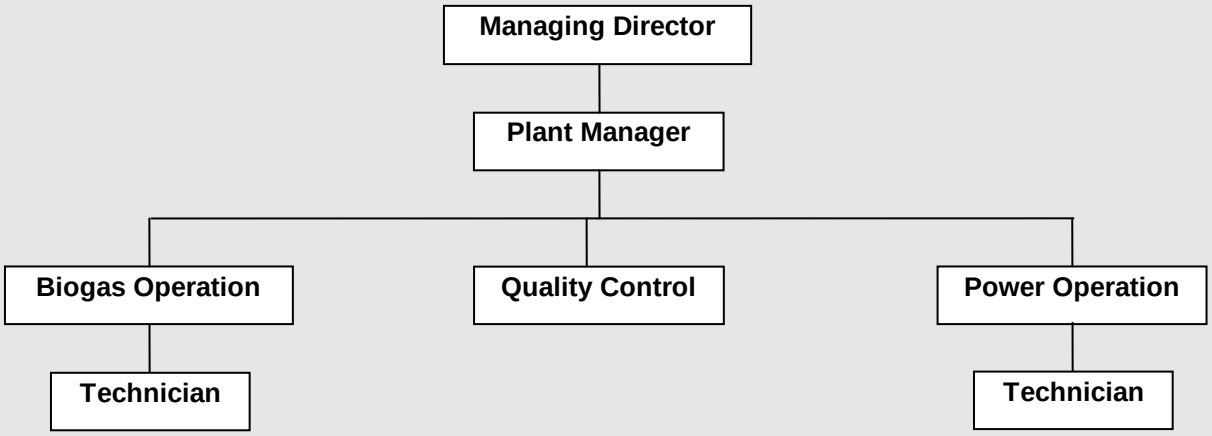

Figure 1: Organization chart

Emergency procedures for the monitoring system

The daily checklist for operation is done on a daily basis by the staff in charge of overall checking the operation. The staff of next shift shall be 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.

Monitoring equipment of the project activity

Parameter Notation				Monitoring equipment	Serial no.	Parameter Description
AM0022	**Registered PDD**	**SCADA representation**	**Tag no.**			
ID1	FM1	FT100	PD-MM-001	Wastewater flow meter	A0642633	Wastewater flows entering the project treatment facility.
ID2[2]	n/a	n/a	n/a	n/a	n/a	Wastewater flow leaving the project treatment facility
ID3	n/a	n/a	PD-CL-001	Portable colorimeter	070890C64902	COD concentration of the wastewater entering the new

[2] There is revision of monitoring plan for this parameter, which was approved on 12/08/2010. This parameter is referred to be established using ID1 and hydrological balance assumed. Therefore, in the actual implementation is not required to install a flow meter at the outlet of the project treatment facility.

						anaerobic digestion system
ID4	n/a	n/a	PD-CL-001	Portable colorimeter	070890C64902	COD concentration of the wastewater leaving the new anaerobic digestion system.
ID5	GM3	n/a	PD-DM-003	Gas Flow meter	91FA19282639	Volume of biogas sent to facility heaters
ID7	PM-A PM-B	n/a	PD-PM-001 PD-PM-002	Power meter	A: A010393 B: A004997	Electricity generated from collected biogas
ID8[3]	n/a	n/a	n/a	n/a	n/a	Fossil fuel volume equivalent to generate same amount of heat generated from the biogas collected
ID9	GM2	FT105	PD-DM-002	Gas Flow meter	265DS6600065941	Biogas sent to flare
ID10	GM4	FT501A, FT501B	PD-DM-004 PD-DM-005	Gas Flow meter	FT501A: 265DS6600032493 FT501B: 265DS6600028459	Biogas sent to genset
ID11	n/a	AIT101	n/a	CH4 analyzer	ARCC 0038	Methane content in biogas
ID13	n/a	n/a	PD-CL-001	Portable colorimeter	070890C64902	Amount of chemical oxidising agents entering system boundary
ID14[4]	n/a	n/a	n/a	n/a	n/a	Gen set combustion efficiency (combustion of methane)
ID15[4]	n/a	n/a	n/a	n/a	n/a	Heating system combustion efficiency (combustion of methane
ID17	n/a	n/a	PD-GD-001	Gas detector	10110R4-006	Loss of biogas from pipeline
ID18	n/a	n/a	n/a	Weigh bridge	2005352	Organic material removed from wastewater facility
ID19[3]	n/a	n/a	n/a	n/a	n/a	Biogas calorific value

[3] Calculated value
[4] Measurement of the parameter is done by third party.

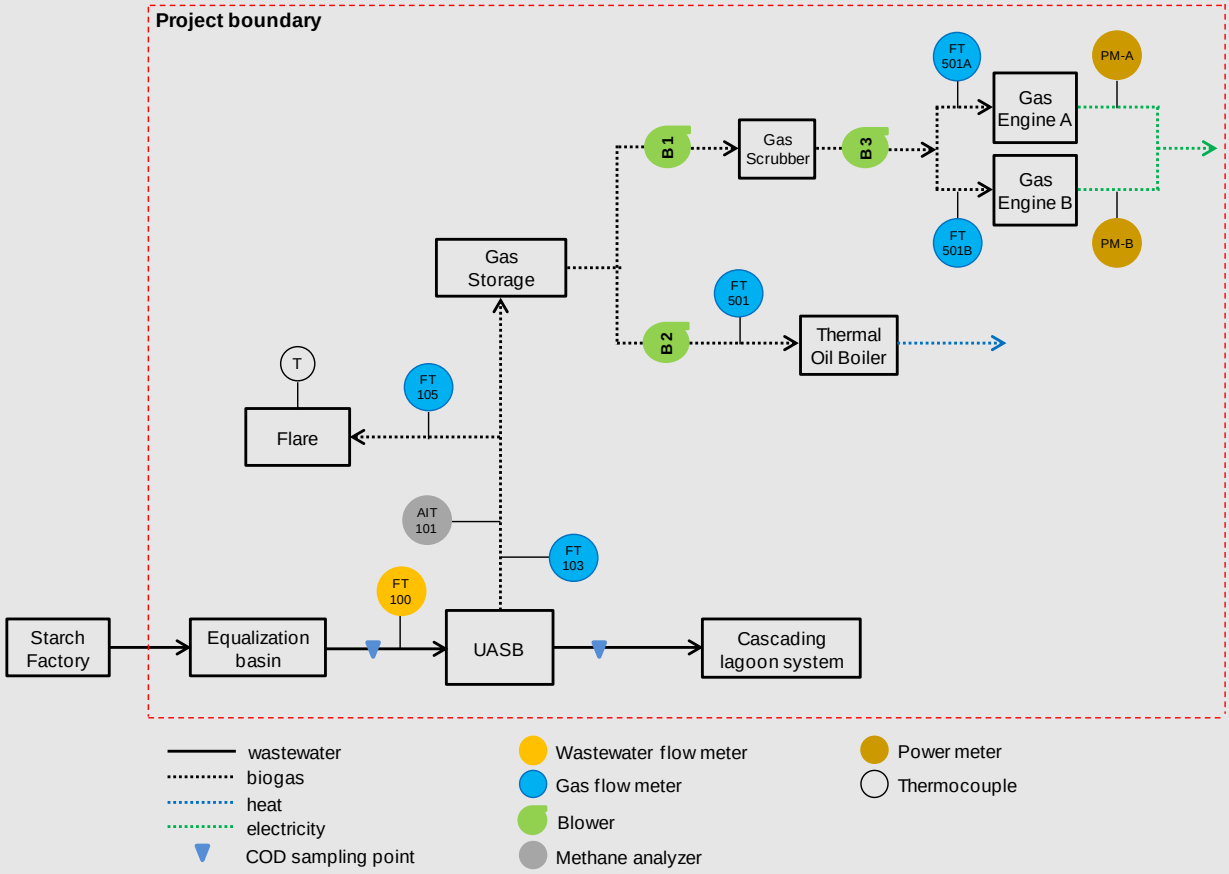

Figure 2: Flow diagram of the project activity representing the actual set-up of the monitoring system after approval of the monitoring plan revision

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter:	**EF_{CH4}**
Unit:	kg CH_4/ kg COD
Description:	Methane emission factor
Source of data:	Estimated based on IPDD default value and available scientific literature
Value(s) applied):	0.21
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	n/a

Data / Parameter:	**Rlagoon**
Unit:	%
Description:	Organic material removal ratio
Source of data:	Chemical analysis of effluent samples at inlet and outlet of lagoon system boundaries
Value(s) applied):	98.90
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	Data provided in Appendix 1

Data / Parameter:	**Surface Aerobic Losses Factor**
Unit:	kg COD/ ha/ day
Description:	Surface aerobic losses factor per hectare of pond surface area per day
Source of data:	Default value AM0022, Version 04
Value(s) applied):	254 kg COD/ ha/ day
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	Sensitivity analysis provided in Appendix 1

Data / Parameter:	**Chemical Oxidation Losses Factor**
Unit:	kg COD/ m^3
Description:	Chemical oxidation losses factor per cubic meter of effluent entering the lagoon based treatment system
Source of data:	Default value AM0022, Version 04
Value(s) applied):	0.07587 * 0.651 = 0.0494 kg COD/ m^3
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	n/a

Data / Parameter:	**$R_{deposition}$**
Unit:	%
Description:	Organic material deposition ratio
Source of data:	Project developer
Value(s) applied):	7.05
Purpose of data:	Calculation of baseline and project emissions.

Additional comment:	Data provided in Appendix1

Data / Parameter:	**E_{CH4_NAWTF}**
Unit:	%
Description:	Proportion of methane emitted from UASB digesters
Source of data:	Information provided by technology provider
Value(s) applied):	1
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

Data / Parameter:	**R_{NAWTF}**
Unit:	%
Description:	Total organic material removal efficiency of the new project wastewater facility
Source of data:	Technical proposal prepared by technology provider
Value(s) applied):	90
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

Data / Parameter:	**f_{boiler}**
Unit:	%
Description:	Proportion of biogas destroyed by combustion in the boilers used for heat generation.
Source of data:	Technical literature
Value(s) applied):	98.5
Purpose of data:	Calculation of project emissions
Additional comment:	

Data / Parameter:	**f_{engine}**
Unit:	%
Description:	Proportion of biogas destroyed by combustion in the boilers used for electricity generation.
Source of data:	Technical literature
Value(s) applied):	99
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

Data / Parameter:	**CEF**
Unit:	tCO_2/ MWh
Description:	Carbon emission factor for the electricity displaced by the electricity generated from the biogas
Source of data:	Electricity Generation Authority of Thailand (EGAT), “Tool to calculate the emission factor for an electricity system”
Value(s) applied):	0.52

Purpose of data:	Calculation of baseline emissions
Additional comment:	n/a

Data / Parameter:	**EF**
Unit:	tCO2/ TJ
Description:	Carbon emission factor of heavy fuel oil
Source of data:	2006 IPCC guidelines for National GHG Inventories
Value(s) applied):	77.40
Purpose of data:	Calculation of baseline emissions
Additional comment:	n/a

Data / Parameter:	**NCV**
Unit:	TJ/ t
Description:	Net calorific value of heavy fuel oil
Source of data:	2006 IPCC guidelines for National GHG Inventories
Value(s) applied):	0.0404
Purpose of data:	Calculation of baseline emissions
Additional comment:	n/a

Data / Parameter:	**Density of CH_4**
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(s) applied):	0.716
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	n/a

Data / Parameter:	**Lagoon surface area**
Unit:	Hectare
Description:	Total lagoon area
Source of data:	Project owner
Value(s) applied):	25.18
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	Detail provided in Appendix 1

Data / Parameter:	**Flare efficiency**
Unit:	%
Description:	Flare efficiency for open flare
Source of data:	Tool to determine project emissions from flaring gases containing methane

Value(s) applied):	0% if the flame is not detected for more than 20 minutes during the hour h. 50%, if the flame is detected for more than 20 minutes during the hour h.
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

Data / Parameter:	**Specific heavy fuel oil consumption**
Unit:	t HFO/t starch
Description:	Historic average heavy fuel oil consumption per ton of output (ton of dry starch)
Source of data:	Historic fuel consumption of 2006/2007
Value(s) applied):	0.033
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

Data / Parameter:	**Specific electricity consumption**
Unit:	MWh/t starch
Description:	Historic average electricity consumption per ton of output (ton of dry starch)
Source of data:	Historic electricity consumption of 2006/2007
Value(s) applied):	0.222.
Purpose of data:	Calculation of project emissions
Additional comment:	n/a

D.2. Data and parameters monitored

Data / Paramet	**AM0022 ID 1** **Wastewater flows entering the project treatment facility**
Unit:	m^3
Description:	Wastewater flow entering into the new anaerobic digestion system
Measured/ Calculated / Default:	Measured continuously by the flow meter In the CDM Monitoring Sheet, the data in m3/day can be done by the following Data in day 'x' = (totalizer in day 'x') - (totalizer in day 'x-1')
Source of data:	Log sheet
Value(s) of monitored parameter:	**Monitoring period** | **Total value (m^3)** 01/01/2013 – 20/08/2013 | 489,566

Monitoring equipment:	<table><tr><td>SCADA representation / Tag no.</td><td>FT100 / PD-MM-001</td></tr><tr><td>Equipment Type</td><td>Electromagnetic flowmeter with flow converter</td></tr><tr><td>Manufacturer</td><td>Krohne</td></tr><tr><td>Model</td><td>IFC010D</td></tr><tr><td>Maximum permissible error</td><td>±0.3%</td></tr><tr><td>Serial No.</td><td>A0642633</td></tr><tr><td>Calibration Frequency</td><td>Annually</td></tr><tr><td>Date of latest calibration</td><td>19/10/2012</td></tr><tr><td>Validity</td><td>18/10/2013</td></tr></table>
Measuring/ Reading/ Recording frequency:	The meter has continuous monitoring of the flow of wastewater. The accumulated reading shall be taken from the SCADA screen and recorded in the log sheet by the operator on a daily basis.
Calculation method (if applicable):	n/a
QA/QC procedures:	Flow meter is undergone maintenance / calibration subject according to appropriate industry standards.
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM0022 ID 2** **Wastewater flows leaving the project treatment facility**
Unit:	m^3
Description:	Wastewater flow leaving the new anaerobic digestion system
Measured/ Calculated / Default:	Established using ID 1 and assuming hydrological balance
Source of data:	Established using ID 1 and assuming hydrological balance
Value(s) of monitored parameter:	<table><tr><th>Monitoring period</th><th>Total value (m^3)</th></tr><tr><td>01/01/2013 – 20/08/2013</td><td>489,566</td></tr></table>
Monitoring equipment:	Refer to the information provider for ID 1
Measuring/ Reading/ Recording frequency:	Refer to the information provider for ID 1
Calculation method (if applicable):	Refer to the information provider for ID 1
QA/QC procedures:	Refer to the information provider for ID 1
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM0022 ID 3** **Wastewater organic material concentration entering the project treatment facility**
Unit:	kg COD/ m^3
Description:	COD concentration of the wastewater entering the new anaerobic digester system
Measured/ Calculated / Default:	The test shall be done and recorded in mg/l by the quality control staff. The value is later converted to kg COD/ m^3
Source of data:	Log sheet

Value(s) of monitored parameter:	**Monitoring period** / **Average value (kg COD/ m^3)**: 01/01/2013 – 20/08/2013 / 21.389
Monitoring equipment:	SCADA representation / Tag no.: n/a / PD-CL-001 Equipment Type: Portable Colorimeter Manufacturer: Hach Model: DR/890 Maximum permissible error: ±0.24% Serial No.: 070890C64902 Calibration Frequency: Annually Date of latest calibration: 30/10/2012 Validity: 29/10/2013
Measuring/ Reading/ Recording frequency:	The samples are taken every two hours and the analysis is performed twice a day on the composite sample. This procedure is followed during the monitoring period.
Calculation method (if applicable):	The daily COD data in kg COD/m^3 is multiplied by the daily wastewater flow to estimate the COD load on a daily basis. The approach is transparently applied in the excel sheet.
QA/QC procedures:	The Standard Solution Method is used for accuracy check of the on-site measurements. Periodic test is carried out by an accredited laboratory/company in order to provide quality assurance.
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM0022 ID 4** **Wastewater organic material concentration leaving the project treatment facility**
Unit:	kg COD/ m^3
Description:	COD concentration of the wastewater leaving the new anaerobic digester system
Measured/ Calculated / Default:	The test shall be done and recorded in mg/l by the quality control staff. The value is later converted to kg COD/ m^3
Source of data:	Log sheet
Value(s) of monitored parameter:	**Monitoring period** / **Average value (kg COD/ m^3)**: 01/01/2013 – 20/08/2013 / 1.965
Monitoring equipment:	SCADA representation / Tag no.: n/a / PD-CL-001 Equipment Type: Portable Colorimeter Manufacturer: Hach Model: DR/890 Maximum permissible error: ±0.24% Serial No.: 070890C64902 Calibration Frequency: Annually Date of latest calibration: 30/10/2012 Validity: 29/10/2013
Measuring/ Reading/ Recording frequency:	The samples are taken every day and the analysis is performed twice a day on the composite sample. This procedure is followed during the monitoring period.
Calculation method (if applicable):	The daily COD data in kg COD/m^3 is multiplied by the daily wastewater flow to estimate the COD load on a daily basis. The approach is transparently applied in the excel sheet.

QA/QC procedures:	The Standard Solution Method is used for accuracy check of the on-site measurements. Periodic test is carried out by an accredited laboratory/company in order to provide quality assurance.
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM022 ID 5** **Volume of biogas sent to facility heaters**
Unit:	Nm^3 biogas
Description:	Volume of biogas sent to facility heaters
Measured/ Calculated / Default:	Measured continuously (normalized to take into account pressure and temperature) by gas flow meters
Source of data:	Boiler Log sheet
Value(s) of monitored parameter:	**Monitoring period** / **Total value (Nm^3)** 01/01/2013 – 20/08/2013 / 1,777,332
Monitoring equipment:	Representation / Tag no.: FT501 / PD-DM-003 Equipment Type: Differential flow meter Manufacturer: Yokogawa Model: EJX110A-EMS5G-719DN Maximum permissible error: ±0.04% Serial No.: 91FA19282639 Calibration Frequency: Annually Date of latest calibration: 19/10/2012 Validity: 18/10/2013
Measuring/ Reading/ Recording frequency:	The meter has continuous monitoring of the biogas flow sent to boiler. The meter readings are recorded in the boiler log sheet by the operator at the starch factory on a daily basis.
Calculation method (if applicable):	n/a
QA/QC procedures:	Gas flow meter is undergone maintenance / calibration subject to appropriate industry standards. In case of technical problems with the meter, value can be calculated based on a mass balance using the other installed gas meters (biogas sent to heaters = total biogas produced – biogas sent to flare – biogas sent to engine). However, this approach was not applied during the monitoring period since there were no problems with the meter.
Purpose of data:	Calculation of baseline emissions

Data / Parameter:	**AM0022 ID 7** **Electricity generated from collected biogas**
Unit:	MWh
Description:	Electricity generated from the biogas collected in the anaerobic treatment facility and consumed on site or sent to the grid
Measured/ Calculated / Default:	Measured continuously in kWh
Source of data:	Log sheet
Value(s) of monitored parameter:	**Monitoring period** / **Total value (MWh)** 01/01/2013 – 20/08/2013 / 5,915.75

Monitoring equipment:	

Location	Generator A
SCADA representation / Tag no.	n/a / PD-PM-001
Equipment Type	Power meter
Manufacturer	DEIF
Model	Multi – Line PPU/2/GS
Maximum permissible error	Class 1.0, ±1.00%
Serial No.	A010393
Calibration Frequency	Annually
Date of latest calibration	27/10/2012
Validity	26/10/2013

Location	Generator B
SCADA representation / Tag no.	n/a / PD-PM-002
Equipment Type	Power meter
Manufacturer	DEIF
Model	Multi – Line PPU/2/GS
Maximum permissible error	Class 1.0, ±1.00%
Serial No.	A004997
Calibration Frequency	Annually
Date of latest calibration	27/10/2012
Validity	26/10/2013

Measuring/ Reading/ Recording frequency:	The equipment has continuous monitoring of the electricity generated. The accumulated reading shall be taken from the meter in the generator room and recorded in the log sheet by the operator on a daily basis.
Calculation method (if applicable):	n/a
QA/QC procedures:	Electricity meters would undergo maintenance / calibration subject to appropriate industry standards.
Purpose of data:	Calculation of project emissions

Data / Parameter:	**AM0022 ID 8** **Fossil fuel volume equivalent to generate same amount of heat generated from the biogas collected in the anaerobic treatment facility**
Unit:	m^3
Description:	Fossil fuel volume equivalent to generate same amount of heat generated from the biogas collected in the anaerobic treatment facility
Measured/ Calculated / Default:	Calculated
Source of data:	Value in m^3 unit Calculated based on amount of biogas sent to the boiler (ID 5), 0.5743 kg of HFO/m^3 biogas (referred to section B.6.1 of the registered PDD) and heavy fuel density of 0.995 kg/l (referred to section B.6.1 of the registered PDD). Value in ton unit Calculated based on amount of biogas sent to the boiler (ID 5), NCV of heavy fuel oil and NCV of biogas.
Value(s) of monitored parameter:	

Monitoring period	**Total value (m^3)**
01/01/2013 – 20/08/2013	1,025.85

Monitoring period	**Total value (tons)**
01/01/2013 – 20/08/2013	1,041.76

Monitoring equipment:	The calculation of this parameter is based on the amount of biogas sent to the boiler which is measured by using the same equipment as ID 5
Measuring/ Reading/ Recording frequency:	The calculation for the data is done on a daily basis. The approach is transparently applied in the excel sheet.
Calculation method (if applicable):	The quantity of biogas used at boiler is multiplied by 0.5743. Then divided by the density of heavy fuel oil to get the volume of heavy fuel oil in m^3. The quantity of biogas used at boiler is multiplied by NCV of biogas. Then divided by NCV of heavy fuel oil to get the volume of heavy fuel oil in ton.
QA/QC procedures:	n/a
Purpose of data:	The data in term of ton unit is used for calculation of baseline emissions

Data / Parameter:	**AM0022 ID 9** **Biogas sent to flares (V1)**
Unit:	Nm^3 biogas
Description:	Surplus biogas sent to flare system (dry basis)
Measured/ Calculated / Default:	Measured continuously (normalized to take into account pressure temperature) by gas flow meters. In the CDM Monitoring Sheet, the data in Nm3/day can be done by the following Data in day 'x' = (totalizer in day 'x') - (totalizer in day 'x-1')
Source of data:	Log sheet
Value(s) of monitored parameter:	**Monitoring period** / **Total value (Nm^3)** 01/01/2013 – 20/08/2013 / 4,286
Monitoring equipment:	SCADA representation / Tag no.: FT105 / PD-DM-002 Equipment Type: Differential flow meter Manufacturer: ABB Model: 265DS CCFA6B1 Maximum permissible error: ±0.04% Serial No.: 265DS6600065941 Calibration Frequency: Annually Date of latest calibration: 19/10/2012 Validity: 18/10/2013
Measuring/ Reading/ Recording frequency:	The meter has continuous monitoring of the biogas flow sent to flare system. The accumulated reading is recorded in the log sheet by the operator on a daily basis.
Calculation method (if applicable):	n/a
QA/QC procedures:	Flow meter is undergone maintenance / calibration subject to appropriate industry standards. In case of technical problems with the meter, value can be calculated based on a mass balance using the other installed gas meters (biogas sent to flare = total biogas produced – biogas sent to boiler – biogas sent to engines). However, this approach was not applied during the monitoring period since there were no problems with the meter.
Purpose of data:	Calculation of project emissions

<table>
<tr><td>Data / Parameter:</td><td>AM0022 ID 10
Biogas sent to generation</td></tr>
<tr><td>Unit:</td><td>Nm^3 biogas</td></tr>
<tr><td>Description:</td><td>Biogas sent to generation facility and used for electricity generation</td></tr>
<tr><td>Measured/
Calculated /
Default:</td><td>Measured continuously (normalized to take into account pressure temperature) by gas flow meters.

In the CDM Monitoring Sheet, the data in Nm3/day can be done by the following

Data in day ‘x’ = (totalizer in day ‘x’) - (totalizer in day ‘x-1’)</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>01/01/2013 – 20/08/2013</td><td>2,855,966</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Location</td><td>Generator A</td></tr>
<tr><td>SCADA representation / Tag no.</td><td>FT501A / PD-DM-004</td></tr>
<tr><td>Equipment Type</td><td>Differential flow meter</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>265DS CCFA6B1</td></tr>
<tr><td>Maximum permissible error</td><td>±0.04%</td></tr>
<tr><td>Serial No.</td><td>265DS6600032493</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of latest calibration</td><td>19/10/2012</td></tr>
<tr><td>Validity</td><td>18/10/2013</td></tr>
</table>
<table>
<tr><td>Location</td><td>Generator B</td></tr>
<tr><td>SCADA representation / Tag no.</td><td>FT501B / PD-DM-005</td></tr>
<tr><td>Equipment Type</td><td>Differential flow meter</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>265DS CCFA6B1</td></tr>
<tr><td>Maximum permissible error</td><td>±0.04%</td></tr>
<tr><td>Serial No.</td><td>265DS6600028459</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of latest calibration</td><td>19/10/2012</td></tr>
<tr><td>Validity</td><td>18/10/2013</td></tr>
</table>
</td></tr>
<tr><td>Measuring/
Reading/
Recording frequency:</td><td>The meters have continuous monitoring of the biogas flow sent to generation facility. The accumulated reading is 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>Flow meters are undergone maintenance / calibration subject to appropriate industry standards.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of project emissions</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>AM0022 ID11
Biogas methane concentration</td></tr>
<tr><td>Unit:</td><td>%</td></tr>
<tr><td>Description:</td><td>Methane concentration in biogas</td></tr>
</table>

Measured/ Calculated / Default:	Measured continuously. The average of data is done for representing the data of the day
Source of data:	Log sheet
Value(s) of monitored parameter:	**Monitoring period**: 01/01/2013 – 20/08/2013; **Average value (%)**: 63.75
Monitoring equipment:	Period used: since 13/05/2011 SCADA representation / Tag no.: AIT101 / n/a Equipment Type: CH4 Analyzer Manufacturer: Drager Model: Polytron IR EX Maximum permissible error: ±1.00% Serial No.: ARCC-0038 Calibration Frequency: Annually Date of latest calibration: 22/12/2012 Validity: 21/12/2013
Measuring/ Reading/ Recording frequency:	Percentage of methane in gas is monitored on minute by minute basis and daily average is used in CDM Monitoring Sheet.
Calculation method (if applicable):	n/a
QA/QC procedures:	The gas analyzer is undergone maintenance / calibration subject to appropriate industry standards.
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM0022 ID 12** **Project emissions from flaring of the residual gas stream (PE_{flare})**
Unit:	t CO_2e
Description:	Project emissions from flaring of the residual gas stream
Measured/ Calculated / Default:	Calculated based on amount of biogas sent to the flare (ID 9), the flare efficiency, the methane concentration of biogas (ID 11), density of methane and GWP_{CH4}
Source of data:	Calculation
Value(s) of monitored parameter:	**Monitoring period**: 01/01/2013 – 20/08/2013; **Total value (t CO_2e)**: 40
Monitoring equipment:	The monitoring equipment for the amount of biogas sent to the flare is same as ID 9 The monitoring equipment for the methane concentration of biogas is same as ID 11
Measuring/ Reading/ Recording frequency:	The calculation for the data is done on a daily basis. The approach is transparently applied in the excel sheet.
Calculation method (if applicable):	The parameter is calculated according to the "Tool to determine project emissions from flaring gases containing methane", step 7 which the mass flow rate of methane in the residual gas ($TM_{RG,h}$) is calculated from ID 9, ID 11 and the density of methane.
QA/QC procedures:	n/a
Purpose of data:	Calculation of project emissions

Data / Parameter:	**AM0022 ID 13** **Amount of chemical oxidizing agents entering system boundary**
Unit:	tonnes/m^3
Description:	Amount of chemical oxidizing agents entering system boundary
Measured/ Calculated / Default:	Measured by the quality control operator The highest value is applied in the calculation for conservativeness.
Source of data:	Log sheet
Value(s) of monitored parameter:	

Monitoring period	Maximum value	
	mg/l	tonnes/m^3
01/01/2013 – 20/08/2013	1,506	1.506

Monitoring equipment:

SCADA representation / Tag no.	- / PD-CL-001
Equipment Type	Portable Colorimeter
Manufacturer	Hach
Model	DR/890
Maximum permissible error	±0.24%
Serial No.	070890C64902
Calibration Frequency	Annually
Date of latest calibration	30/10/2012
Validity	29/10/2013

Measuring/ Reading/ Recording frequency:	Daily test for waste water samples are carried out to determine the amount of oxidising agent entering the wastewater system. The daily test result is recorded in the log sheet on a daily basis
Calculation method (if applicable):	n/a
QA/QC procedures:	Regular samples are tested for concentration of oxidising agents where they are identified as being likely to be present in wastewater when they are part of the process.
Purpose of data:	Calculation of baseline and project emissions

Data / Parameter:	**AM0022 ID 14** **Gen set combustion efficiency (f)**
Unit:	%
Description:	Proportion of biogas combusted by generation facility
Measured/ Calculated / Default:	Measured and calculated by the project developer or the default value in the registered PDD can be used. The lowest value is applied in the project emission calculation for conservativeness.
Source of data:	Reports by third party or the registered PDD
Value(s) of monitored parameter:	

Monitoring period	Measured value (%)	
	Generator A	Generator B
01/01/2013 – 20/08/2013	99.9857%	99.9746%

Monitoring equipment:	**Generator A** **Period** / **Date of measurement** / **Done by** previous measurement / 23/02/2012 / United Analyst and Engineering Consultant Co.,Ltd. latest measurement / 09/03/2013 **Generator B** **Period** / **Date of measurement** / **Done by** previous measurement / 23/02/2012 / United Analyst and Engineering Consultant Co.,Ltd. latest measurement / 09/03/2013
Measuring/ Reading/ Recording frequency:	The measurement is conducted once a year
Calculation method (if applicable):	The reports are shown the result in ppm unit. The value of the combustion efficiency is as follows - conversion of unit from ppm to percentage of non-combusted methane and; - the figure is deducted from 100% to determine the combustion efficiency of the generators during the monitoring period.
QA/QC procedures:	Measurements to be conducted on the basis of standard industry practice
Purpose of data:	Calculation of project emissions
Additional comment:	For this monitoring period the default value of 99% is applied in the calculation of emission reductions for the sake of conservativeness.

Data / Parameter:	**AM0022 ID 15** **Heating system combustion efficiency**
Unit:	%
Description:	Combustion efficiency of boilers using biogas for heat generation
Measured/ Calculated / Default:	Measured and calculated by the project developer or the default value in the registered PDD can be used. The lowest value is applied in the project emission calculation for conservativeness.
Source of data:	Reports by third party or the registered PDD
Value(s) of monitored parameter:	**Monitoring period** / **Measured value (%)** 01/01/2013 – 20/08/2013 / 99.9997%
Monitoring equipment:	**Period** / **Date of measurement** / **Done by** previous measurement / 24/02/2012 / United Analyst and Engineering Consultant Co.,Ltd. latest measurement / 10/03/2013
Measuring/ Reading/ Recording frequency:	The measurement is conducted once a year

Calculation method (if applicable):	The reports are shown the result in ppm unit. The value of the combustion efficiency is as follows - conversion of unit from ppm to percentage of non-combusted methane and; - the figure is deducted from 100% to determine the combustion efficiency of the generators during the monitoring period.
QA/QC procedures:	Measurements to be conducted on the basis of standard industry practice
Purpose of data:	Calculation of project emissions
Additional comment:	For this monitoring period the default value of 98.5% is applied in the calculation of emission reductions for the sake of conservativeness.

Data / Parameter:	**AAM0022 ID 17** **Loss of biogas from pipeline**
Unit:	%
Description:	Loss of biogas from pipeline
Measured/ Calculated / Default:	The biogas pipeline is checked by using mobile gas detector
Source of data:	Report by the project developer
Value(s) of monitored parameter:	**Monitoring period**: 01/01/2013 – 20/08/2013; **Measured value (%)**: 0%
Monitoring equipment:	SCADA representation / Tag no.: - / PD-GD-001 Equipment Type: Portable gas detector Manufacturer: Industrial Scientific Model: MX4 Maximum permissible error: ±5% Serial No.: 10110R4-006 Calibration Frequency: Annually Date of latest calibration: 29/11/2012 Validity: 28/11/2013
Measuring/ Reading/ Recording frequency:	Weekly test for gas leakage is carried out by the operator which the test readings are recorded in the test report accordingly.
Calculation method (if applicable):	n/a
QA/QC procedures:	Checks to be carried out according to international standards.
Purpose of data:	Calculation of project emissions
Additional comment:	There were no leakages detected in this monitoring period.

Data / Parameter:	**AM0022 ID 18** **Organic material removed from wastewater facility**
Unit:	t COD
Description:	Organic material removed from wastewater facility
Measured/ Calculated / Default:	Measured by using weighing machine
Source of data:	Log sheet
Value(s) of monitored parameter:	There is no organic material removal during the monitoring period

Monitoring equipment:	

SCADA representation / Tag no.	n/a
Equipment Type	Weighing machine
Manufacturer	Linear
Model	PM02
Maximum permissible error	±20 kg
Serial No.	2005352
Calibration Frequency	Once in two years
Date of previous calibration	01/03/2011
Date of latest calibration	18/01/2013
Validity	17/01/2015

Measuring/ Reading/ Recording frequency:	The measurement shall be done when the organic material is removed from the reactors by using the weighing machine at the starch plant.
Calculation method (if applicable):	n/a
QA/QC procedures:	The weighing machine at the starch plant was undergone maintenance / calibration subject to appropriate industry standards.
Purpose of data:	Calculation of project emissions

Data / Parameter:	**AM0022 ID 19** **Biogas calorific value**
Unit:	J/Nm^3
Description:	Calorific value of biogas
Measured/ Calculated / Default:	Calculation based on the methane concentration of biogas (ID 11) and NCV of methane
Source of data:	ID 11 and NCV of methane
Value(s) of monitored parameter:	

Monitoring period	**Average value (MJ/Nm^3)**
01/01/2013 – 20/08/2013	22.61

Monitoring equipment:	The methane concentration of biogas is same as ID 11
Measuring/ Reading/ Recording frequency:	The calculation for the data is done on a daily basis. The approach is transparently applied in the excel sheet.
Calculation method (if applicable):	The methane concentration of biogas is multiplied by the NCV of methane
QA/QC procedures:	n/a
Purpose of data:	Calculation of baseline emissions

Data / Parameter:	**Flame detection period**
Unit:	Min
Description:	Amount of minutes per hour where a flame is detected, whenever biogas is sent to the flare. If flame is detected for less than 20 minutes in an hour (whenever biogas is sent to flare), flare efficiency is assumed to be 0%. Otherwise flare efficiency is assumed to be 50%.
Measured/ Calculated / Default:	Measured based on flame detection signals by flare
Source of data:	Electronic files from Data logger

Value(s) of monitored parameter:	The samples of electronic file shall be provided during the site visit for the available of data and the estimated amount of minutes per hour where a flame is detected
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:	The flame detection period shall be compared to the period of biogas being sent to the flare. The flare efficiency is determined based on the ratio of these two values in analogy to the default value determination method.
Calculation method (if applicable):	n/a
QA/QC procedures:	n/a
Purpose of data:	Calculation of project emissions
Additional comment:	For the sake of conservativeness the flare efficiency was assumed as 0% during this monitoring period.

Data / Parameter:	**Period of biogas being sent to the flare**
Unit:	Min
Description:	Amount of minutes per hour where biogas is sent to the flare
Measured/ Calculated / Default:	Measured/calculated based on SCADA records of biogas flow meter at the entrance of the flare
Source of data:	Electronic files from Data logger
Value(s) of monitored parameter:	The samples of electronic file shall be provided during the site visit for the available of data and the estimated amount of minutes per hour where biogas is sent to the flare.
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:	Calculation of project emissions
Additional comment:	For the sake of conservativeness the flare efficiency was assumed as 0% during this monitoring period.

D.3. Implementation of sampling plan

>> The section is left blank intentionally.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>> The baseline scenario is based on what would have happened in the absence of the project activity. In

this case, the baseline scenario is continued operation of the open anaerobic lagoon system, consumption of HFO for thermal energy generation and of electricity from the grid:

Formula (8) AM0022 v4, baseline scenario:

$$E_{BL} = E_{CH4\ lagoons\ BL} + E_{CO2\ heat\ BL} + E_{CO2\ power\ BL} \quad (8)$$

Where:

E_{BL}	are the Total Baseline Emission (tCO_2e)
$E_{CH4\_lagoons\_BL}$	are the fugitive methane emissions from lagoons in the baseline case (tCO_2e). They are calculated with baseline data based on equation 2 in the section on project emissions.
$E_{CO2\_heat\_BL}$	are the CO_2 emissions from on site fossil heat and/or power generation in the baseline case (tCO_2) that are displaced by generation based on biogas collected in the anaerobic treatment facility.
$E_{CO2\_power\_BL}$	are the CO_2 emissions related electricity supplied by the grid in the baseline case (tCO_2) that are displaced by generation based on biogas collected in the anaerobic treatment facility

Formula 8 (baseline)	**2013 1 Jan - 20 Aug**
$E_{CH4\_lagoons\_BL}$ (tCO_2e)	35,064
$E_{CO2\_heat\_BL}$ (tCO_2e)	3,258
$E_{CO2\_power\_BL}$ (tCO_2e)	2,655
E_{BL} (tCO_2e)	**40,976**

1) <u>Fugitive methane emissions from lagoons ($E_{CH4\ lagoon\ BL}$)</u>

Methane emissions from lagoons are calculated using equations (2), (3), (5) and (6). In the baseline case, without the new anaerobic treatment facility, no wastewater material degrades before entering the lagoon system and all the organic material to be treated enters the lagoons system. Therefore, equation (4) has to be changed for the baseline calculations as shown below:

Formula (11) AM0022 v4, baseline scenario:

$$M_{lagooon\ input\ BL} = M_{input\ total} \quad (11)$$

Where:

$M_{lagooon\_input\_BL}$	is the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system
$E_{CO2\_power\_BL}$	are the CO_2 emissions related electricity supplied by the grid in the baseline case (tCO_2) that are displaced by generation based on biogas collected in the anaerobic treatment facility
M_{input_total}	is the total amount of organic material fed into the baseline wastewater treatment facility

All emission factors for surface aerobic losses of organic material, aerobic degradation, deposition or removal as well as chemical oxidation are determined in the same way as described for project emissions calculations.

Formula 11 (baseline)	2013 1 Jan - 20 Aug
M_{input_total} (kg COD)	10,710,908
$M_{lagoon\_input\_BL}$ (kg COD)	**10,710,908**

2) <u>On site heat generation emissions displaced by generation based on biogas collected in the anaerobic treatment facility ($E_{CO2\_heat\_BL}$)</u>

In calculating CO_2 emissions from on site heat displaced by biogas collected in the anaerobic treatment, the use of fossil fuels (HFO) is considered:

Formula (9) AM0022 v4, baseline scenario:

$$E_{CO2\ heat} = F * NCV * EF \quad (9)$$

Where:

F	is the corresponding amount of fossil fuel used for on-site heat generation (tons of HFO)
NCV	is the net calorific value of the fossil fuel considered (HFO) in (TJ/t). The default IPCC value of 0.0404 TJ/t from the 2006 IPCC guidelines for National GHG Inventories is applied.
EF	is the carbon emission factor of the fossil fuel considered (HFO) in (tCO_2/TJ). According to the 2006 IPCC guidelines for National GHG Inventories, this value is 77.40 tCO_2/TJ.

Formula 9 (baseline)	2013 1 Jan - 20 Aug
V_{heat} (Nm^3)	1,777,332
F (t)	1,041.76
F_biogas_HFO (tHFO/Nm^3)	0.00056
NCV (MJ/Nm^3) - Methane	35.94
Methane Percentage	63.75%
NCV (MJ/Nm^3) - Biogas	22.61
NCV (TJ/t) - Fuel oil	0.0404
EF (tCO_2/TJ)	77.4
E_{CO2_heat} (tCO_2e)	**3,258**

3) Off-site grid power generation emissions displaced by generation based on biogas collected in the anaerobic treatment facility ($E_{CO2\_power\_BL}$)

Formula (10) AM0022 v4, baseline scenario:

$$E_{CO2\_power} = EL * CEF \quad (10)$$

Where:

EL — is the amount of electricity displaced by the electricity generation from the biogas collected from the anaerobic treatment facility. This is estimated as product of: (1) average specific electricity consumption for the output of the facility, estimated using 3 years historical data: and (2) the annual production.

CEF — is the carbon emission factor for the electricity displaced by the electricity generated from the biogas. (tCO_2e/MWh)

Formula 10 (baseline)	2013 1 Jan - 20 Aug
EL (MWh)	5,105.03
CEF (tCO_2/MWh)	0.52
E_{CO2_power} (tCO_2e)	**2,655**

E.2. Calculation of project emissions or actual net GHG removals by sinks

>> Total estimated project emissions are the sum of fugitive methane emissions from the existing lagoon-based water treatment system, from possible methane emissions from the new anaerobic waste water treatment facility, from incomplete biogas combustion and biogas leaks.

Formula (1) AM0022 v4, project scenario:

$E_{project} = E_{CH4\ lagoons} + E_{CH4\ NAWTF} + E_{CH4\ IC+Leaks}$ (1)

Where:

$E_{project}$ are the Total Project Emissions (tCO_2e)

$E_{CH4\_lagoons}$ are the fugitive methane emissions from the new anaerobic wastewater treatment facility (tCO_2e)

$E_{CH4\ IC+Leaks}$ are the methane emissions from inefficient combustion and leaks (tCO_2e)

Formula 1	2013 1 Jan - 20 Aug
$E_{CH4\_lagoons}$ (tCO_2e)	0
E_{CH4_NAWTF} (tCO_2e)	351
$E_{CH4\_IC+Leaks}$ (tCO_2e)	570
$E_{project}$ (tCO_2e)	**921**

The calculations for each component of equation (1) are provided below.

1) Fugitive Methane Emissions from Lagoons in the project scenario ($E_{CH4\ lagoons}$)

The treated digester effluent is discharged into the old lagoon based system for final treatment. While the residual organic load of the digester is low and removal of the residual COD in the lagoons is expected to occur under aerobic conditions. Fugitive Methane Emissions from the lagoons are calculated assuming mostly anaerobic conditions, which is conservative.

Formula (2) AM0022 v4, project scenario:

$E_{CH4\ lagoons} = M_{lagoon\ anaerobic} * EF_{CH4} * GWP_{CH4} / 1000$ (2)

Where:

$M_{lagoon\_anaerobic}$ is the amount of organic material removed by anaerobic processes in the lagoon system (kgCOD).

EF_{CH4} is the methane emission factor (kgCH4/kgCOD). 0.21 kgCH4/kgCOD of COD to Methane conversion factor is used.

GWP_{CH4} is the Global Warming Potential of methane (GWP_{CH4} = 21)

Formula 2 (project)	2013 1 Jan - 20 Aug
$M_{lagoon\_anaerobic\_PJ}$ (kg COD)	0
EF_{CH4} (kg CH_4/kg COD)	0.21
GWP_{CH4} (tCO_2e/tCH_4)	21
$E_{CH4\_lagoons\_PJ}$ (tCO_2e)	**0**

Amount of organic material removed by anaerobic processes in the lagoon system ($M_{lagoon\_anaerobic}$)

Formula (3) AM0022 v4, project scenario:

$$M_{lagoon\ anaerobic} = M_{lagoon\ total} - M_{lagoon\ aerobic} - M_{lagoon\ chemical\ ox} - M_{lagoon\ deposit} \quad (3)$$

Where:

M_{lagoon_total}	is the total amount of organic material removed in the lagoon system from equation (5) (kgCOD)
$M_{lagoon\_aerobic}$	is the amount of organic material degraded aerobically in the lagoon system (kg COD). Surface aerobic losses of organic material in pond based systems equal to 254 kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processed.
$M_{lagoon\_chemical\_ox}$	is the amount of organic material lost through chemical oxidation in the lagoon system (kg COD)
$M_{lagoon\_deposit}$	is the amount of organic material lost through deposition in the lagoon system from equation (6) (kg COD)

Formula 3 (project)	2013 1 Jan - 20 Aug
$M_{lagoon\_total\_PJ}$ (kg COD)	1,059,309
$M_{lagoon\_aerobic\_PJ}$ (kg COD)	1,407,058
$M_{lagoon\_chemical\_ox\_PJ}$ (kg COD)	479,973
$M_{lagoon\_deposition\_PJ}$ (kg COD)	75,512
$M_{lagoon\_anaerobic\_PJ}$ (kg COD)	**0**

Amount of organic material removed in the lagoon system ($M_{lagoon\ total}$)

Formula (5) AM0022 v4, project scenario:

$$M_{lagoon\ total} = M_{lagoon\ input} * R_{lagoon} \quad (5)$$

with Formula (4) AM0022 v4, project scenario:

$M_{lagoon\ input} = M_{input\ total} * (1 - R_{NAWTF})$ (4)

Where:

M_{lagoon_input}	is the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
R_{lagoon}	is the total organic material removal ratio of the lagoon. It is a project specific factor, and is equal to the proportion of organic material removed (though all route) within the boundarie of the lagoon system under consideration.
M_{input_total}	is the total amount of organic material fed into the new project wastewater treatment facility (kg COD)
R_{NAWTF}	is the total organic material removal efficiency of the new project wastewater treatment facility. The manufacture's guaranteed COD removal ratio of 90% (according to the technical proposal) is used as a project specific value.

The Total Organic Removal Ratio (R_{lagoon}) factor has been determined according to Appendix 2 of AM0022, Version 04 by undertaking a series of chemical analyses based on COD samples at the inlet and the outlet of the lagoon system boundary. Based on the results of the chemical analysis, the Total Organic Removal Ratio is calculated as average value of the test series as follows:

$R_{lagoon} = ((COD_{in} - COD_{out}) / COD_{in})_{average}$

Where:

COD_{in}	is the COD concentration of the wastewater at the inlet of the lagoon system
COD_{out}	is the COD concentration of the wastewater at the outlet of the lagoon system

The series of collected COD samples at the inlet and outlet of the lagoon system indicate an average Total Organic Removal Ratio (R_{lagoon}) of 98.9% (see Appendix 1 for more details).

Formula 4 (project)	**2013 1 Jan - 20 Aug**
M_{input_total} (kg COD)	10,710,908
R_{NAWTF} (%)	90.00%
$M_{lagoon\_input\_PJ}$ (kg COD)	**1,071,091**

Formula 5 (project)	**2013 1 Jan - 20 Aug**
R_{lagoon} (%)	98.9%
$M_{lagoon\_input\_PJ}$ (kg COD)	1,071,091
$M_{lagoon\_total\_PJ}$ (kg COD)	**1,059,309**

Amount of organic material degraded aerobically in the lagoon system ($M_{lagoon\ aerobic}$)

The amount of organic material degraded aerobically in the lagoon system is calculated as the product of the AM0022, Version 04 default value for surface aerobic losses of organic material in pond based systems

(254 kg COD/ha/day), total surface area of the lagoons (25.18 ha) and number of days in a year (365 days). Although no explicit equation is provided in AM0022, Version 04, following formula is applied:

$M_{lagoon\ aerobic} = COD_{loss\ aerobic} \times A_{lagoon\ surface} \times dd_{year}$

Where:

$COD_{loss\_aerobic}$	is the default value for surface aerobic losses of organic material (254 kg COD/ha/day)
$A_{lagoon\ surface}$	is the total surface area of the lagoon based wastewater treatment system (in ha)
dd_{year}	is the number of days per year (in days)

$M_{lagoon\ aerobic}$ = 254 (kg COD/ha/day) x 25.18 (ha) x 365 day/yr = 2,334,438 kg COD/year

As per the methodology, sensitivity analysis is conducted in order to determine the effect of change in the surface aerobic loss of COD to the emission reductions. The results of the sensitivity analysis indicate that the default value of 254 kg COD/ha/day) is appropriate for emission reduction calculations (see Appendix 1 for details).

	2013 1 Jan - 20 Aug
Surface loss (kg COD/ha/day)	254
Area of lagoon (ha)	25.18
dd year (days)	220
$M_{lagoon\_aerobic\_PJ}$ (kg COD)	**1,407,058**

Amount of organic material lost through chemical oxidation in the lagoon system ($M_{lagoon\ chemical\ ox}$)

The amount of organic material lost through chemical oxidation in the lagoon system is calculated based on guidance provided in Appendix 2 of AM0022, Version 04. Although no explicit equation is provided, following formula is applied:

$M_{lagoon\ chemical\ ox} = WW_{in} \times SO_4^{2-}{}_{concentration} \times COD_{loss\ chem\ ox}$

Where:

WW_{in}	wastewater flow entering system boundaries in m^3/yr
$SO_4^{2-}{}_{concentration}$	sulphate (Q_{ox}) concentration in kg Q_{ox} /m^3
$COD_{loss\ chem\ ox}$	COD removal factor in kg COD/kg Q_{ox} (0.651 kg COD/kg SO_4^{2-})

	2013 1 Jan - 20 Aug
WW_{in_PJ} (m^3/yr)	489,566
Sulphate conc. (kg Qox/m^3)	1.506
$COD_{loss\_chem\_ox}$ (kgCOD/kgSO_4^{2-})	0.651
$M_{lagoon\_chemical\_ox\_PJ}$ (kg COD)	**479,973**

Amount of organic material lost through deposition in the lagoon system ($M_{lagoon\ deposition}$)

Formula (6) AM0022 v4, project scenario:

$$M_{lagoon\ deposition} = M_{lagoon\ input} * R_{deposition} \quad (6)$$

Where:

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

A series of experiments described in detail under Appendix 1 show that the average Organic Material Deposition Ratio ($R_{deposition}$) is determined based on a conservative approach as 7.05%.

Formula 6 (project)	2013 1 Jan - 20 Aug
$M_{lagoon\_input\_PJ}$ (kg COD)	1,071,091
$R_{deposition}$ (%)	7.05%
$M_{lagoon\_deposition\_PJ}$ (kg COD)	**75,512**

2) Methane emissions from new anaerobic waste water treatment facility (E_{CH4_NAWTF})

Methane emissions from the specific anaerobic wastewater treatment facilities that are installed by the Project, are assessed and estimated based on monitoring measurements, technology supplier data and expert estimates. They may be disregarded if documented evidence for their insignificance is given.

The technology provider, GLOBAL WATER ENGINEERING (GWE) LTD., has estimated based on their experience that the physical leakage from the UASB system is less than 1% for systems with similar size and design to the project activity. To ensure conservativeness, physical leakage factor of 1% of total biogas production is used for the Project activity.

Although no explicit formula is provided under AM0022, Version 04 for calculation of methane emissions from the new anaerobic wastewater treatment facility ($E_{CH4\ NAWTF}$), following formula is applied:

$E_{CH4\ NAWTF} = (E_{CH4\ lagoon\ BL} - E_{CH4\ lagoon}) \times F_{leakage\ NAWTF}$

Where:

$E_{CH4\ lagoon\ BL}$	are the fugitive methane emissions from lagoons in the baseline scenario (t CO_2e)
$E_{CH4\ lagoon}$	are the fugitive methane emissions from lagoons in the project scenario (t CO_2e)
$F_{leakage\ NAWTF}$	is the leakage factor for the new wastewater treatment system (1%)

	2013 1 Jan - 20 Aug
$E_{CH4\_lagoons\_BL}$ (tCO_2e)	35,064
$E_{CH4\_lagoons\_PJ}$ (tCO_2e)	0
$F_{leakage\_NAWTF}$ (%)	1%
E_{CH4_NAWTF} (tCO_2e)	**351**

3) Methane emissions from inefficient combustion emissions ($E_{CH4\ IC+Leaks}$)

The project involves on site heat and electricity generation and biogas flaring (in case of excess biogas production or technical problems related to the heat and electricity generation equipment).

Formula (7) AM0022 v4, project scenario:

$$E_{CH4\ IC+Leaks} = (\sum_r V_r * C_{CH4\ r} * (1- f_r) * GWP_{CH4}) + PE_{flare} \quad (7)$$

Where:

the sum	is made over two routes r for methane destruction (heating and power generation)
V_r	is the biogas combustion process volume in route r (Nm^3)
$C_{CH4\ r}$	is the methane concentration in biogas (tCH_4/Nm^3)
f_r	is the proportion of biogas destroyed by combustion (-)
PE_{flare}	are the project emissions from flaring of the residual gas stream (tCO_2e) calculated following the procedures described in the "Tool to determine project emissions from flaring gases containing Methane". PE_{flare} can be calculated on an annual basis or for the required period of time using this tool.

The values applied as "proportion of biogas destroyed by combustion" are 98.5% for the heat generation equipment (f_{boiler}) and 99% for the electricity generation equipment (f_{engine}).

Among the options for flaring systems, an open flare system is chosen by the project participants. For the determination of the flare efficiency, the default values for open flares proposed in the "Tool to determine project emissions from flaring of gases containing methane" are used for the calculation of project emissions from flaring gases. Following equations from the flaring tool are used to determine the project emissions from flaring of the residual gas stream.

Formula 7 (project)	2013 1 Jan - 20 Aug
Biogas sent to flare V_1 (Nm^3)	4,286
Methane Percentage	63.75%
$p_{CH4,n}$ (kg/Nm^3)	0.716
$\eta_{flare,h}$ (%)	0%
GWP_{CH4} (tCO_2e/tCH_4)	21
PE_{flare} (tCO_2e)	**41**

f_{heat}: the test was done on 10/03/2013 for the exhaust gas analysis provides the percentage of un-burnt hydrocarbon in the exhaust gas.

2013

The result from the report is 25.75 ppm at actual oxygen levels

25.75 ppm = 25.75 in 1,000,000 units = 25.75 * 10^{-6} = 0.002575% of non-combustion

Therefore, the combustion efficiency is 99.9974%.

The ex-ante value of the PDD (98.5%) being lower than the test report value results in higher project emissions. The PDD value is thus used for conservativeness.

f_{elec}: the test for two generators was done on 09/03/2013 for the exhaust gas analysis provides the percentage of un burnt hydrocarbon in the exhaust gas.

2013

Generator A:

The result of combustion efficiency from the report is 39 ppm at actual oxygen levels

39 ppm = 39 in 1,000,000 unit = 0.000039 = 0.0039% of non-combustion

Therefore, the combustion efficiency is 99.9961%.

Generator B:

The result of combustion efficiency from the report is 68.60 ppm at actual oxygen levels

68.60 ppm = 68.60 in 1,000,000 unit = 0.0000686 = 0.00686% of non-combustion

Therefore, the combustion efficiency is 99.9931%.

The ex-ante value of the PDD (99%) being lower than the test report value results in higher project emissions. The PDD value is thus used for conservativeness.

Formula 7 (project)	2013 1 Jan - 20 Aug
V_{heat} (Nm^3)	1,777,332
Methane Percentage	63.75%
$p_{CH4,n}$ (kg/Nm^3)	0.716
f_{boiler} (%)	98.50%
GWP_{CH4} (tCO_2e/tCH_4)	21
$E_{CH4\_IC\_heat}$ (tCO_2e)	**256**

Formula 7 (project)	2013
V_{elec} (Nm^3)	2,855,966
Methane Percentage	63.75%
$p_{CH4,n}$ (kg/Nm^3)	0.716
f_{engine} (%)	99%
GWP_{CH4} (tCO_2e/tCH_4)	21
$E_{CH4\_IC\_elec}$ (tCO_2e)	**274**

4) Methane Emissions from Leaks in Biogas System

Leaks in the biogas system include leaks from the anaerobic digester and leaks from the biogas pipeline delivery system. The UASB reactor gas collection system consists of a gas-tight concrete, coated gas dome and the biogas pipeline is made of stainless steel (AISI 304) and approximately 385 m long. Given the short length of the biogas pipeline (as compared to the reference value of 2 km provided in AM0022, Version 04) and the utilisation of high quality materials, emissions from leaks in the biogas system are assumed to be negligible.

E.3. Calculation of leakage

>> As determined in AM0022, Version 04, leakage is considered to be negligible.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	40,976	921	0	40,055

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	64,979	40,055

E.6. Remarks on difference from estimated value in registered PDD

>> The actual emission reduction achieved during this monitoring period is less than the values estimated in ex-ante calculation of the registered PDD.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	-	40,055

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Appendix 1

Laboratory results and calculation of project specific parameters required to determine baseline and project emissions related to anaerobic COD removal in the lagoon based wastewater treatment system

Total Organic Removal Ratio

Table 3 Organic material removal ratio

Sample No.	Parameter	Unit	Method	Waste water inlet	Waste water outlet	Organic mat. Removal ratio (Rlagoon)	Remarks
1	COD total	mg/L	Open Reflux, Titrimetric	16286	201	98.77%	sample16/11/07
2	COD total	mg/L	Open Reflux, Titrimetric	17048	201	98.82%	sample17/11/07
3	COD total	mg/L	Open Reflux, Titrimetric	17303	201	98.84%	sample15/11/07
4	COD total	mg/L	Open Reflux, Titrimetric	18168	207	98.86%	sample 13/11/07
5	COD total	mg/L	Open Reflux, Titrimetric	35385	393	98.89%	sample 04/06/08
6	COD total	mg/L	Open Reflux, Titrimetric	33846	374	98.89%	sample 02/06/08
7	COD total	mg/L	Open Reflux, Titrimetric	34359	377	98.90%	sample 31/05/08
8	COD total	mg/L	Open Reflux, Titrimetric	36410	397	98.91%	sample 06/06/08
9	COD total	mg/L	Open Reflux, Titrimetric	37949	374	99.01%	sample 29/05/08
10	COD total	mg/L	Open Reflux, Titrimetric	22510	205	99.09%	sample14/11/07
Average	**COD total**	**mg/L**	**Open Reflux, Titrimetric**	**26926.4**	**293**	**98.90%**	

Test by : Test Tech Co.,Ltd

Average Total Organic Removal Ratio (Rlagoon) based on the test series above:

R_{lagoon} = 98.9 %

COD lost by deposition

The procedure for the measurement of COD lost by deposition is as follows:

(1) Samples of untreated effluent are collected at the inlet of the system boundaries.

(2) COD is measured for each sample taken before any deposition occurs.

(3) The wastewater is put in a funnel-shaped flask and left until the level of sediment does not change.

(4) After removing the sediment, COD is measured again.

(5) The difference between COD before the sedimentation and after the sedimentation is considered as the COD lost by deposition.

This approach is considered to be conservative since the non-soluble COD content of the effluent is allowed to sediment without any disturbance in the flask, leading to an ideal deposition rate. In reality, anaerobic pond dynamics would lead to mixing within the lagoon, which would disturb the sedimentation process keeping the organic material in the anaerobically active zone of the lagoon. Quote from AM0022, Appendix 2, p. 32: “In parallel the conditions in the pond system under investigation must also be assessed to characterize the pond dynamics in relation to mixing. Some ponds will be so anaerobically active as to keep alls material that would sediment in a state of permanent suspension, this material is then anaerobically degraded.”

The Organic Material Deposition Ratio ($R_{deposition}$) has been determined based on the test results provided in the table below:

COD lost by deposition

Table 4 COD lost by deposition

Sample No.	COD before deposition	COD after deposition	COD lost by deposition	COD deposition ratio (Rdeposit)	Remarks
	mg/L	mg/L	mg/L	%	
1	23738	22349	1389	5.85%	sample 22/10/07
2	20265	19445	820	4.05%	sample 23/10/07
3	22727	19886	2841	12.50%	sample 24/10/07
4	22349	20707	1642	7.35%	sample 25/10/07
5	22917	20707	2210	9.64%	sample 26/10/07
6	17303	16285	1018	5.88%	sample15/11/07
7	16286	15522	764	4.69%	sample16/11/07
8	17048	16285	763	4.48%	sample17/11/07
9	37949	35385	2564	6.76%	sample 29/05/08
10	34359	31154	3205	9.33%	sample 31/05/08
Average	23494	21773	1721.6	7.05%	

Test by : Test Tech Co.,Ltd

Average Organic Material Deposition Ratio ($R_{deposition}$) based on the test series above:

$R_{deposition}$ = 7.05%

Aerobic COD removal at the lagoon surface

As suggested in Appendix 1 of AM0022, Version 04, a sensitivity analysis is conducted in order to analyze the impact of the chosen default value (254 kg COD/ha/day) for aerobic decomposition of COD at the lagoons surface. The results of the sensitivity analysis are provided in the table below:

Surface aerobic losses	Error factor applied	Project emissions from lagoons	Sensiitivity	Baseline emissions from lagoons	Sensiitivity	Emission reductions	Sensiitivity
kg COD/ha/day	%	(tCO2e)	%	(tCO2e)	%	(tCO2e)	%
127	-50%	4,303	na	90,918	6%	98,301	1%
190	-25%	1,730	na	88,344	3%	98,301	1%
229	-10%	186	na	86,800	1%	98,301	1%
254	0%	-	-	85,771	-	97,466	-
279	10%	0	0%	84,741	-1%	96,447	-1%
318	25%	0	0%	83,197	-3%	94,918	-3%
381	50%	0	0%	80,623	-6%	92,370	-5%

It can be observed that a variation of the parameter towards a lower aerobic removal efficiency does not have a significant impact on the emission reduction calculations. A variation of plus 50% in the default value leads to a slight decrease in emission reductions in the range of -5%. Even though, a discount of 5% in emission reduction calculations is not negligible, the project participants are of the opinion that the standard default value of 254 kg COD/ha/day) is appropriate and conservative due to following reasons:

- The major reason for the results displayed in the table above is the lack of project emissions from the lagoons for all positive variations of the default value. When analyzing the parameters behind the equation to estimate the aerobic decomposition route and comparing the numbers to the other two registered starch effluent treatment projects (Korat Waste to Energy Project, CDM Ref. 1040 and PT Budi Acid Jaya Tapioca Starch Project, CDM Ref. 1176), it becomes evident that the very large surface area of the 22 ponds at the CYY project site is the main cause for the results displayed above. As opposed to the other two projects, CYY Starch Ltd. does not have a license to discharge the treated effluent in local wastewater streams. Hence the project owner needs to

operate the effluent treatment system as a zero discharge system, always building new lagoons whenever the flow rate of the incoming effluent into the lagoon system surpasses the water evaporation rate. Therefore, many of the ponds at the end of the flow line are rather reservoirs of clean treated water with negligible quantities of COD. Hence, the active anaerobic-aerobic treatment in the lagoons takes only part in a fraction of the 22 existing lagoons.

- As described in Appendix 1 of AM0022, Version 04, the default value is based on an "ultra-conservative" estimate and is comparable to values of facultative lagoons with an average depth of 1 to 2.5 m, which fosters the aerobic decomposition process. The average depth of the existing lagoons at the project site is 5 m, with a clear tendency towards anaerobic processes. Given the long residence time of the effluent in each lagoon and the depth of the first lagoons, it s very likely that most of the COD entering the lagoon system is decomposed mostly anaerobically in the first lagoons along the flow line. This is confirmed by the high activity (bubbles and foam formation typical of anaerobic lagoons) of the first lagoons at the project site.

General Wastewater Characteristics

Table 5 Wastewater characteristics

COD removal efficiency of new waste water treatment system	90.00%	%
COD (before WWT)	30,000	mg/liter
COD (after WWT)	3,000	mg/liter
Effluent flow rate	2,400	m3/day
Annual COD load to lagoons before UASB system implementation	23,760,000	Kg COD/a
Annual COD load to lagoons after UASB system implementation	23,760,000	Kg COD/a
Sulphate concentration	75.87	mg/liter
Plant operation	330	Days/a

Table 6 Lagoon characteristics & organic removal ratio for lagoons (historical data)

Lagoon Depth	5	m
Area	25.18	ha
Minimum Lagoon Temperature (2005)	28	Degree Celsius
Minimum Ambient Temperature (2005)	28	Degree Celsius
Average COD in to the lagoon	30,000	mg/l
Average COD out from the lagoon	330	mg/l
Average COD removal ratio	98.9%	%

Wastewater produced per ton of starch produced	7.3	m3 per ton of starch
Heavy fuel oil consumption	35	liters per ton of starch
Electricity consumption	0.28	MWh per ton of starch
Fraction of COD likely to degrade in Pond 1 - 22 (anaerobic ponds) of open lagoon	98.90%	
Pond surface areas	251,780	m2
Pond 1	4,870	m2
Pond 2	10,953	m2
Pond 3	7,140	m2
Pond 4	4,242	m2
Pond 5	1,960	m2
Pond 6	12,277	m2
Pond 7	1,180	m2
Pond 8	13,152	m2
Pond 9	15,011	m2
Pond 10	6,543	m2
Pond 11	5,929	m2
Pond 12	10,395	m2
Pond 13	3,850	m2
Pond 14	13,040	m2
Pond 15	15,524	m2
Pond 16	14,835	m2
Pond 17	13,475	m2
Pond 18	23,625	m2
Pond 19	8,750	m2
Pond 20	14,858	m2
Pond 21	17,640	m2
Pond 22	32,531	m2
Surface COD loss	254	kgCOD/day/ha
Surface Oxidation of Organic Material	6,395	kgCOD per day

Document information

Version	*Date*	*Description*
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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