



Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	Chao Khun Agro Biogas Energy Project
Reference number of the project activity	2138
Version number of the monitoring report	02
Completion date of the monitoring report	04/05/2013
Registration date of the project activity	09/03/2009
Monitoring period number and duration of this monitoring period	2 nd Monitoring period; 01/04/2011-31/12/2012 (both dates are included)
Project participant(s)	<ul style="list-style-type: none"> • Thai Biogas Energy Company • Asian Development Bank as trustee of the Asia Pacific Carbon Fund • Kingdom of Spain • Swedish Energy Agency
Host Party(ies)	Thailand
Sectoral scope(s) and applied methodology(ies)	<ul style="list-style-type: none"> • Sectoral scope 13: Waste handling and disposal • Applied Methodology: AM0022 Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector, Version 04
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	84,589 tCO ₂ e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	86,269 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The Chao Khun Agro Biogas Energy Project was developed by Thai Biogas Energy Company Ltd is an industrial anaerobic wastewater treatment which treats wastewater from the cassava processing factory located in Saraburi, Thailand. The Covered In-Ground Anaerobic Reactor (CIGAR) has been installed as an anaerobic digester before the series of open lagoons. As the wastewater flow in to CIGAR, organic material is digested and resulting biogas. Then the generated biogas is captured and utilized. The capture biogas replaces the fossil fuel using for heat generation and surplus biogas is flared in open flaring system. The detail description of the main equipment is given in the section "B.1 Implementation status of the project description of the project activity".

The purpose of the project activity is to reduce the greenhouse gas emission from the anaerobic open lagoons wastewater treatment. The methane generated from anaerobic digesting was directly released to atmosphere and not utilized. Also the fossil fuel was used in heat generation and generated the greenhouse gas to atmosphere; however, the fossil fuel is replaced by biogas generated from new anaerobic wastewater treatment technology. Therefore, the project activity can reduce the greenhouse gas emission from direct methane emission and replacing the fossil fuel consumption from heat generation.

Since the project activity has been started from 16/12/2006, the relevant dates for the project activity are presented in the Table 1.

Table 1: The relevant date for the project activity

Status	Date	Description
Operation start date of project Activities	16/12/2006	The new anaerobic wastewater treatment facility had started its operation.
Start date of boiler/burner operation	16/12/2006	The new burner had started its operation.
UNFCCC Registered date	09/03/2009	The project activity was registered as CDM project.

The amount of emission reductions during the second monitoring period; 01/04/2011-31/12/2012 (both dates are included) is 86,269 tCO₂e.

A.2. Location of project activity

- (a) Thailand
- (b) Saraburi province
- (c) Kaengkoi city / Songkorn district
- (d) Physical location: Chao Khun Agro Products Project, 44 Moo 2, Songkorn, Kaengkoi, Saraburi, 18110, Thailand
- (e) Geographical location: Latitude 14°35'59.28"N Longitude 101°00'41.30"E

The geographical map of the project activity has been showed in the Figure 1.



Figure 1: The geographical map of project activity

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)
Kingdom of Thailand (Host)	Thai Biogas Energy Company	No
Spain	<ul style="list-style-type: none"> Kingdom of Spain Asian Development Bank, as trustee of the Asian Pacific Carbon Fund 	No
Sweden	<ul style="list-style-type: none"> Asian Development Bank, as trustee of the Asian Pacific Carbon Fund Swedish Energy Agency 	No

The Asian Development Bank, as trustee of the Asian Pacific Carbon Fund has been involved as project participant under Spain since 16/07/2012 according to MoC Annex2. All details can be found on the UNFCCC website as below;

(<http://cdm.unfccc.int/Projects/DB/DNV-CUK1218616482.16/view>)

A.4. Reference of applied methodology

- (a) AM0022 "Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector" (Version 04)
- (b) "Tool to determine project emissions from flaring gases containing methane"

The applied methodology and tool refer to UNFCCC website;

(<http://cdm.unfccc.int/methodologies/DB/BM4NZO7YAH9373G9P0UZHN6G1XM3IW/view.html>)

A.5. Crediting period of project activity

Type of crediting period: Fixed at 10 years

Starting date of the crediting period: 09/03/2009

The corresponding to this monitoring period: 01/04/2011-31/12/2012 (both dates are included)

SECTION B. Implementation of project activity**B.1. Description of implemented registered project activity**

This section will include a description of the implementation and operation status of the project as of this monitoring period. The project activity has installed the main machines with a specification as shown in Table 2 and fully been operating since 16/12/2006 as mentioned in section A.1.

Table 2: The specification of main machines installed in the project activity

Main machine	Type of equipment	Specification
New wastewater treatment reactor	CIGAR	41,000 m ³
Boiler	Steam boiler	15,000 kg/hr, 13 bar, 195°C
Burner	Weishaupt WKGMS 70/2-A	Rating: min 1400 kW/max 10800 kW
Flare system	Open flare	Flow rate 2000 m ³ /hr

However, during this monitoring period there were downtimes of equipment which mainly due to no supplies of wastewater from the host factory. There were several reasons to stop operation of the host factory such as raw material shortage.

The total downtime of the project activity during this monitoring period is presented in the Table 3; however, the detail of the downtimes has been provided in Annex I.

Table 3: The summary of downtimes during 01/04/2011-31/12/2012 (both dates included)

Period	Total downtimes (days)
01/04/2011-31/03/2012	43
01/04/2012-31/12/2012	14
Total	57

From the above table, it can be summarized that the total downtimes during this monitoring period of equipment is approximately 57 days. However, not only the downtimes of equipment but also other special events that occurred during this monitoring period, which may impact the CERs generation and the applicability of the methodology.

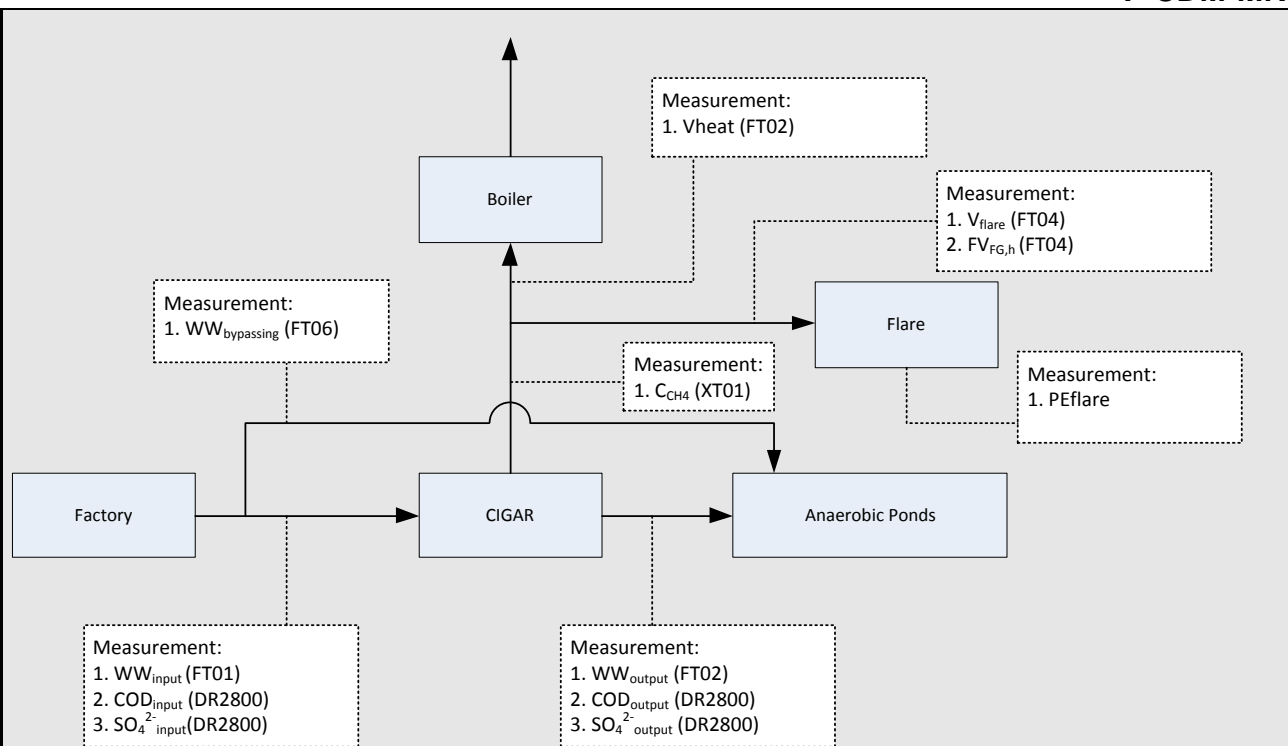


Figure 2: The project activity process diagram

B.2. Post registration changes

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

No any temporary deviations from registered monitoring plan or applied methodology.

B.2.2. Corrections

No any corrections to the project information or parameters fixed at validation.

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

No any permanent changes from registered monitoring plan or applied methodology.

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

No any changes to project design of registered project activity.

B.2.5. Changes to start date of crediting period

No changes to start date of crediting period.

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

N/A

SECTION C. Description of monitoring system

Organizational structure, roles and responsibilities

TBEC is responsible for the on-site monitoring and implementation of the quality assurance and quality management system (ISO: 9001/2008) that has been certified since June 2011 both ISO 9001-2008 and ISO 14001-2004, and compiling the CDM monitoring report for verification. Its objectives are to achieve assured quality and consistency of the output. The standard prescribes formal documentation of procedures, performance measurements and records, which can be audited internally and externally. TBEC focus on statements of requirements, prevention and detection of problems, corrective actions, inspection and testing, and monitoring and review. TBEC is practical documents, emphasizing workplace acceptance. The operational and management structure that is implemented to monitor emission reductions is described in the following diagram.

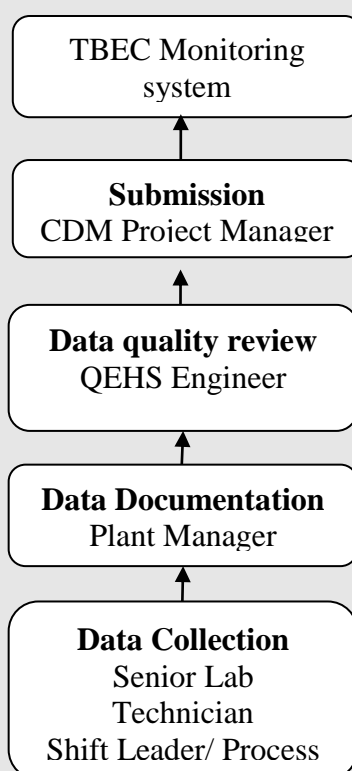


Figure 3: The organization structure to monitor the emission reduction

The roles and responsibility of positions presented in the diagram above has been clearly identified below:

a. Shift Leader/Process Operator

TBEC will designate shift leader/process operator to fulfill the primary monitoring activities. The shift leader/Process operator will be responsible for checking SCADA midnight report, Electricity reports, and daily gas & liquid system daily check sheet on daily basis and share data with Senior Lab technician.

b. Senior Lab Technician

TBEC will designate Senior Lab Technician to fulfill the primary monitoring activities, mostly on wastewater analysis. Senior Lab Technician will be responsible for checking wastewater analysis report on daily basis and share with Shift leader. The Senior Lab technician is also responsible for collating all monitored data into the monitoring and verification workbook and submitting to the plant manager daily.

c. Plant Manager

Plant manager will be responsible for checking all monitoring data which they receive from the senior lab technician daily and ensure that the data continues to be recorded as per the monitoring requirements for each parameter. The Plant manager is responsible for sending the data on a weekly basis to QEHS Engineer.

d. QEHS Engineer

TBEC will designate a QEHS Engineer to administer the monitoring plan and ensure Quality Assurance and Quality Control Procedures are adherent. The QEHS Engineer will be responsible for internal integrating the Monitoring Plan to TBECs operation and maintenance procedures for the site. The QEHS Engineer will be responsible for training the Shift leader/Process operator and Senior lab technician in the correct procedures and to ensure that they understand the requirements of the monitoring plan.

Prior to operation of the project, the QEHS Engineer will ensure that all meters and monitoring equipment meet the required accuracy and manufacturing standards. During the project, they will ensure the on-going maintenance and calibration of the all meters and monitoring equipment. Any equipment faults recorded by the Shift leader/Process operator and Senior lab technician will be followed up by the QEHS Engineer who will ensure that the equipment is repaired/replaced as necessary.

The QEHS Engineer is responsible for compiling the quarterly report and submitting it to TBEC management.

Periodically the QEHS undertake a cross check with the data report and the raw data.

e. CDM Project Manager

TBEC will designate a Senior Engineer/CDM Project Manager to oversee the preparation of the project annual Monitoring Report. They will review the monitored data provided quarterly by the Quality Control Officer and write the report for submission to the Designated Operational Entity (DOE). The Manager may also participate in and review the annual audit in co-ordination with the QESH Engineer

All data required for verification and issuance will be kept for at least two years after the end of the crediting period or the last issuance of CERs of this project, whichever occurs later. Data will be archived electronically and data backup will be maintained. Paper data backup will also be available.

All equipment calibrated and maintained in accordance to the manufacturer's recommendations to ensure accuracy of measurements. Records of calibration certificates and maintenance retained as part of the CDM monitoring system.

Data collection proceduresProcedures of Monitoring Plan

The proposed monitoring plan for the Project activity should be implemented and followed by the Project developer on-site. The methods and parameters to be monitored are as described in Section D.2 The monitoring plan should be implemented based on the following criteria:

- Data Collection – the parameters should be measured according to the monitoring plan. The frequency of monitoring proposed should be followed based on the proposed monitoring schedule. The results of the monitoring should be recorded and a set of these data should be kept on-site for easier retrieval and reference for operational and maintenance purposes.

The list of procedure is indicated below:

- Procedure for Document control
 - Procedure for Clean Development Mechanism
 - Procedure for Quality Analysis
 - Procedure for Biogas operation process (Liquid & Gas phase)
 - Procedure for preventive maintenance
 - Procedure for Instrument calibration
 - Other documentations
- Reporting and documentation – All results and observations made during the monitoring should be reported and documented based on a standardized format. The collected data of the monitored parameters should be arranged, filed and documented for easy reference and better management. The retention/ archiving period for verification and CER issuance documents should be kept for at least 2 years after the end of the crediting period or the last issuance of CERs for this project activity whichever occurs later.
- The documents will be kept in both hard and soft copies (where available). For manual recording of monitoring data, the data sheets will be scanned/keyed into computer in soft-copy for safe-keeping.
- Quality Assurance / Quality Control (QA/QC) – The QA/QC procedures should be carried out during each monitoring exercise to ensure best quality and reliable data are obtained. Manual recording will be recorded and verified by different personnel as a cross-checking measure. Observations during the monitoring exercise should be recorded and reported to the CDM manager immediately. The CDM manager should review the findings and update/improve the monitoring plan from periodically to suit the project's development.
- Communication, training and supervision – the monitoring plan should be communicated with relevant staff at all levels within the company. Relevant staff involved in the monitoring plan should be trained to implement the monitoring plan more effectively. Constant supervision and audits will be conducted to cross-check the results of the monitoring plan.
- Data protection, the data will be protected by creating the password and plant manager is authorize to access the data.

SECTION D. Data and parameters

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

Data / Parameter:	EF _{CH4}
Unit:	kgCH4/kg COD
Description:	Methane emission factor
Source of data:	AM0022 ver.04
Value(s) applied):	0.21
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	The 2006 IPCC default of 0.25 kg CH4/kg COD has been corrected to 0.21 kg CH4/kg COD to account for uncertainties. This is also the value applied in AM0022.

Data / Parameter:	GWP _{CH4}
Unit:	-
Description:	Methane emission factor
Source of data:	AM0022 ver.04
Value(s) applied:	21
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	-

Data / Parameter:	M _{lagoon_aerobic}
Unit:	kg COD/ha/day
Description:	Amount of organic material degraded aerobically in the lagoon system
Source of data:	AM0022 ver.04
Value(s) applied:	254
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	As provided by the Methodology and tested by the sensitivity analysis

Data / Parameter:	R _{lagoon}
Unit:	%
Description:	Total organic material removal ratio of the lagoon
Source of data:	Project developer
Value(s) applied:	96
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	Determined in accordance with AM0022 prior to the start of the project activity through on-site biochemical testing in the lagoon system

Data / Parameter:	R _{deposition}
Unit:	%
Description:	Organic material deposition ratio of the lagoon
Source of data:	Project developer
Value(s) applied:	1.78
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	In accordance with AM0022, testing was done prior to the start of the project activity which determined the rate of deposition

Data / Parameter:	NCV _{fuel,oil}
Unit:	TJ/dm ³
Description:	Net calorific value of fuel oil
Source of data:	IPCC 2006 and density from Engineer's Edge
Value(s) applied:	39.996 x 10 ⁻⁶
Purpose of data:	Used for calculated baseline emission; E _{CO2_heat}
Additional comment:	IPCC default value from Table 1.2 of Chapter 1 of Vol.2 used for the NCV of fuel oil expressed in TJ/t. This value is multiplied by the density value of 0.99Kg/l from Engineer's Edge (http://www.engineersedge.com/fluid_flow/fluid_data.htm)

Data / Parameter:	EF _{fuel oil}
Unit:	tCO ₂ /TJ
Description:	Carbon emission factor of the fuel oil
Source of data:	IPCC 2006
Value(s) applied:	77.367
Purpose of data:	Used for calculated baseline emission; E _{CO2_heat}
Additional comment:	IPCC default value from Table 1.3 of Chapter 1 of Vol.2 gives an EF for residual fuel oil of 21.1kg _{carbon} /GJ _{fueloil} . Applying the coefficient 44 g of CO ₂ /12 g of Carbon gives 77.367 tCO ₂ /TJ

Data / Parameter:	Lagoon surface area
Unit:	Ha
Description:	Total lagoon area
Source of data:	Project developer
Value(s) applied:	2.09
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	-

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:	50
Purpose of data:	Used for calculated project emission calculation; PE _{flare}
Additional comment:	This is calculated according to the "Tool to determine project emissions from flaring gases containing methane" for open flares which consists of using a 50% default if a flame is detected for at least 20 min in the hour and ensuring that flare is operated properly

Data / Parameter:	RSO ₄ ²⁻
Unit:	kg/tonne (kg _{COD} /tSO ₄ ²⁻)
Description:	Reduction factor for SO ₄ ²⁻ oxidative substance
Source of data:	AM0022 ver.04
Value(s) applied:	651
Purpose of data:	Used for calculated both baseline emission and project emission calculation
Additional comment:	AM0022 ver.04 states in p.32 under the section <u>Determining losses of Chemical Oxygen Demand through chemical oxidation</u> : "where the concentration of sulphate is observed to be 1 kg/m ³ of waste water, 0.651 kg/m ³ of Chemical Oxygen Demand is removed through chemical reaction with the sulphate" hence the reduction factor is 0.651 kg _{COD} /kgSO ₄ ²⁻ => 651 kg _{COD} /tSO ₄ ²⁻

D.2. Data and parameters monitored

Data / Parameter:	WW _{input}														
Unit:	m ³														
Description:	Total wastewater flows entering system boundary														
Measured/ Calculated / Default:	Measured														
Source of data:	Daily reports by SCADA														
Value(s) of monitored parameter:	<table><tr><th>Period</th><th>WW_{input} (m³)</th></tr><tr><td>01/04/2011-31/03/2012</td><td>667,150</td></tr><tr><td>01/04/2012-31/12/2012</td><td>461,540</td></tr></table>			Period	WW _{input} (m ³)	01/04/2011-31/03/2012	667,150	01/04/2012-31/12/2012	461,540						
Period	WW _{input} (m ³)														
01/04/2011-31/03/2012	667,150														
01/04/2012-31/12/2012	461,540														
Monitoring equipment:	<p>Tag No: FT01 Manufacturer: ABB Type/Model: COPA-XE DE43F Serial No: Convert: 000469020/X002, Detector: 024436 Calibration frequency : every 2 years Accuracy class : +/- 0.50 % Operational period: 19/08/2010 – 31/12/2012 Date of last calibration and validity:</p> <table><tr><th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr><tr><td>LC1208-085</td><td>16/08/2012</td><td>16/08/2012-15/08/2014</td><td>Miracle International Technology (MIT)</td></tr><tr><td>L1008-187</td><td>19/08/2010</td><td>19/08/2010-18/08/2012</td><td>MIT</td></tr></table>			Certificate Number	Date of calibration	Validity	Calibrator	LC1208-085	16/08/2012	16/08/2012-15/08/2014	Miracle International Technology (MIT)	L1008-187	19/08/2010	19/08/2010-18/08/2012	MIT
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LC1208-085	16/08/2012	16/08/2012-15/08/2014	Miracle International Technology (MIT)												
L1008-187	19/08/2010	19/08/2010-18/08/2012	MIT												
Measuring/ Reading/ Recording frequency:	To be measured continuously with a cumulative flow meter located at the incoming pipe to the CIGAR and reading recorded daily														
Calculation method (if applicable):	-														

QA/QC procedures:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy		
Purpose of data:	Baseline and project emissions calculations		
Additional comment:	-		

Data / Parameter:	WW _{output}																						
Unit:	m ³																						
Description:	Total wastewater flows leaving treatment system																						
Measured/ Calculated / Default:	Measured																						
Source of data:	Daily reports by SCADA																						
Value(s) of monitored parameter:	<table border="1"> <tr> <th>Period</th> <th>WW_{output} (m³)</th> </tr> <tr> <td>01/04/2011-31/03/2012</td> <td>673,888</td> </tr> <tr> <td>01/04/2012-31/12/2012</td> <td>441,245</td> </tr> </table>			Period	WW _{output} (m ³)	01/04/2011-31/03/2012	673,888	01/04/2012-31/12/2012	441,245														
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01/04/2011-31/03/2012	673,888																						
01/04/2012-31/12/2012	441,245																						
Monitoring equipment:	<p>Tag No: FT05 Manufacturer: ABB Type/Model: ProcessMaster Serial No: 3K672012180486 Calibration frequency : every 2 years Accuracy class : +/- 0.40 % Operational period: 21/09/2012 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <tr> <th>Certificate Number</th> <th>Date of calibration</th> <th>Validity</th> <th>Calibrator</th> </tr> <tr> <td>12/2/2/500457</td> <td>14/05/2012</td> <td>14/05/2012-13/05/2014</td> <td>ABB</td> </tr> </table> <p>Manufacturer: ABB Type/Model: COPA-XE DE43F Serial No: Convert:000422483/X002, Detector:019442 Calibration frequency : every 2 years Accuracy class : +/- 0.50 % Operational period: 19/08/2010 – 21/09/2012 Date of last calibration and validity:</p> <table border="1"> <tr> <th>Certificate Number</th> <th>Date of calibration</th> <th>Validity</th> <th>Calibrator</th> </tr> <tr> <td>LC1208-086</td> <td>16/08/2012</td> <td>16/08/2012-15/08/2014</td> <td>MIT</td> </tr> <tr> <td>L1008-188</td> <td>19/08/2010</td> <td>19/08/2010-18/08/2012</td> <td>MIT</td> </tr> </table>			Certificate Number	Date of calibration	Validity	Calibrator	12/2/2/500457	14/05/2012	14/05/2012-13/05/2014	ABB	Certificate Number	Date of calibration	Validity	Calibrator	LC1208-086	16/08/2012	16/08/2012-15/08/2014	MIT	L1008-188	19/08/2010	19/08/2010-18/08/2012	MIT
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L1008-188	19/08/2010	19/08/2010-18/08/2012	MIT																				
Measuring/ Reading/ Recording frequency:	To be measured continuously with a cumulative flow meter located at the pipe leaving the CIGAR and reading recorded daily																						
Calculation method (if applicable):	-																						
QA/QC procedures:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy																						
Purpose of data:	Baseline and project emissions calculations																						
Additional comment:	-																						

Data / Parameter:	COD _{input}																		
Unit:	kg _{COD} / m ³																		
Description:	Total wastewater organic material concentration entering the project boundary																		
Measured/ Calculated / Default:	Measured																		
Source of data:	Daily analyzed by Lab-technician																		
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>COD_{input}</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>21.57</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>21.58</td></tr> </tbody> </table>			Period	COD _{input}	01/04/2011-31/03/2012	21.57	01/04/2012-31/12/2012	21.58										
Period	COD _{input}																		
01/04/2011-31/03/2012	21.57																		
01/04/2012-31/12/2012	21.58																		
Monitoring equipment:	<p>Manufacturer: Hach Tag No: - Type/Model: Spectrophotometer / DR2800 Serial No. : 1156884 Calibration frequency : once a year Accuracy class : +/- 1.5 nm Operational period: 05/10/2009 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>C06120262</td><td>22/09/2012</td><td>22/09/2012-21/09/2013</td><td>SPC Calibration Center</td></tr> <tr> <td>C06110236</td><td>22/09/2011</td><td>22/09/2011-21/09/2012</td><td>SPC Calibration Center</td></tr> <tr> <td>C06100204</td><td>04/10/2010</td><td>04/10/2010-03/10/2011</td><td>SPC Calibration Center</td></tr> </tbody> </table>			Certificate Number	Date of calibration	Validity	Calibrator	C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center	C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center	C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center
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C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center																
C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center																
Measuring/ Reading/ Recording frequency:	To be measure daily by internal laboratory, and the recording will be done daily																		
Calculation method (if applicable):	The test result is reported in mg COD/l. This unit is converted to kg COD/m ³ by simple unit conversion																		
QA/QC procedures:	Daily sampling of the untreated wastewater influent and tested on site at the TBEC laboratory using Hach meter following international COD standard method 5220 D. Daily samples have been taken and used to calculate average monthly and annual values																		
Purpose of data:	Baseline and project emissions calculations																		
Additional comment:	-																		

Data / Parameter:	COD _{output}		
Unit:	kg _{COD} / m ³		
Description:	Total wastewater organic material concentration leaving the treatment facility		
Measured/ Calculated / Default:	Measured		

Source of data:	Daily analyzed by Lab-technician																
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>COD_{output}</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>5.48</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>6.11</td></tr> </tbody> </table>	Period	COD _{output}	01/04/2011-31/03/2012	5.48	01/04/2012-31/12/2012	6.11										
Period	COD _{output}																
01/04/2011-31/03/2012	5.48																
01/04/2012-31/12/2012	6.11																
Monitoring equipment:	<p>Manufacturer: Hach Tag No: - Type/Model: Spectrophotometer / DR2800 Serial No. : 1156884 Calibration frequency : once a year Accuracy class : +/- 1.5 nm Operational period: 05/10/2009 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>C06120262</td><td>22/09/2012</td><td>22/09/2012-21/09/2013</td><td>SPC Calibration Center</td></tr> <tr> <td>C06110236</td><td>22/09/2011</td><td>22/09/2011-21/09/2012</td><td>SPC Calibration Center</td></tr> <tr> <td>C06100204</td><td>04/10/2010</td><td>04/10/2010-03/10/2011</td><td>SPC Calibration Center</td></tr> </tbody> </table>	Certificate Number	Date of calibration	Validity	Calibrator	C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center	C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center	C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center
Certificate Number	Date of calibration	Validity	Calibrator														
C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center														
C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center														
C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center														
Measuring/ Reading/ Recording frequency:	To be measure daily by internal laboratory, and the recording will be done daily																
Calculation method (if applicable):	The test result is reported in mg COD/l. This unit is converted to kg COD/m ³ by simple unit conversion																
QA/QC procedures:	Daily sampling of the untreated wastewater influent and tested on site at the TBEC laboratory using Hach meter following international COD standard method 5220 D. Daily samples have been taken and used to calculate average monthly and annual values																
Purpose of data:	Baseline and project emissions calculations																
Additional comment:	-																
Data / Parameter:	V _{heat}																
Unit:	Nm ³																
Description:	Total volume of biogas sent to facility heaters																
Measured/ Calculated / Default:	Measured																
Source of data:	Daily reports by SCADA																
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>V_{heat} (Nm³)</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>5,337,756</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>3,660,403</td></tr> </tbody> </table>	Period	V _{heat} (Nm ³)	01/04/2011-31/03/2012	5,337,756	01/04/2012-31/12/2012	3,660,403										
Period	V _{heat} (Nm ³)																
01/04/2011-31/03/2012	5,337,756																
01/04/2012-31/12/2012	3,660,403																

Monitoring equipment:	<p>Tag No: FT02 Manufacturer: ABB Type : Sensyflow FMT500 IG Serial No. : 241163131 X001 Calibration frequency : every 3 years Accuracy class : +/- 0.50 % Operational period: 14/02/2012 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>0184 D-K-15081-01-00 2011-11</td><td>25/11/2011</td><td>25/11/2011-24/11/2014</td><td>ABB</td></tr> </tbody> </table> <p>Manufacturer: ABB Type : Sensyflow iG-EX Serial No. : 27751278 Calibration frequency : every 3 years Accuracy class : +/- 0.50 % Operational period: 30/05/2011 – 14/02/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>240278981</td><td>14/10/2009</td><td>14/10/2009-23/10/2012</td><td>ABB</td></tr> </tbody> </table> <p>Manufacturer: ABB Type : Sensyflow iG-EX Serial No. : 27751279 Calibration frequency : every 3 years Accuracy class : +/- 0.50 % Operational period: 15/08/2008 – 30/05/2011 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>1612 DKD-K-05701 2008-07</td><td>29/07/2008</td><td>29/07/2008-28/07/2011</td><td>ABB</td></tr> </tbody> </table>	Certificate Number	Date of calibration	Validity	Calibrator	0184 D-K-15081-01-00 2011-11	25/11/2011	25/11/2011-24/11/2014	ABB	Certificate Number	Date of calibration	Validity	Calibrator	240278981	14/10/2009	14/10/2009-23/10/2012	ABB	Certificate Number	Date of calibration	Validity	Calibrator	1612 DKD-K-05701 2008-07	29/07/2008	29/07/2008-28/07/2011	ABB
Certificate Number	Date of calibration	Validity	Calibrator																						
0184 D-K-15081-01-00 2011-11	25/11/2011	25/11/2011-24/11/2014	ABB																						
Certificate Number	Date of calibration	Validity	Calibrator																						
240278981	14/10/2009	14/10/2009-23/10/2012	ABB																						
Certificate Number	Date of calibration	Validity	Calibrator																						
1612 DKD-K-05701 2008-07	29/07/2008	29/07/2008-28/07/2011	ABB																						
Measuring/ Reading/ Recording frequency:	To be measured continuously, reading and recorded daily																								
Calculation method (if applicable):	-																								
QA/QC procedures:	Biogas meters should be subject to a regular maintenance and testing regime to ensure accuracy																								
Purpose of data:	Baseline and project emissions calculations																								
Additional comment:	-																								
Data / Parameter:	V_{flare} (also $FV_{FG,h}$)																								
Unit:	Nm^3																								
Description:	Total biogas sent to flare																								

Measured/ Calculated / Default:	Measured																		
Source of data:	Daily reports by SCADA																		
Value(s) of monitored parameter:	<table><tr><th>Period</th><th>V_{flare} (Nm³)</th></tr><tr><td>01/04/2011-31/03/2012</td><td>153,219</td></tr><tr><td>01/04/2012-31/12/2012</td><td>176,197</td></tr></table>			Period	V _{flare} (Nm ³)	01/04/2011-31/03/2012	153,219	01/04/2012-31/12/2012	176,197										
Period	V _{flare} (Nm ³)																		
01/04/2011-31/03/2012	153,219																		
01/04/2012-31/12/2012	176,197																		
Monitoring equipment:	<p>Tag No: FT04 Manufacturer: ABB Type/Model: Sensyflow FMT500 IG Serial No. : Converter: 241151957 Y001 Sensor: 241151957 X001 Calibration frequency : every 3 years Accuracy class : +/- 0.50 % Operational period: 10/07/2012 – 31/12/2012 Date of last calibration and validity:</p> <table><tr><th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr><tr><td>0186 D-K-15081- 01-00 2011-12</td><td>15/12/2011</td><td>15/12/2011- 14/12/2014</td><td>ABB</td></tr></table> <p>Manufacturer: ABB Type/Model: Sensyflow IG-EX Serial No. : 26750814 Calibration frequency : every 3 years Accuracy class : +/- 0.50 % Operational period: 28/08/2009 - 10/07/2012 Date of last calibration and validity:</p> <table><tr><th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr><tr><td>Order No. 240236990</td><td>24/06/2009</td><td>24/06/2009- 23/06/2012</td><td>ABB</td></tr></table>			Certificate Number	Date of calibration	Validity	Calibrator	0186 D-K-15081- 01-00 2011-12	15/12/2011	15/12/2011- 14/12/2014	ABB	Certificate Number	Date of calibration	Validity	Calibrator	Order No. 240236990	24/06/2009	24/06/2009- 23/06/2012	ABB
Certificate Number	Date of calibration	Validity	Calibrator																
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Certificate Number	Date of calibration	Validity	Calibrator																
Order No. 240236990	24/06/2009	24/06/2009- 23/06/2012	ABB																
Measuring/ Reading/ Recording frequency:	To be measured continuously, reading and recorded daily																		
Calculation method (if applicable):	-																		
QA/QC procedures:	Biogas meters should be subject to a regular maintenance and testing regime to ensure accuracy. This parameter is equivalent to the variable FV _{RG,h} (volumetric flow rate of the residual gas in dry basis at normal conditions) as described in the “Tool to determine project emissions from flaring gases containing methane”																		
Purpose of data:	Project emissions calculations																		
Additional comment:	-																		

Data / Parameter:	C _{SO4²⁻} in
Unit:	Tonnes/m ³
Description:	Amount of chemical oxidizing agents entering system boundary

Measured/ Calculated / Default:	Measured																		
Source of data:	Daily analyzed by Lab-technical																		
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th> <th>C_{SO4²⁻ in} (tonnes/m³)</th> </tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td> <td>0.0002135</td> </tr> <tr> <td>01/04/2012-31/12/2012</td> <td>0.000252</td> </tr> </tbody> </table>			Period	C _{SO4²⁻ in} (tonnes/m ³)	01/04/2011-31/03/2012	0.0002135	01/04/2012-31/12/2012	0.000252										
Period	C _{SO4²⁻ in} (tonnes/m ³)																		
01/04/2011-31/03/2012	0.0002135																		
01/04/2012-31/12/2012	0.000252																		
Monitoring equipment:	<p>Manufacturer: Hach Tag No: - Type/Model: Spectrophotometer / DR2800 Serial No. : 1156884 Calibration frequency : once a year Accuracy class : +/- 1.5 nm Operational period: 05/10/2009 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th> <th>Date of calibration</th> <th>Validity</th> <th>Calibrator</th> </tr> </thead> <tbody> <tr> <td>C06120262</td> <td>22/09/2012</td> <td>22/09/2012-21/09/2013</td> <td>SPC Calibration Center</td> </tr> <tr> <td>C06110236</td> <td>22/09/2011</td> <td>22/09/2011-21/09/2012</td> <td>SPC Calibration Center</td> </tr> <tr> <td>C06100204</td> <td>04/10/2010</td> <td>04/10/2010-03/10/2011</td> <td>SPC Calibration Center</td> </tr> </tbody> </table>			Certificate Number	Date of calibration	Validity	Calibrator	C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center	C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center	C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center
Certificate Number	Date of calibration	Validity	Calibrator																
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C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center																
C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center																
Measuring/ Reading/ Recording frequency:	Samples are collected daily, mixed, and concentration measured weekly. For emission reduction calculations the most recent value from testing is kept until a new test result is received from the lab																		
Calculation method (if applicable):	-																		
QA/QC procedures:	-																		
Purpose of data:	Baseline and project emissions calculations																		
Additional comment:	-																		

Data / Parameter:	C _{SO4²⁻ out}						
Unit:	Tonnes/m ³						
Description:	Amount of chemical oxidizing agents out of the digester						
Measured/ Calculated / Default:	Measured						
Source of data:	Daily analyzed by Lab-technical						
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th> <th>C_{SO4²⁻ out} (tonnes/m³)</th> </tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td> <td>0.0000254</td> </tr> <tr> <td>01/04/2012-31/12/2012</td> <td>0.000026</td> </tr> </tbody> </table>	Period	C _{SO4²⁻ out} (tonnes/m ³)	01/04/2011-31/03/2012	0.0000254	01/04/2012-31/12/2012	0.000026
Period	C _{SO4²⁻ out} (tonnes/m ³)						
01/04/2011-31/03/2012	0.0000254						
01/04/2012-31/12/2012	0.000026						

Monitoring equipment:	<p>Manufacturer: Hach Tag No: - Type/Model: Spectrophotometer / DR2800 Serial No. : 1156884 Calibration frequency : once a year Accuracy class : +/- 1.5 nm Operational period: 05/10/2009 – 31/12/2012 Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>C06120262</td><td>22/09/2012</td><td>22/09/2012-21/09/2013</td><td>SPC Calibration Center</td></tr> <tr> <td>C06110236</td><td>22/09/2011</td><td>22/09/2011-21/09/2012</td><td>SPC Calibration Center</td></tr> <tr> <td>C06100204</td><td>04/10/2010</td><td>04/10/2010-03/10/2011</td><td>SPC Calibration Center</td></tr> </tbody> </table>	Certificate Number	Date of calibration	Validity	Calibrator	C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center	C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center	C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center
Certificate Number	Date of calibration	Validity	Calibrator														
C06120262	22/09/2012	22/09/2012-21/09/2013	SPC Calibration Center														
C06110236	22/09/2011	22/09/2011-21/09/2012	SPC Calibration Center														
C06100204	04/10/2010	04/10/2010-03/10/2011	SPC Calibration Center														
Measuring/ Reading/ Recording frequency:	Samples are collected daily, mixed, and concentration measured weekly. For emission reduction calculations the most recent value from testing is kept until a new test result is received from the lab																
Calculation method (if applicable):	-																
QA/QC procedures:	-																
Purpose of data:	Baseline and project emissions calculations																
Additional comment:	-																
Data / Parameter:	WW _{bypassing}																
Unit:	m ³																
Description:	Total flow of wastewater directly to the current water treatment system, and bypassing the new wastewater treatment facility																
Measured/ Calculated / Default:	Measured																
Source of data:	Daily analyzed by SCADA																
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>WW_{bypassing} (m³)</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>0</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>0</td></tr> </tbody> </table>	Period	WW _{bypassing} (m ³)	01/04/2011-31/03/2012	0	01/04/2012-31/12/2012	0										
Period	WW _{bypassing} (m ³)																
01/04/2011-31/03/2012	0																
01/04/2012-31/12/2012	0																

Monitoring equipment:	<p>Tag No: FT06</p> <p>Manufacturer: ABB</p> <p>Type/Model: ProcessMaster</p> <p>Serial No. : 3K672011450101</p> <p>Calibration frequency : every 2 years</p> <p>Accuracy class : +/- 0.40%</p> <p>Operational period: 25/01/2012 – 31/12/2012</p> <p>Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>11/4/2/215103</td><td>17/11/2011</td><td>17/11/2011-16/11/2013</td><td>ABB</td></tr> </tbody> </table> <p>Manufacturer: ABB</p> <p>Type/Model: DE41F</p> <p>Serial No. : Convertor: 000420831/Y004 Detector: 000282153/X001</p> <p>Calibration frequency : every 2 years</p> <p>Accuracy class : +/- 0.50%</p> <p>Operational period: 08/09/2010 – 08/04/2011 and 23/09/2011 – 25/01/2012</p> <p>Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>L1009-028</td><td>07/09/2010</td><td>07/09/2010-06/09/2012</td><td>MIT</td></tr> </tbody> </table> <p>Manufacturer: ABB</p> <p>Type/Model: ProcessMaster</p> <p>Serial No. : 6711071069</p> <p>Calibration frequency : every 2 years</p> <p>Accuracy class : +/- 0.40%</p> <p>Operational period: 08/04/2011 – 23/09/2011</p> <p>Date of last calibration and validity:</p> <table border="1"> <thead> <tr> <th>Certificate Number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr> </thead> <tbody> <tr> <td>11/4/2/210339</td><td>23/02/2011</td><td>23/02/2011-22/02/2013</td><td>ABB</td></tr> </tbody> </table>	Certificate Number	Date of calibration	Validity	Calibrator	11/4/2/215103	17/11/2011	17/11/2011-16/11/2013	ABB	Certificate Number	Date of calibration	Validity	Calibrator	L1009-028	07/09/2010	07/09/2010-06/09/2012	MIT	Certificate Number	Date of calibration	Validity	Calibrator	11/4/2/210339	23/02/2011	23/02/2011-22/02/2013	ABB
Certificate Number	Date of calibration	Validity	Calibrator																						
11/4/2/215103	17/11/2011	17/11/2011-16/11/2013	ABB																						
Certificate Number	Date of calibration	Validity	Calibrator																						
L1009-028	07/09/2010	07/09/2010-06/09/2012	MIT																						
Certificate Number	Date of calibration	Validity	Calibrator																						
11/4/2/210339	23/02/2011	23/02/2011-22/02/2013	ABB																						
Measuring/ Reading/ Recording frequency:	Measured continuously and data recorded hourly																								
Calculation method (if applicable):	-																								
QA/QC procedures:	Regular maintenance and calibration of the flow meter																								
Purpose of data:	Project emissions calculations																								
Additional comment:	-																								
Data / Parameter:	Biogas loss from pipeline																								
Unit:	%																								
Description:	Loss of biogas from pipeline																								

Measured/ Calculated / Default:	Measured												
Source of data:	Pressure test report by External laboratory <table border="1"> <tr> <th>Report Number</th> <th>Testing date</th> <th>Validity</th> <th>Tester</th> </tr> <tr> <td>Pressure test 2011</td> <td>22/08/2011</td> <td>22/08/2011-21/08/2012</td> <td>SWA</td> </tr> <tr> <td>Pressure test 2012</td> <td>17/08/2012</td> <td>17/08/2012-16/08/2013</td> <td>SWA</td> </tr> </table>	Report Number	Testing date	Validity	Tester	Pressure test 2011	22/08/2011	22/08/2011-21/08/2012	SWA	Pressure test 2012	17/08/2012	17/08/2012-16/08/2013	SWA
Report Number	Testing date	Validity	Tester										
Pressure test 2011	22/08/2011	22/08/2011-21/08/2012	SWA										
Pressure test 2012	17/08/2012	17/08/2012-16/08/2013	SWA										
Value(s) of monitored parameter:	<table border="1"> <tr> <th>Period</th> <th>Biogas loss from pipeline</th> </tr> <tr> <td>01/04/2011-31/03/2012</td> <td>0</td> </tr> <tr> <td>01/04/2012-31/12/2012</td> <td>0</td> </tr> </table>	Period	Biogas loss from pipeline	01/04/2011-31/03/2012	0	01/04/2012-31/12/2012	0						
Period	Biogas loss from pipeline												
01/04/2011-31/03/2012	0												
01/04/2012-31/12/2012	0												
Monitoring equipment:	-												
Measuring/ Reading/ Recording frequency:	Integrity of biogas pipeline for losses of biogas methane is tested annually through pressurizing the system and establishing pressure drops through leakage												
Calculation method (if applicable):	-												
QA/QC procedures:	The annual testing by third party has been included on period of 2008 in monitoring report. The standard method for testing has followed by Department of Energy's liquefied petroleum gas piping and equipped with storage tanks and gas in the liquefied petroleum gas by 2554 are submitted to DOE												
Purpose of data:	Project emissions calculations												
Additional comment:	-												

Data / Parameter:	NCV _{biogas}												
Unit:	J/Nm ³												
Description:	Biogas calorific value												
Measured/ Calculated / Default:	Measured												
Source of data:	NCV test report by External Laboratory <table border="1"> <tr> <th>Testing report Number</th> <th>Testing date</th> <th>Validity</th> <th>Tester</th> </tr> <tr> <td>COA-L6-1107-01322</td> <td>22/07/2011</td> <td>22/07/2011-21/07/2012</td> <td>PTT</td> </tr> <tr> <td>COA-EX-1208-01215</td> <td>10/08/2012</td> <td>10/08/2012-09/08/2013</td> <td>PTT</td> </tr> </table>	Testing report Number	Testing date	Validity	Tester	COA-L6-1107-01322	22/07/2011	22/07/2011-21/07/2012	PTT	COA-EX-1208-01215	10/08/2012	10/08/2012-09/08/2013	PTT
Testing report Number	Testing date	Validity	Tester										
COA-L6-1107-01322	22/07/2011	22/07/2011-21/07/2012	PTT										
COA-EX-1208-01215	10/08/2012	10/08/2012-09/08/2013	PTT										
Value(s) of monitored parameter:	<table border="1"> <tr> <th>Period</th> <th>NCV_{biogas} (J/Nm³)</th> </tr> <tr> <td>01/04/2011-31/03/2012</td> <td>20,343,389</td> </tr> <tr> <td>01/04/2012-31/12/2012</td> <td>20,566,943</td> </tr> </table>	Period	NCV _{biogas} (J/Nm ³)	01/04/2011-31/03/2012	20,343,389	01/04/2012-31/12/2012	20,566,943						
Period	NCV _{biogas} (J/Nm ³)												
01/04/2011-31/03/2012	20,343,389												
01/04/2012-31/12/2012	20,566,943												

Monitoring equipment:	-						
Measuring/ Reading/ Recording frequency:	To be measured annually						
Calculation method (if applicable):	-						
QA/QC procedures:	-						
Purpose of data:	Baseline emissions calculations						
Additional comment:	-						
Data / Parameter:	PE _{flare}						
Unit:	tCO ₂						
Description:	Project emissions from flaring of the residual gas stream						
Measured/ Calculated / Default:	Calculated						
Source of data:	Emission reduction calculation sheet						
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>PE_{flare} (tCO₂e)</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>669.3819</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>757.4584</td></tr> </tbody> </table>	Period	PE _{flare} (tCO ₂ e)	01/04/2011-31/03/2012	669.3819	01/04/2012-31/12/2012	757.4584
Period	PE _{flare} (tCO ₂ e)						
01/04/2011-31/03/2012	669.3819						
01/04/2012-31/12/2012	757.4584						
Monitoring equipment:	-						
Measuring/ Reading/ Recording frequency:	-						
Calculation method (if applicable):	Following the "Tool to determine project emissions from flaring gases containing methane"						
QA/QC procedures:	-						
Purpose of data:	Project emissions calculations						
Additional comment:	-						
Data / Parameter:	F						
Unit:	dm ³						
Description:	Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility						
Measured/ Calculated / Default:	Calculated						
Source of data:	Emission reduction calculation sheet						
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th>Period</th><th>F (dm³)</th></tr> </thead> <tbody> <tr> <td>01/04/2011-31/03/2012</td><td>2,714,972.684</td></tr> <tr> <td>01/04/2012-31/12/2012</td><td>1,882,270.711</td></tr> </tbody> </table>	Period	F (dm ³)	01/04/2011-31/03/2012	2,714,972.684	01/04/2012-31/12/2012	1,882,270.711
Period	F (dm ³)						
01/04/2011-31/03/2012	2,714,972.684						
01/04/2012-31/12/2012	1,882,270.711						

Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	Calculated from the monitored V_{heat} multiplied by monitored NCV_{Biogas} and divided by fixed parameter NCV_{fuel}
QA/QC procedures:	-
Purpose of data:	Baseline emission calculations
Additional comment:	-

Data / Parameter:	C_{CH_4} (also $FV_{\text{CH}_4,y}$)						
Unit:	% of Nm^3/Nm^3						
Description:	Biogas methane concentration						
Measured/ Calculated / Default:	Measured						
Source of data:	SCADA midnight report						
Value(s) of monitored parameter:	<table><tr><th>Period</th><th>C_{CH_4} (% of Nm^3/Nm^3)</th></tr><tr><td>01/04/2011-31/03/2012</td><td>58.45</td></tr><tr><td>01/04/2012-31/12/2012</td><td>58.35</td></tr></table>	Period	C_{CH_4} (% of Nm^3/Nm^3)	01/04/2011-31/03/2012	58.45	01/04/2012-31/12/2012	58.35
Period	C_{CH_4} (% of Nm^3/Nm^3)						
01/04/2011-31/03/2012	58.45						
01/04/2012-31/12/2012	58.35						

Monitoring equipment:	<p>Tag No: XT01 Manufacturer: ANRI Type : CAM-3L Serial No. : LFB-028 Calibration frequency : 1 years Accuracy class : +/- 0.5 of full scale Date of last calibration and validity:</p> <table><tr><th>Certificate number</th><th>Date of calibration</th><th>Validity</th><th>Calibrator</th></tr><tr><td>G 550249</td><td>15/08/2012</td><td>15/08/2012-14/08/2013</td><td>Entech Associate</td></tr><tr><td>G 540277</td><td>02/09/2011</td><td>02/09/2011-01/09/2012</td><td>Entech Associate</td></tr><tr><td>G 530268</td><td>09/09/2010</td><td>09/09/2010-08/09/2011</td><td>Entech Associate</td></tr></table>	Certificate number	Date of calibration	Validity	Calibrator	G 550249	15/08/2012	15/08/2012-14/08/2013	Entech Associate	G 540277	02/09/2011	02/09/2011-01/09/2012	Entech Associate	G 530268	09/09/2010	09/09/2010-08/09/2011	Entech Associate
Certificate number	Date of calibration	Validity	Calibrator														
G 550249	15/08/2012	15/08/2012-14/08/2013	Entech Associate														
G 540277	02/09/2011	02/09/2011-01/09/2012	Entech Associate														
G 530268	09/09/2010	09/09/2010-08/09/2011	Entech Associate														

Measuring/ Reading/ Recording frequency:	Measured continuously by continuous analyser and data recorded hourly ("Primary Measurement Method"). In case of malfunction/unavailability of the Primary Measurement Method, an Alternative Measurement Method with measurements by handheld calibration gas analyser can be applied. The Alternative Measurement Method shall be hourly measurement and recorded data daily during the affected period and apply a 95 % confidence interval shall be applied.
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	Baseline and project emissions calculations

Additional comment:	<p>Also referred as $f_{v_{CH_4,h}}$ (Volumetric fraction of component i in the biogas in the hour h, where $i = CH_4$) in the “Tool to determine project emissions from flaring gases containing methane”. Only CH_4 will be monitored, the remaining part will be considered as N_2 (simplified approach according to Tool).The monitored value will actually have to be multiplied by the CH_4 density of $0.0007168 \text{ tCH}_4/\text{m}^3\text{CH}_4$ from ACM0001 at normal conditions to obtain the value of CCH_4 in tCH_4/Nm^3.</p> <p>In case of using an Alternative Measurement Method, the results of hourly measurements by handheld calibration gas analyser shall be compared with the last 3 months measurement by the continuous analyser and the lower value will be applied for baseline emission calculation and higher value will be applied for project emission calculation.</p>	
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Data / Parameter:	f_{heat}							
Unit:	%							
Description:	Heating system combustion efficiency							
Measured/ Calculated / Default:	Measured							
Source of data:	Combustion efficiency test report by External laboratory							
Value(s) of monitored parameter:	<table><tr><th>Period</th><th>f_{heat} (%)</th></tr><tr><td>01/04/2011-31/03/2012</td><td>92.44</td></tr><tr><td>01/04/2012-31/12/2012</td><td>91.19</td></tr></table>		Period	f_{heat} (%)	01/04/2011-31/03/2012	92.44	01/04/2012-31/12/2012	91.19
Period	f_{heat} (%)							
01/04/2011-31/03/2012	92.44							
01/04/2012-31/12/2012	91.19							
Monitoring equipment:	-							
Measuring/ Reading/ Recording frequency:	Measuring and recording at least annually							
Calculation method (if applicable):	-							
QA/QC procedures:	Boiler is maintained regularly by Weishaupt in order to ensure optimal performance. During the monitoring period, there is one boiler used which is Weishaupt.							
Purpose of data:	Project emissions calculations							
Additional comment:	-							

Data / Parameter:	M_{Removed}	
Unit:	t COD	
Description:	Organic material removed from wastewater facility	
Measured/ Calculated / Default:	Calculated	
Source of data:	Based on data source of COD_{in} and COD_{out}	

Value(s) of monitored parameter:	<table><tr><th>Period</th><th>M_{Removed} (tCOD)</th></tr><tr><td>01/04/2011-31/03/2012</td><td>10,699.13</td></tr><tr><td>01/04/2012-31/12/2012</td><td>7,260.11</td></tr></table>		Period	M _{Removed} (tCOD)	01/04/2011-31/03/2012	10,699.13	01/04/2012-31/12/2012	7,260.11
	Period	M _{Removed} (tCOD)						
	01/04/2011-31/03/2012	10,699.13						
	01/04/2012-31/12/2012	7,260.11						
Monitoring equipment:	-							
Measuring/ Reading/ Recording frequency:	-							
Calculation method (if applicable):	The parameter is calculated from COD _{input} and COD _{output} . $M_{\text{Removed}} = [(WW_{\text{input}} \times \text{COD}_{\text{in}}) - (WW_{\text{output}} \times \text{COD}_{\text{out}})]/1000$							
QA/QC procedures:	-							
Purpose of data:	-							
Additional comment:	-							

D.3. Implementation of sampling plan

There are no any data and parameter monitored described in section D.2 are determined by a sampling approach. Therefore, this section is not applicable for this project activity.

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

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

As per the equation set out in AM0022 version 04 which applied for registered project activity, the following equations are applied to calculate the baseline emission.

Total Baseline emissions:

$$E_{BL} = E_{CH4_lagoons_BL} + E_{CO2_heat_BL} + E_{CO2_power_BL}$$

Where:

- E_{BL} = total Baseline emission (tCO₂e).
- $E_{CH4_lagoons_BL}$ = the fugitive methane emissions from lagoons in the baseline case (tCO₂e).
- $E_{CO2_heat_BL}$ = CO₂ emissions from on-site fossil heat in the baseline case (tCO₂) that are displaced by generation based on biogas collected in the anaerobic treatment facility.
- $E_{CO2_power_BL}$ = CO₂ emissions from on-site power generation in the baseline case (tCO₂) that are displaced by generation based on biogas collected in the anaerobic treatment facility.

Since in this registered project activity, there are no any electricity generation that are displaced base on biogas collected in the anaerobic treatment facility, the $E_{CO2_power_BL} = 0$.

Then the follow equation has been applied for this case:

$$E_{BL} = E_{CH4_lagoons_BL} + E_{CO2_heat_BL}$$

Period of 01/04/2011-31/03/2012

E_{BL}	$E_{CH_4_lagoon_BL}$	$E_{CO_2_heat_BL}$	$E_{CO_2_power_BL}$
tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
67,036	58,635	8,401	0

Period of 01/04/2012-31/12/2012

E_{BL}	$E_{CH_4_lagoon_BL}$	$E_{CO_2_heat_BL}$	$E_{CO_2_power_BL}$
tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
46,191	40,430	5,761	0

Total baseline emissions during of 01/04/2011 to 31/12/2012 is 113,227 tCO₂e.

a) On-site heat generation emission displaced by generation base on biogas collected in the anaerobic treatment facility.

In calculating CO₂ emission from on-site heat displaced by biogas collected in the anaerobic treatment, the use of fossil fuels is considered:

$$E_{CO_2_heat} = F \cdot NCV \cdot EF$$

Where:

- F = the corresponding amount of fossil fuel displaced by the use of biogas for the generation of on-site heat (dm³). This is estimated as product of:
 (1) Average specific fuel consumption for the output of the facility and
 (2) The annual production.
- NCV = the net calorific value of the fossil fuel considers (TJ/unit).
- EF = the carbon emission factor of the fossil fuel considers (tCO₂/TJ).

According to heat balance equation, the corresponding amount of fossil fuel displaced by the use of biogas for the generation of on-site heat can be calculated as equation below:

$$F_{fueloil} \times NCV_{fueloil} = F_{biogas_heat} \times NCV_{biogas}$$

$$F_{fueloil} = F_{biogas_heat} \times \frac{NCV_{biogas}}{NCV_{fueloil}}$$

Then:

$$E_{CO_2_heat} = \left(F_{biogas_heat} \times \frac{NCV_{biogas}}{NCV_{fueloil}} \right) \times NCV_{fueloil} \times EF$$

$$E_{CO_2_heat} = F_{biogas_heat} \times NCV_{biogas} \times EF$$

As equation above, the CO₂ emission from on-site heat displaced by biogas collected in the anaerobic treatment, the use of fossil fuels is considered as:

Period of 01/04/2011-31/03/2012

$E_{CO_2_heat}$	F_{biogas}	NCV	EF
tCO ₂ e	Nm ³	TJ/Nm ³	tCO ₂ /TJ
8,401	5,337,756	2.03434E-05	77.367

Note: 77.367 tCO₂/TJ has been applied for the carbon emission factor of the fuel oil referred to IPCC default value from Table 3.1, Chapter 1 vol.2

Period of 01/04/2012-31/12/2012

$E_{CO_2_heat}$	F_{biogas}	NCV	EF
tCO ₂ e	Nm ³	TJ/Nm ³	tCO ₂ /TJ
5,761	3,660,403	2.03434E-05	77.367

Therefore, the total CO₂ emission from on-site heat displaced by biogas collected in the anaerobic treatment from 01/04/2011-31/12/2012 is 14,162 tCO₂.

b) On-site and/or off site Grid Power Generation Emissions displaced by generation based on biogas collected in the anaerobic treatment facility

No electricity was generated.

c) Baseline organic material entering lagoon system from new anaerobic wastewater treatment system:

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

Where:

- $M_{lagoon_input_BL}$ = the value used to specify the amount of organic material flowing into the lagoon System from the CIGAR in the project scenario equation (kg COD).
- M_{input_total} = the total amount of organic material fed into the baseline waste water treatment facility (kg COD). It is same amount as fed into the project water treatment facility.

In the baseline, organic material from the facility enters directly into the lagoon system with no degradation of the wastewater before entering the lagoon system and all organic material to be treated enters the lagoon system. The pond based fugitive methane emissions are quantified by determining;

- How much material enters the lagoon system;
- How much is lost through aerobic and oxidative processes;
- How much is lost through sedimentation in the lagoon system; and
- How much is removed through anaerobic process.

All emission factors, 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 the project scenario in the section on project emission above.

Therefore; the equation to determine the fugitive methane emission from lagoons for project emission has been applied for baseline scenario according to the methodology.

Fugitive methane emission from lagoons in baseline scenario

$$E_{CH_4_lagoon_BL} = M_{lagoon_anaerobi} \cdot EF_{CH_4} \cdot GWP_{CH_4} / 1000$$

Where:

$E_{CH_4_lagoon_BL}$	=	the methane emission from the lagoons (tCO ₂)
$M_{lagoon_anaerobic}$	=	the amount of organic material removed by anaerobic processes in the lagoon System (kg COD)
EF_{CH_4}	=	the methane emission factor (kg CH ₄ / kg COD)
GWP_{CH_4}	=	the Global Warming Potential of methane ($GWP_{CH_4} = 21$)

Note: A default COD to methane conversion factor of 0.21 kg CH₄/kg COD is used referred to IPCC, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, page 5.16 and/or methodology AM0022/ Version 04, page 3.

Period of 01/04/2011-31/03/2012

$E_{CH_4_lagoon_BL}$	$M_{lagoon_anaerobic}$	EF_{CH_4}	GWP_{CH_4}
tCO ₂ e	kg COD	-	-
58,635	13,296,058	0.21	21

Period of 01/04/2012-31/12/2012

$E_{CH_4_lagoon_BL}$	$M_{lagoon_anaerobic}$	EF_{CH_4}	GWP_{CH_4}
tCO ₂ e	kg COD	-	-
40,430	9,167,924	0.21	21

Total fugitive methane emission from lagoons in baseline scenario in this monitoring period from 01/04/2011-31/12/2012 is 99,065 tCO₂e.

The total removal of COD from individual lagoons is a function of:

- Aerobic surface oxidation of COD
- Chemical oxidation in lagoons (where oxidative species such as sulphate are present)
- Sedimentation of material that microbes are unable to degrade before they form a bottom sediment
- COD degradation as a result of anaerobic micro bacterial activity

The mass balance in the considered lagoon system provides the amount of organic material by anaerobic process:

$$M_{lagoon_anaerobic} = M_{lagoon_total} - M_{lagoon_aerobic} - M_{lagoon_chemical_ox} - M_{lagoon_deposition}$$

Where:

$M_{lagoon_anaerobic}$	=	the amount of organic material removed by anaerobic processes in the lagoon system (kg COD)
M_{lagoon_total}	=	the total amount of organic material removed in the lagoon system
$M_{lagoon_aerobic}$	=	the amount of organic material degraded aerobically in the lagoon system (kg COD).
$M_{lagoon_chemical_ox}$	=	the amount of organic material lost through chemical oxidation in the lagoon system (kg COD)
$M_{lagoon_deposition}$	=	the amount of organic material lost through deposition in the lagoon system (kg COD)

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_anaerobic}}$	$M_{\text{lagoon_total}}$	$M_{\text{lagoon_aerobic}}$	$M_{\text{lagoon_chemical_ox}}$	$M_{\text{lagoon_deposition}}$
kg COD	kg COD	kg COD	kg COD	kg COD
13,296,058	13,816,423	171,468	92,717	256,180

Period of 01/04/2012 – 31/12/2012

$M_{\text{lagoon_anaerobic}}$	$M_{\text{lagoon_total}}$	$M_{\text{lagoon_aerobic}}$	$M_{\text{lagoon_chemical_ox}}$	$M_{\text{lagoon_deposition}}$
kg COD	kg COD	kg COD	kg COD	kg COD
9,167,924	9,559,442	138,554	75,715	177,248

In order to assess the amount of COD actually entering the anaerobic system (the lagoons) the amount of COD removed as a result of the new wastewater treatment facility must be determined. This is set out in equation below.

Project organic material entering lagoon system from new anaerobic water treatment system is:

$$M_{\text{lagoon_input}} = M_{\text{input_total}}$$

Where:

- $M_{\text{lagoon_input}}$ = the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
 $M_{\text{input_total}}$ = the total amount of organic material fed into the new project water treatment facility (kg COD)
 R_{NAWTF} = the total organic material removal efficiency of the new project water treatment facility

Note: In case of baseline calculation, the $R_{\text{NAWTF}} = 0$ is applied because the new project water treatment was not implemented yet.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_input}}$	$M_{\text{input_total}}$
kg COD	kg COD
14,392,107	14,392,107

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_input}}$	$M_{\text{input_total}}$
kg COD	kg COD
9,957,752	9,957,752

Total material removal in lagoon system is:

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

Where:

- $M_{\text{lagoon_total}}$ = the total amount of organic material removed in the lagoon system through various routes (kg COD)
 $M_{\text{lagoon_input}}$ = the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
 R_{lagoon} = the total organic material removal ratio of the lagoon (-).

Note: the total organic material removal ratio of the lagoon is equal to the proportion of organic material removed within the boundaries of the lagoon system under consideration. This factor should be determined by carrying out a series of biochemical tests period to project implementation. This test will determine the COD flows into the system, and the COD flows out of the system boundary. The relative difference of COD flowing in and out of the system over a period of time will allow determination of the Total Organic Material Removed Ratio which already tested during validation process. Refer to registered PDD-page 22, the R_{lagoon} is 96%.

Period of 01/04/2011-31/03/2011

$M_{\text{lagoon_total}}$	$M_{\text{lagoon_input}}$	R_{lagoon}
kg COD	kg COD	%
13,816,423	14,392,107	96

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_total}}$	$M_{\text{lagoon_input}}$	R_{lagoon}
kg COD	kg COD	%
9,559,442	9,957,752	96

Material degraded aerobically in the lagoon system

$$M_{\text{lagoon_aerobic}} = 254 \cdot \text{pond_surface_area} \cdot \text{operation_time}$$

Note: Surface aerobic losses of organic material in pond based system equal to 254 kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_aerobic}}$	Constant value	Pond surface area	Operation day
kg COD	kg COD/ha/day	ha	day
171,468	254	2.09	323

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_aerobic}}$	Constant value	Pond surface area	Operation day
kg COD	kg COD/ha/day	ha	day
138,554	254	2.09	261

Material lost through chemical oxidation in lagoon system

$$M_{\text{lagoon_chemical_ox}} = C_{\text{SO}_4^{2-} \text{ in}} \cdot R_{\text{SO}_4^{2-}}$$

Where:

- $M_{\text{lagoon_chemical_ox}}$ = the amount of organic material lost through deposition in the lagoon system (kg COD)
 $C_{\text{SO}_4^{2-} \text{ in}}$ = the concentration of sulphate is absorbed (t SO_4^{2-})
 $R_{\text{SO}_4^{2-}}$ = the removal factor of COD through chemical reaction with the sulphate, 651 kg COD/ t SO_4^{2-} referred to AM0022/Version 04, page 32

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_chemical_ox}}$	$C_{\text{so42-in}}$	$R_{\text{so42-}}$
kg COD	$t_{\text{so42-}}$	kg COD / $t_{\text{so42-}}$
92,717	142.42	651

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_chemical_ox}}$	$C_{\text{so42-in}}$	$R_{\text{so42-}}$
kg COD	$t_{\text{so42-}}$	kg COD / $t_{\text{so42-}}$
75,715	116.31	651

Material deposition in lagoon system is:

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

Where:

- $M_{\text{lagoon_deposition}}$ = the amount of organic material lost through deposition in the lagoon system (kg COD)
 $M_{\text{lagoon_input}}$ = the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
 $R_{\text{deposition}}$ = the organic material deposition ratio of the lagoon.

Note: The organic material deposition ratio of the lagoon is equal to the proportion of organic material physically sediment in lagoons within the project boundaries. For the baseline, $R_{\text{deposition}}$ is 1.78% mentioned in registered PDD, page 23.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_deposition}}$	$M_{\text{lagoon_input}}$	$R_{\text{deposition}}$
kg COD	kg COD	%
256,180	14,392,107	1.78

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_deposition}}$	$M_{\text{lagoon_input}}$	$R_{\text{deposition}}$
kg COD	kg COD	%
177,248	9,957,752	1.78

According to the calculation above, the conclusion of baseline emission in this monitoring period (01/04/2011-31/12/2012, both dates included) can be presented in the table below:

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO ₂ e)
01/04/2011-31/03/2012	67,036
01/04/2012-31/12/2012	46,191
Total	113,227

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

Total project emissions are the sum of fugitive methane emissions from the existing lagoon based water treatment system, from possible methane emission from the new anaerobic wastewater treatment facility, from incomplete biogas combustion, biogas leaks.

Total project emissions:

$$E_{project} = E_{CH4_lagoons} + E_{CH4_NAWTF} + E_{CH4_IC+Leaks}$$

Where:

$E_{project}$	= the total project emission (tCO ₂ e)
$E_{CH4_lagoons}$	= the fugitive methane emissions from lagoons (tCO ₂ e)
E_{CH4_NAWTF}	= the fugitive methane emissions from the new anaerobic wastewater treatment facility (tCO ₂ e)
$E_{CH4_IC+Leaks}$	= the methane emissions from inefficient combustion and leaks (tCO ₂ e)

Period of 01/04/2011-31/03/2012

$E_{project}$	E_{CH4_lagoon}	E_{CH4_NAWTF}	$E_{CH4_IC+Leaks}$
tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
15,091	14,386	0	705

Period of 01/04/2012-31/12/2012

$E_{project}$	E_{CH4_lagoon}	E_{CH4_NAWTF}	$E_{CH4_IC+Leaks}$
tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
11,867	11,081	0	786

Total project emissions during of 01/04/2011 to 31/12/2012 is 26,958 tCO₂e.

a. Fugitive methane emission from lagoons

$$E_{CH4_lagoons} = M_{lagoon_anaerobic} \cdot EF_{CH4} \cdot GWP_{CH4} / 1000$$

Where:

E_{CH4_lagoon}	= the methane emission from the lagoons (tCO ₂)
$M_{lagoon_anaerobic}$	= the amount of organic material removed by anaerobic processes in the lagoon System (kg COD)
EF_{CH4}	= the methane emission factor (kg CH ₄ / kg COD)
GWP_{CH4}	= the Global Warming Potential of methane ($GWP_{CH4} = 21$)

Note: A default COD to methane conversion factor of 0.21 kg CH₄/kg COD is used referred to IPCC, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, page 5.16 and/or methodology AM0022/ Version 04, page 3.

Period of 01/04/2011-31/03/2012

$E_{CH_4_lagoon}$	$M_{lagoon_anaerobic}$	EF_{CH_4}	GWP_{CH_4}
tCO ₂ e	kg COD	-	-
14,386	3,262,132	0.21	21

Period of 01/04/2012-31/12/2012

$E_{CH_4_lagoon}$	$M_{lagoon_anaerobic}$	EF_{CH_4}	GWP_{CH_4}
tCO ₂ e	kg COD	-	-
11,081	2,512,622	0.21	21

The total fugitive methane emission from lagoons during this monitoring period (01/04/2011-31/12/2012 both dates included) is 25,467 tCO₂e.

The total removal of COD from individual lagoons is a function of:

- Aerobic surface oxidation of COD;
- Chemical oxidation in lagoons (where oxidative species such as sulphate are present);
- Sedimentation of material that microbes are unable to degrade before they form a bottom sediment; and
- COD degradation as a result of anaerobic micro bacterial activity.

The mass balance in the considered lagoon system provides the amount of organic material by an anaerobic process:

$$M_{lagoon_anaerobic} = M_{lagoon_total} - M_{lagoon_aerobic} - M_{lagoon_chemical_ox} - M_{lagoon_deposition}$$

Where:

$M_{lagoon_anaerobic}$	= the amount of organic material removed by anaerobic processes in the lagoon system (kg COD)
M_{lagoon_total}	= the total amount of organic material removed in the lagoon system
$M_{lagoon_aerobic}$	= the amount of organic material degraded aerobically in the lagoon system (kg COD).
$M_{lagoon_chemical_ox}$	= the amount of organic material lost through chemical oxidation in the lagoon system (kg COD)
$M_{lagoon_deposition}$	= the amount of organic material lost through deposition in the lagoon system (kg COD)

Period of 01/04/2011-31/03/2012

$M_{lagoon_anaerobic}$	M_{lagoon_total}	$M_{lagoon_aerobic}$	$M_{lagoon_chemical_ox}$	$M_{lagoon_deposition}$
kg COD	kg COD	kg COD	kg COD	kg COD
3,262,132	3,509,806	171,468	11,129	65,078

Period of 01/04/2012-31/12/2012

$M_{lagoon_anaerobic}$	M_{lagoon_total}	$M_{lagoon_aerobic}$	$M_{lagoon_chemical_ox}$	$M_{lagoon_deposition}$
kg COD	kg COD	kg COD	kg COD	kg COD
2,512,622	2,708,856	138,554	7,453	50,227

In order to assess the amount of COD actually entering the anaerobic system (the lagoons) the amount of COD removed as a result of the new wastewater treatment facility must be determined. This is set out in equation below.

Project organic material entering lagoon system from new anaerobic water treatment system is:

$$M_{\text{lagoon_input}} = M_{\text{input_total}} \cdot (1 - R_{\text{NAWTF}})$$

Where:

- $M_{\text{lagoon_input}}$ = the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
 $M_{\text{input_total}}$ = the total amount of organic material fed into the new project water treatment facility (kg COD)
 R_{NAWTF} = the total organic material removal efficiency of the new project water treatment facility (-).

Note: For the project emission calculation, the R_{NAWTF} is determined in methodology AM0022/Version 04, page 31.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_input}}$	$M_{\text{input_total}}$	R_{NAWTF}
kg COD	kg COD	-
3,656,048	14,392,107	0.75

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_input}}$	$M_{\text{input_total}}$	R_{NAWTF}
kg COD	kg COD	-
2,821,725	9,957,752	0.72

Total material removal in lagoon system is:

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

Where:

- $M_{\text{lagoon_total}}$ = the total amount of organic material removed in the lagoon system through various routes (kg COD)
 $M_{\text{lagoon_input}}$ = the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
 R_{lagoon} = the total organic material removal ratio of the lagoon

Note: the total organic material removal ratio of the lagoon is equal to the proportion of organic material removed within the boundaries of the lagoon system under consideration. This factor should be determined by carrying out a series of biochemical tests period to project implementation. This test will determine the COD flows into the system, and the COD flows out of the system boundary. The relative difference of COD flowing in and out of the system over a period of time will allow determination of the Total Organic Material Removed Ratio which already tested during validation process. Referred to registered PDD-page 22, the R_{lagoon} is 96%.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_total}}$	$M_{\text{lagoon_input}}$	R_{lagoon}
kg COD	kg COD	%
3,509,806	3,656,048	96

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_total}}$	$M_{\text{lagoon_input}}$	R_{lagoon}
kg COD	kg COD	%
2,708,856	2,821,725	96

Material degraded aerobically in the lagoon system

$$M_{\text{lagoon_aerobic}} = 254 \cdot \text{pond_surface_area} \cdot \text{operation_time}$$

Note: Surface aerobic losses of organic material in pond based system equal to 254 kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_aerobic}}$	Constant value	Pond surface area	Operation day
kg COD	kg COD/ha/day	ha	day
171,468	254	2.09	323

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_aerobic}}$	Constant value	Pond surface area	Operation day
kg COD	kg COD/ha/day	ha	day
138,554	254	2.09	261

Material lost through chemical oxidation in lagoon system

$$M_{\text{lagoon_chemical_ox}} = C_{\text{SO42-in}} \cdot R_{\text{SO42-}}$$

Where:

$M_{\text{lagoon_chemical_ox}}$ = the amount of organic material lost through deposition in the lagoon system (kg COD)

$C_{\text{SO42-in}}$ = the concentration of sulphate is aboserved (t SO_4^{2-})

$R_{\text{SO42-}}$ = the removal factor of COD through chemical reaction with the sulphate, 651 kg COD/ t SO_4^{2-} referred to AM0022/Version 04, page 32

Period of 09/03/2009 – 31/12/2009

$M_{\text{lagoon_chemical_ox}}$	$C_{\text{so42-in}}$	$R_{\text{SO42-}}$
kg COD	t SO_4^{2-}	kg COD / t SO_4^{2-}
11,129	17.095	651

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_chemical_ox}}$	$C_{\text{so42-out}}$	$R_{\text{SO42-}}$
kg COD	t SO_4^{2-}	kg COD / t SO_4^{2-}
7,453	11.449	651

Material deposition in lagoon system is:

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

Where:

$M_{\text{lagoon_deposition}}$	= the amount of organic material lost through deposition in the lagoon system (kg COD)
$M_{\text{lagoon_input}}$	= the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)
$R_{\text{deposition}}$	= the organic material deposition ratio of the lagoon.

Note: The organic material deposition ratio of the lagoon is equal to the proportion of organic material physically sedimented in lagoons within the project boundaries. For the baseline, $R_{\text{deposition}}$ is 1.78% mentioned in registered PDD, page 23.

Period of 01/04/2011-31/03/2012

$M_{\text{lagoon_deposition}}$	$M_{\text{lagoon_input}}$	$R_{\text{deposition}}$
kg COD	kg COD	%
65,078	3,656,048	1.78

Period of 01/04/2012-31/12/2012

$M_{\text{lagoon_deposition}}$	$M_{\text{lagoon_input}}$	$R_{\text{deposition}}$
kg COD	kg COD	%
50,227	2,821,725	1.78

b. Methane emissions from new anaerobic wastewater treatment facility

Methane emission from the specific anaerobic wastewater treatment facility that is implemented with the project should be assessed and estimated based on measurements, technology supplier data and expert estimates. They may be neglected if documented evidence for their insignificance is given.

In this case, the leakage of wastewater treatment facility has been inspected every day internally and inspecting and checking by other party annually. The result during this monitoring period (01/04/2011-31/12/2012, both dates included) found there were no leakages. Therefore, the methane emissions from new anaerobic wastewater treatment facility is neglected in the project during this monitoring period.

c. Methane emissions from Inefficient Combustion Emissions

The combustion of biogas methane may give rise to significant methane emissions as a result of incomplete or inefficient combustion. The three predominant potential routes for the destruction of methane are:

- Biogas flaring;
- Biogas use in heating system
- Biogas use for onsite electricity generation

However, in this project activity there is no electricity generated from biogas; so, the methane emissions from biogas use for onsite electricity generation are not applicable and can be avoided.

$$E_{\text{CH}_4\text{-IC+Leaks}} = E_{\text{CH}_4\text{-heat}} + E_{\text{CH}_4\text{-power}} + PE_{\text{flare}}$$

Since there is no electricity generated from biogas in this project, $E_{CH_4 \text{ power}} = 0$; therefore;

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

$$E_{CH_4_IC+Leaks} = E_{CH_4_heat} + PE_{flare}$$

For this project activity, $r = \text{heat only}$; then

$$E_{CH_4_heat} = V_{heat} \cdot C_{CH_4_heat} \cdot (1 - f_{heat}) \cdot GWP_{CH_4}$$

Period	$E_{CH_4 \text{ heat}}$ tCO ₂ e	V_{heat} Nm ³	$C_{CH_4 \text{ heat}}$ tCH ₄ /Nm ³	f_{heat} %	GWP_{CH_4} -
01/04/2011-31/03/2012	36	5,337,756	0.000419	92.4375	21
01/04/2012-31/12/2012	28	3,660,403	0.000418	91.1875	21

PE_{flare} is the project emission from flaring of the residual gas stream calculated following the procedure described in the “Tool to determine project emission from flaring gases containing Methane”. Since no continuous monitoring takes place, the default flare efficiency prescribed by the tool is utilized. The calculation steps for project emissions are as follows:

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

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

$$FM_{RG,h} = \rho_{RGn,h} \cdot FV_{RG,h}$$

As stated in the “Tool to determine project emission from flaring gases containing Methane”, a simplified approach may be taken, in which only the volumetric fraction of methane is measured and the difference to 100% is considered as nitrogen (N₂). Hence step 2 is not applicable to the chosen methodological application of the tool and it is not included here for clarity purposes. As the methane combustion efficiency of the flare will not be continuously monitored as a default value for open flares will be used, step 3 and 4 are also not applicable and will not be included.

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

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH_4, RG,h}$) and the density of methane ($\rho_{CH_4,n,h}$) in the same reference conditions.

$$TM_{RG,h} = FV_{RG,h} \cdot fv_{CH_4, RG,h} \cdot \rho_{CH_4,n}$$

Step 7: Calculation of annual project emissions from flaring

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

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \cdot (1 - \eta_{flare,h}) \cdot \frac{GWP_{CH_4}}{1000}$$

Since the value is calculated on hourly basis, then only one day sample is taken in the monitoring report; however, the detail for calculation is provided in the calculation sheet.

10/01/2012	1:00	858	57.6	60	508	354.25	50	3.720
	2:00	864	57.8	60	509	357.96	50	3.759
	3:00	858	57.8	60	509	355.48	50	3.733
	4:00	862	58	60	510	358.37	50	3.763
	5:00	857	58	60	510	356.29	50	3.741
	6:00	0	0	0	0	0.00	0	0.000
	7:00	0	0	0	0	0.00	0	0.000
	8:00	0	0	0	0	0.00	0	0.000
	9:00	0	0	0	0	0.00	0	0.000
	10:00	0	0	0	0	0.00	0	0.000
	11:00	0	0	0	0	0.00	0	0.000
	12:00	0	0	0	0	0.00	0	0.000
	13:00	0	0	0	0	0.00	0	0.000
	14:00	0	0	0	0	0.00	0	0.000
	15:00	0	0	0	0	0.00	0	0.000
	16:00	0	0	0	0	0.00	0	0.000
	17:00	0	0	0	0	0.00	0	0.000
	18:00	0	0	0	0	0.00	0	0.000
	19:00	0	0	0	0	0.00	0	0.000
	20:00	0	0	0	0	0.00	0	0.000
	21:00	0	0	0	0	0.00	0	0.000
	22:00	0	0	0	0	0.00	0	0.000
	23:00	0	0	0	0	0.00	0	0.000
	0:00	0	0	0	0	0.00	0	0.000
								18.715

The sum of emission from flaring of the residual gas stream is presented below:

Period	PE _{flare} (tCO ₂ e)
01/04/2011 - 31/03/2012	669.3819
01/04/2012 - 31/12/2012	757.4584

The fugitive methane emission from inefficient combustion and leaks; E_{CH₄ IC+leaks} is presented as:

Period	E _{CH₄ IC+leaks}	E _{CH₄ heat}	E _{CH₄ power}	PE _{flare}
	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
01/04/2011 - 31/03/2012	705	36	0	669.3819
01/04/2012 - 31/12/2012	786	282	0	757.4584

According to the calculation above, the conclusion of project emissions in this monitoring period (01/04/2011-31/12/2012, both dates included) can be presented in the table below:

Time Period	Project emissions or actual net GHG removals by sinks (tCO ₂ e)
01/04/2011-31/03/2012	15,091
01/04/2012-31/12/2012	11,867
Total	26,958

E.3. Calculation of leakage

Leaks in the biogas system include leaks from any anaerobic digester and leaks from the biogas pipeline delivery system. Leaks monitored on a daily basis and the pipeline pressurized testing annually, as required by AM0022. A conservative value of 1 % was included in the ex-ante emissions reductions calculations. However, as the annual test report for pressure test at pipelines could be confirmed that 0% or no leakage can be account for this project.

Methane emissions from the CIGAR are zero in this project. Because the CIGAR is being operated effectively under sub atmospheric pressures, it is reasonable to expect that air will actually be sucked in as opposed to biogas leaking out. The biogas delivery pipe to the off-taker site is also less than 2km, and thus there is no expectation that there will be significant leaks of biogas.

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 ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e)
01/04/2011-31/03/2012	67,036	15,091	0	51,945
01/04/2012-31/12/2012	46,191	11,867	0	34,325
Total	113,227	26,958	0	86,269

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 CO₂e)	84,589	86,269

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

The higher ER achieved as compared to ex-ante ER during the monitoring period is contributed by the high amount of wastewater treated which is 14.22% higher than expected wastewater treated in 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
1st Monitoring Period; 09/03/2009 – 31/03/2011	101,765	0
2nd Monitoring Period; 01/04/2011 – 31/12/2012	86,269	0
Emission reductions or GHG removals by sinks (t CO₂e)	188,034	0

Document information

Version	Date	Description
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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