**Monitoring report form**

**(Version 04.0)**

| MONITORING REPORT | |
|---|---|
| **Title of the project activity** | UPOIC Wastewater Treatment for Energy Generation, Krabi |
| **Reference number of the project activity** | 4322 |
| **Version number of the monitoring report** | 01 |
| **Completion date of the monitoring report** | 21/11/2014 |
| **Registration date of the project activity** | 18/10/2011 |
| **Monitoring period number and duration of this monitoring period** | 18/10/2011 to 31/07/2014 |
| **Project participant(s)** | 1. United Palm Oil Industry PCL. (Thailand)<br>2. Swiss Carbon Asset Ltd. (Switzerland) |
| **Host Party(ies)** | Thailand |
| **Sectoral scope and selected methodology(ies), and where applicable, applied standardized baseline(s)** | Sectoral scope 1: Energy Industries<br>Sectoral Scope 13: Waste handling and disposal<br><br>Methodologies used:<br>AMS-I.D. version 16<br>AMS-III.H. version 14 |
| **Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD** | 52,506 tCO2e |
| **Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period** | 61,276 tCO2e |
| **Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)** | 20,703 tCO2e |
| **Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).** | 40,573 tCO2e |

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

(a) Purpose of the project activity and the measures taken for GHG emission reductions;

The purpose of project activity is to treat the wastewater from the CPO mill factory in order to generate biogas. The project activity entails the installation of an anaerobic wastewater treatment facility, based on a "Completely Stirred Tank Reactor" (CSTR) system; to complement the existing open lagoon based system. The implementation of the project activity will enable the generation and capture of biogas which are utilised for electricity generation. The electricity generated is supplied to the national grid and CPO mill.

(b) Brief description of the installed technology and equipment;

| **Equipment** | **Manufacturer / Technology provider** | **Type/Model** | **Specifications** |
|---|---|---|---|
| Wastewater treatment system | Energy Research and Development Institute (ERDI) | Completely Stirred Tank Reactor (CSTR) | The biogas system has a designed COD reduction efficiency of 90%. The expected biogas production is around 8,741 Nm3 per day (at 65% of $CH_4$). |
| Gas engine | Guascor | SFGLD 560 | Two sets of electricity generators are installed with each capacity of 952 kWe approximately. |
| Flare | BKE | Enclosed flare | The enclosed flare has a maximum capacity of 500 $Nm^3$/hr. |

(c) Relevant dates for the project activity

| Event | Date | Reference |
|---|---|---|
| The project owner signed contract with the technology provider of biogas system. | 01/04/2008 | Contract between Lam Soon and ERDI |
| Commissioning of project activity | 26/10/2009 | Commissioning certificate by ERDI |
| Commissioning of gas engines | 21/12/2009 | Commissioning test report |
| Registration under CDM scheme | 18/10/2011 | UNFCCC website |
| 1st monitoring period | 18/10/2011 to 31/07/2014 | - |

(d) Total GHG emission reductions in this monitoring period are 61,276 $tCO_2e$.

## A.2. Location of project activity

(a) Host Party (ies); Thailand
(b) Region/State/Province; Trang province
(c) City/Town/Community; Kalasae sub-district, Sikao Distrct
(d) Physical/Geographical location;
- Latitude: 7° 42' 3514" N
- Longitude: 99° 19' 1360" 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) | United Palm Oil Industry Public Company Limited (private entity) | No |
| Switzerland | Swiss Carbon Asset Ltd. (private entity) | No |

## A.4. Reference of applied methodology and standardized baseline

(a) The applied methodologies;
- AMS-III.H: “Methane recovery in wastewater treawtment” (version 14) (http://cdm.unfccc.int/methodologies/DB/4ND00PCGC7WXR3L0LOJTS6SVZP4NSU)
- AMS-I.D: “Grid connected renewable electricity generation” (version 16) (http://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X)

(b) Within the applied methodologies, the following tools are used for this project activity;
- “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 02.1.0) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf)
- “Tool to determine project emissions from flaring gases containing methane” (version 01) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf)
- “Tool to calculate the emission factor for an electricity system” (version 02.1.0) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf)

## A.5. Crediting period of project activity

Type: Fixed crediting period
Start date and end of the crediting period: 18/10/2011 to 17/10/2021
Current monitoring period: 18/10/2011 to 31/07/2014
Length of the current monitoring period: 2 years, 9 months, 18 days

## A.6. Contact information of responsible persons/ entities

Renat Heuberger
Swiss Carbon Asset Ltd.
Technoparkstrass 1
8005 Zürich

Switzerland

## SECTION B. Implementation of project activity

### B.1. Description of implemented registered project activity

The project activity replaces the existing wastewater treatment practice (open lagoon system) and thus avoids the release of methane into the atmosphere that results from the anaerobic digestion in the lagoon system. The implementation of the project activity enables the generation and capture of biogas, which is utilised for electricity generation.

The biogas captured by project activity is supplied to the gas engines. The electricity generated by the gas engine is used in the biogas plant and remaining is supplied to the CPO mill and exported the grid that displaces electricity mainly produced from fossil fuels. In the emergency case, the excess biogas is flared in the enclosed flare system.

**Technical description:**

The technology installed under the project activity is the anaerobic wastewater treatment facility based on CSTR system. This biogas system is designed by local technology provider; the Energy Research and Development Institute of Chaing Mai University (ERDI). The biogas system is a hybrid system that combines the advantage of completely stirred reactor (CSTR) and Plug-Flow digester. This system can treat the wastewater with high COD and high loading of suspended solids.

The CSTR system receives the wastewater from CPO mill factory with a maximum production capacity of 60 ton FFB/hour. In the project activity, the wastewater is supplied to pre-treatment system in order to reduce the temperature. Then the elimination of solid component in the wastewater is done via sedimentation process. Accordingly, the wastewater is sent to the hybrid system which ensures a continuous high contact rate of bacteria in the reactor. The COD removal efficiency of the biogas system is about 90%, the production of biogas expected around 8,741 Nm3 per day (with the methane of 65%). The treated wastewater is pumped to the open lagoon system. The wastewater in the final lagoon is applied to the factory's grass area.

In order to utilize biogas for electricity generation, the biogas captured is first treated to remove the sulphur content by $H_2S$ scrubber. Then, the cleaned biogas is consumed in the generators. The electricity generated is supplied to CPO mill and national grid. The excess biogas is flared by the enclosed flaring system. The figure 1: project diagram is shown below.

**Implementation status of the project activity during the monitoring period:**

During the monitoring period, there were no significant occurrences of events, which affected the project activity as described above. The data monitoring of the project activity were carried out as described in the registered PDD.

Further, the calibration of the equipment was conducted as per the plan of the project activity. In case of calibration delay, the measured values during the delay period are adjusted by applying an identified error in a calibration report in a conservative manner, which is in line with the latest version of clean development mechanism validation and verification standard (VVS).

### B.2. Post registration changes

#### B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

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

#### B.2.2. Corrections

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

#### B.2.3. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>
No permanent changes in the monitoring plan during the current monitoring period.

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

>>
No change to project design of registered project activity during the current monitoring period.

#### B.2.5. Changes to start date of crediting period

>>
No change to start date of crediting period

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

>>
This section is not applicable to the project activity.

## SECTION C. Description of monitoring system

>>

**1. Monitoring Management**

The required monitoring equipment is installed in the project activity. The monitoring procedures are followed as mentioned in section D of this monitoring report. The data is recorded on a continuous basis or as indicated in section D and fed into the log sheets and the data logger. The monitoring data is kept in both soft and hard copy format. The calibrations of monitoring equipment are conducted on regular intervals.

All biogas plant staffs have been trained by the technology provider prior to full commissioning of biogas plant. Figure 1 outlines the structure of operation and management of the Project activity.

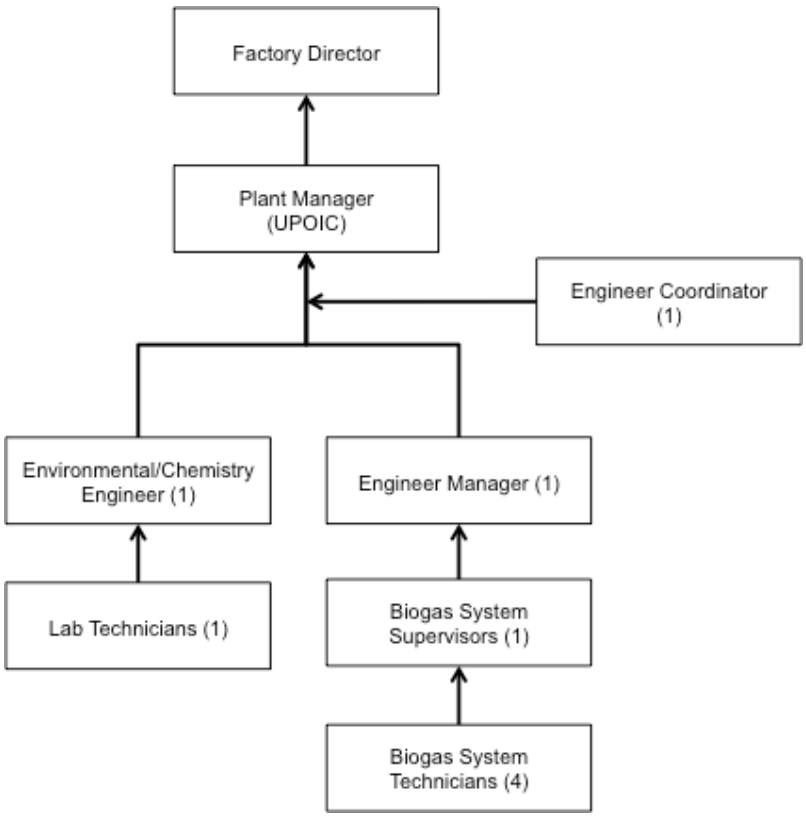


**Figure 1:** Organisation chart showing the responsible persons in the project activity

**Role and Responsibility:**

| | |
|---|---|
| Factory director | The factory director is responsible to set and revise the monitoring policy and communicate with the UNFCCC regarding the CDM project. |
| Plant manager | The plant manager is responsible to supervise overall biogas and electricity generation system by interacting with engineering manager, environmental/chemistry engineer, engineer coordinator, and staffs in the factory. The plant manager is a coordinating point of the factory with external stakeholder i.e. local people, NGO, PEA, DOE, etc. for smooth biogas and electricity system operation, sustainability management, and CDM process. |
| Engineering manager | The engineering manager is responsible for supporting and guiding the biogas system supervisor in order to ensure the effective operation of biogas system management. This position reports to the plant manager. |
| Bioas system supervisor | The supervisor is responsible to control the entire operation, guiding decision making on process management and changes, and resolving equipment, operational and monitoring issues; include managing all monitoring data from data of Biogas Plant to prepare monthly Operational, Maintenance and Monitoring Report of Biogas Project and submitting to Engineer Manager including corporation with the Provincial Electricity Authority (PEA) |
| Biogas plant technicians | The technician is responsible to maintain daily operational and maintenance for smooth operational of the biogas system, electricity generation system, flare and monitoring system. Detailed information on site concerning the operation of the plant will be recorded and reported to the biogas system supervisor. |

| | |
|---|---|
| Environment/chemisty engineer | The environmental/chemistry engineer is responsible to supervise Lab Technician to assure quality of waste water sampling and analysis as well as preparing laboratory report and arrange quality control check with QC manager and checking daily on the quality control data collection and filing procedure. |
| Lab technician | The lab technician is responsible for maintaining all daily laboratories testing to international standards, including COD and oxidation substances. The parameters required by the CDM projects are done by an internal laboratory and periodically crosschecked with the external certified laboratory. Laboratory results will be daily recorded in electronic file and reported to Environmental/Chemistry engineer. |
| Engineer coordinator | The coordinator works with CPO factory and biogas plants. This position coordinates and reviews annual calibration checks of equipment with equipment suppliers and the external certified agencies for equipment calibration. All of CDM monitoring data are gathered by the coordinator. The monitoring data are submitted to the plant manager. |

**2. Quality Assurance and Quality Control**

The biogas plant supervisor monitors the overall biogas plant's performance, ensuring proper and timely calibration (in accordance with the manufacturer specifications) of systems, data acquisition and storage. Either erroneous data or uncertainties found in measurement of the monitoring devices for the biogas plant (i.e. flow rate, methane analyser, etc.) are included in the quality assurance and quality control procedures for individual monitoring parameters as per Section D of this monitoring report.

**3. Data Storage and Filing**

All monitoring data are stored in the log-sheets and electronically. The monitoring records has been archived for a period of the crediting period plus 2 years.

**4. Emergency preparedness**

The project activity is not expected to result in any emergency that can result in substantial emissions.

However, leakages, if any, in the piping or digester shall come to the attention of the plant operator either instantly on the control screen, or at the time of data logging. The team shall take necessary action to stop any such leakage etc. and put plant operation back on track.

**5. Uncertainty in data**

Some uncertainties may result due to malfunction of meters, calibration issues and wrong data collection (gaps in manual log sheets, human errors by plant operators). The operators are expected to put best efforts to prevent such errors; however regular internal audits shall rectify any such uncertainty in the monitored data.

## 6. Monitoring equipment of the project activity

| Tag no. | Parameters | Equipment | Brands | Serial Number |
|---|---|---|---|---|
| 1a, 1b, 7 | $Q_{ww,y}$ (Influent) | Magnetic flow meter | Kobold (previous installation) | A0908519 |
| | | Magnetic flow meter | ABB (new one) | 401123 |
| 2 | $COD_{ww,untreated, PJ,k,y}$ | Analysis equipment/method applied | Mettler Toledo Burette | 474804802 |
| 3 | $COD_{ww,untreated, PJ,k,y}$ | | | |
| 4 | $COD_{ww,treated, PJ,k,y}$ | | | |
| 5 | $COD_{ww,treated, PJ,k,y}$ | | | |
| 6 | $COD_{ww,treated, PJ,k,y}$ | | | |
| 8 | $COD_{ww,discharged, PJ,k,y}$ | | | |
| 9 | $FV_{digester,y}$ | Gas flow meter | KOBOLD | 5843 |
| | | Flow Computing | Fuji Electric | 863676T |
| 11 | $W_{CH4,y}$ | Methane analyzer (Portable) | Geotechnical Instruments | BM11818109 |
| 10, 12, 17 | Temp. & Pressure sensor | Temperature sensor (TS) | 1. at biogas out of digester: Kobold | C0046105 |
| | | | 2. at flare: Kobold | 193118 |
| | | | 3. at generator no. 1: Kobold | Not specify |
| | | | 4. at generator no. 2: Kobold | Not specify |
| 11, 12, 17 | Temp. & pressure sensor | Pressure Transmitter | 1. at biogas leaving digester: Honeywell | 1006 80027880002 |
| | | | 2. at flare: Kobold | 260O422 |
| | | | 3. at generator no. 1: Kobold | 260O502 |
| | | | 4. at generator no. 2: Kobold | 260 TZXA |
| 13 | $FV_{RG,h}$ | Gas flow meter | Kobold | 5594 |
| | | Flow computing | Fuji Electric | 9422144T |
| 15 | $fv_{CH4,RG,h}$ | Methane analyzer | JE Gas Sensor | 28959 |
| 16 | $T_{flare}$ | N/A | N/A | N/A |
| 17 | $T_{flare\ operation}$ | N/A | N/A | N/A |
| 18 | $FV_{electricity,y}$ | Gas flow meter (at generator no.1) | Kobold | 5592 |
| | | Flow computing (at generator no.1) | Fuji Electric | 8623677T |
| | | Gas flow meter (at generator no.2) | Kobold | 5593 |
| | | Flow computing (at generator no.2) | Fuji Electric | 8623675T |
| 19 | $W_{CH4,y}$ | Methane analyzer | at generator no.1 :JE Gas Sensor (previous installation)<br>:Ambetronics (new one) | 1st: 28960<br>2nd: 2160913 |
| | | | At Generator no.2: JE Gas Sensor | 29193 |
| 20 | Total electricity | Power meter at | Carlo Gavazzi | BI1290012101P |

| Tag no. | Parameters | Equipment | Brands | Serial Number |
|---|---|---|---|---|
| | generated | generator no. 1 (internal) | | |
| | | Power meter at generator no. 2 (internal) | Carlo Gavazzi | BI0980037101I |
| 21 | $EC_{PJ,y}$ | Power meter (internal consumption) | Merlin Gerin | 0058033222 |
| 22 | $EC_{PJ,y}$ | PEA meter and Invoice/Receipt to PEA (Electricity consumed from grid) | (Internal meter) Merlin Gerin (PM210) | 0058010741 |
| 23 | $EG_{PJ,y}$ | Power meter (internal) for CPO mill | Schneider (PM7 10MG CA) | 4A943A98 |
| 24 | $EG_{PJ,y}$ | PEA meter and Invoice/Receipt to PEA | EDMI | 206500126 |

## 7. Flow diagram of current implementation of project activity

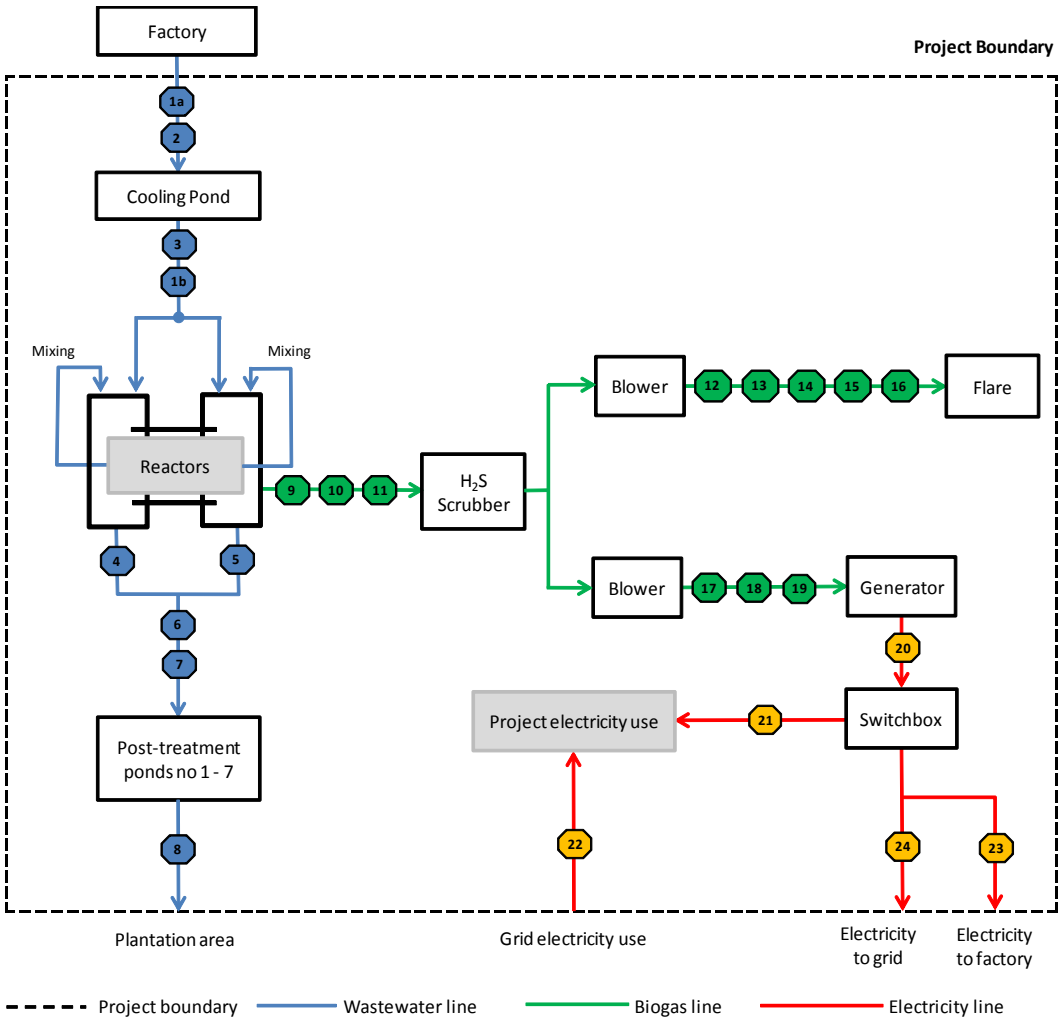


Figure 2: project activity diagram

## SECTION D. Data and parameters

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

| Data / Parameter: | $GWP_{CH4}$ |
|---|---|
| Unit: | - |
| Description: | Global warming potential |
| Source of data: | Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996) |
| Value(s) applied): | 21 (25 effective from 01/01/2013) |
| Purpose of data: | Calculation of baseline and project emissions |
| Additional comment: | n/a |

| Data / Parameter: | $B_{o,ww}$ |
|---|---|
| Unit: | kg $CH_4$/ kg COD |
| Description: | IPCC default value, as per methodology AMS-III.H |
| Source of data: | IPCC default value |
| Value(s) applied): | 0.25 |
| Purpose of data: | Calculation of baseline and project emissions |
| Additional comment: | - |

| Data / Parameter: | $UF_{BL}$ |
|---|---|
| Unit: | Factor |
| Description: | Model correction factor to account for model uncertainties |
| Source of data: | AMS-III.H, version 15 |
| Value(s) applied): | 0.89 |
| Purpose of data: | Calculation of baseline emssions |
| Additional comment: | - |

| Data / Parameter: | $UF_{PJ}$ |
|---|---|
| Unit: | Factor |
| Description: | Model correction factor to account for model uncertainties |
| Source of data: | AMS-III.H, version 15 |
| Value(s) applied): | 1.12 |
| Purpose of data: | Calculation of project emissions |
| Additional comment: | - |

| Data / Parameter: | $MCF_{ww,BL,discharge}$ / $MCF_{ww,PJ,discharge}$ |
|---|---|
| Unit: | Fraction |

| | |
|---|---|
| Description: | Methane correction factor based on discharge pathway in the baseline situation/Methane correction factor based on discharge pathway in the project situation |
| Source of data: | AMS-III.H, version 15 |
| Value(s) applied): | 0.1 |
| Purpose of data: | Calculation of baseline and project emissions |
| Additional comment: | - |

| **Data / Parameter:** | **$MCF_{ww, treatment, BL,j}$** |
|---|---|
| Unit: | Fraction |
| Description: | Methane correction factor for the baseline anaerobic wastewater treatment systems |
| Source of data: | Table III.H.1. of AMS III.H., Version 15 |
| Value(s) applied): | 0.8 (for anaerobic deep lagoon)<br>0.3 (for aerobic poor managed) |
| Purpose of data: | Calculation of baseline emissions |
| Additional comment: | The wastewater treatment system in the baseline scenario consists of series of ponds containing the different conditions. The details of baseline system is described as shown in Figure 5 of the registered PDD. |

| **Data / Parameter:** | **$MCF_{ww, treatment, PJ,k}$** |
|---|---|
| Unit: | Fraction |
| Description: | Methane conversion factor for the wastewater treatment system that will be equipped with methane recovery and combustion. |
| Source of data: | Table III.H.1. of AMS III.H., Version 15 |
| Value(s) applied): | 0.8 |
| Purpose of data: | Calculation of project emissions |
| Additional comment: | - |

| **Data / Parameter:** | **$COD_{removal,y}$** |
|---|---|
| Unit: | Tonnes/$m^3$ |
| Description: | The chemical oxygen demand removed by the anaerobic wastewater treatment system in the baseline |
| Source of data: | Measurement campaign in the baseline wastewater system for 10 days |
| Value(s) applied): | From anaerobic pond, CODremoval, y = 0.0622<br>From aerobic, poorly manage pond, $COD_{removal, y}$ = 0.00048 |
| Purpose of data: | Calculation of baseline emissions |
| Additional comment: | The COD removed value is based on COD campaign data and multiplied by a factor of 0.89 to account of uncertainty due to data from the campaign measurement. This is in line with the guidance given in paragraph 19 (a) which requires a measurement campaign of the baseline waste water treatment system for at least 10 days. The campaign was conducted by Lam Soon Laboratory. The data results were cross-checked with the value done by accredited laboratory for accuracy purpose. |

| Data / Parameter: | $CFE_{ww}$ |
|---|---|
| Unit: | Fraction |
| Description: | Capture efficiency of the biogas recovery equipment in the wastewater treatment systems. |
| Source of data: | Default value specified in AMS-III.H, Version 15 methodology |
| Value(s) applied): | 0.9 |
| Purpose of data: | Calculation of project emissions |
| Additional comment: | n/a |

| Data / Parameter: | $DE_{CH4}$ |
|---|---|
| Unit: | $Kg/m^3$ |
| Description: | Density of methane at normal conditions |
| Source of data: | "Tool to determine project emissions from flaring gases containing methane" |
| Value(s) applied): | 0.716 |
| Purpose of data: | Calculation of project emissions |
| Additional comment: | n/a |

| Data / Parameter: | $EF_{CO2, grid, y}$ |
|---|---|
| Unit: | $tCO_2/MWh$ |
| Description: | CO2 emission factor of the Thailand grid |
| Source of data: | EGAT, DEDE, EPPO, IPCC |
| Value(s) applied): | 0.52 |
| Purpose of data: | Calculation of baseline and project emissions. |
| Additional comment: | Please refer to details in Annex 3 of the registered Annex 3. |

**D.2. Data and parameters monitored**

| Data / Parameter: | $Q_{ww,i,y}$ , $Q_{ww,k,y}$ |
|---|---|
| Unit: | $m^3$ |
| Description: | Volume of wastewater treated in year y entering the cooling pond and entering the digester. |
| Measured/ Calculated / Default: | Measured by the flow meter |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | |

| Monitoring period | Total value ($m^3$) |
|---|---|
| 18/10/2011 – 31/12/2011 | 21,231 |
| 01/01/2012 – 31/12/2012 | 92,302 |
| 01/01/2013 – 31/12/2013 | 95,309 |
| 01/01/2014 – 31/07/2014 | 75,564 |

<table>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Tag no.</td><td>1b (before digester)</td></tr>
<tr><td>Equipment Type</td><td>Magnetic flow meter</td></tr>
<tr><td>Manufacturer</td><td>Kobold</td></tr>
<tr><td>Model</td><td>MID-2C1FA0AA00L</td></tr>
<tr><td>Maximum permissible error</td><td>±0.30%</td></tr>
<tr><td>Serial No.</td><td>A0792017<br><br>(Previous Installation period: 18/10/2011 to 31/12/2013)</td></tr>
<tr><td>Calibration Frequency</td><td>Not specified in the guideline.</td></tr>
<tr><td>Date of previous calibration</td><td>• 01/03/2011<br>• 07/03/2012</td></tr>
<tr><td>Date of latest calibration</td><td>04/02/2013</td></tr>
<tr><td>Validity of calibration</td><td>03/02/2014</td></tr>
</table>
<br>
<table>
<tr><td>Tag no.</td><td>1b (before digester)</td></tr>
<tr><td>Equipment Type</td><td>Magnetic flow meter</td></tr>
<tr><td>Manufacturer</td><td>ABB</td></tr>
<tr><td>Model</td><td>FEP 311.xxx.AIAI01</td></tr>
<tr><td>Maximum permissible error</td><td>±0.40%</td></tr>
<tr><td>Serial No.</td><td>1401123<br><br>(New installation period: 01/01/2014 to present)</td></tr>
<tr><td>Calibration Frequency</td><td>Not specified in the guideline.</td></tr>
<tr><td>Date of previous calibration</td><td>N/A</td></tr>
<tr><td>Date of latest calibration</td><td>N/A</td></tr>
<tr><td>Validity of calibration</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>The data was measured continuously using magnetic flow meters. The measurement was conducted hourly. The data were recorded hourly into the log-sheets during this monitoring period. The daily data were summarised and integrated into the spreadsheets monthly. The daily data were applied in the calculation of emission reductions.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The magnetic flow meter was calibrated periodically based on manufacturer’s specification from a certified testing agency but at least once per year.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline and project emissions</td></tr>
</table>

| | |
|---|---|
| Additional comment: | • The volume of wastewater treated at the 1b is monitored before entering the digester; therefore the data recorded at this monitoring point were applied in the emission reduction calculation.<br>• The flow meter with S/N: A0792017 was installed during 18/01/2011 to 31/12/2013. Then, it was replaced by the flow meter with S/N 1401123 on 01/01/2014.<br>• The calibration of flow meter was conducted periodically and mostly on time as described above. The calibration frequency is not specified in the guideline. However, the calibration shall be done at least once in a year according to the registered PDD. The calibration gap was considered during the date of calibration. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The conservative value is applied for emission reduction calculation. |

| **Data / Parameter:** | **$COD_{ww,untreated,\ y}$** |
|---|---|
| Unit: | $tCOD/m^3$ |
| Description: | Chemical oxygen demand of wastewater before the treatment system k |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | At the cooling pond for aerobic poor managed system (ID-2) |

| **Monitoring period** | **Average value (**$tCOD/m^3$**)** |
|---|---|
| 18/10/2011 – 31/12/2011 | 0.0585 |
| 01/01/2012 – 31/12/2012 | 0.0652 |
| 01/01/2013 – 31/12/2013 | 0.0690 |
| 01/01/2014 – 31/07/2014 | 0.0715 |

At the digester for anaerobic treatment system (ID-3)

| **Monitoring period** | **Average value (**$tCOD/m^3$**)** |
|---|---|
| 18/10/2011 – 31/12/2011 | 0.0480 |
| 01/01/2012 – 31/12/2012 | 0.0511 |
| 01/01/2013 – 31/12/2013 | 0.0556 |
| 01/01/2014 – 31/07/2014 | 0.0577 |

| | |
|---|---|
| Monitoring equipment: | <table><tr><td>Tag no.</td><td>n/a</td></tr><tr><td>Equipment Type</td><td>Burette</td></tr><tr><td>Manufacturer</td><td>Mettler Toledo</td></tr><tr><td>Model</td><td>N/A</td></tr><tr><td>Maximum permissible error</td><td>+/- 0.20 %</td></tr><tr><td>Serial No.</td><td>399004802</td></tr><tr><td>Calibration Frequency</td><td>Not specified in the guideline.</td></tr><tr><td>Date of previous calibration</td><td>17/10/2011<br>27/09/2012<br>10/09/2013</td></tr><tr><td>Date of latest calibration</td><td>15/09/2014</td></tr><tr><td>Validity</td><td>15/09/2015</td></tr></table> |
| Measuring/ Reading/ Recording frequency: | The measurement was conducted in an onsite laboratory. The COD content was analysed in compliance with the closed-reflux method. The analysis method applied is international standard. The results were logged in the plant operation report on a daily basis. The measurement shall ensure a 90/10-confidence level. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The monitoring equipment was calibrated at regular interval based on manufacturer specification from a certified testing agency or institution. Furthermore, monthly samples were collected and analyzed by accredited laboratory using the similar or equal standard in order to obtain the accuracy of the crosschecked results. |
| Purpose of data: | Calculation of baseline emissions |
| Additional comment: | • This parameter is used for the determination of $COD_{y,removed,j}$.<br>• Since, the operation manual of equipment does not specify the calibration frequency. The equipment shall be calibrated at least once a year. The calibration was conducted before the end of validity. The calibration gap was considered only during the time of equipment calibration. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The conservative value is applied for emission reduction calculation. |

| **Data / Parameter:** | **$COD_{ww,treated,y}$** |
|---|---|
| Unit: | $tCOD/m^3$ |
| Description: | Chemical oxygen demand of the wastewater after the treatment system k |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant data |

Value(s) of monitored parameter:

The monitored value at the cooling pond before wastewater supplied to the digester.

| Monitoring period | ID 3 |
|---|---|
| | Average value (tCOD/$m^3$) |
| 18/10/2011 – 31/12/2011 | 0.0480 |
| 01/01/2012 – 31/12/2012 | 0.0511 |
| 01/01/2013 – 31/12/2013 | 0.0556 |
| 01/01/2014 – 31/07/2014 | 0.0577 |

The average value of two monitoring points after the digester.

| Monitoring period | ID 4 and ID 5 |
|---|---|
| | Average value (tCOD/$m^3$) |
| 18/10/2011 – 31/12/2011 | 0.0086 |
| 01/01/2012 – 31/12/2012 | 0.0044 |
| 01/01/2013 – 31/12/2013 | 0.0052 |
| 01/01/2014 – 31/07/2014 | 0.0051 |

The monitored value at the combination point of wastewater leaving the digesters.

| Monitoring period | ID 6 |
|---|---|
| | Average value (tCOD/$m^3$) |
| 18/10/2011 – 31/12/2011 | 0.0087 |
| 01/01/2012 – 31/12/2012 | 0.0046 |
| 01/01/2013 – 31/12/2013 | 0.0052 |
| 01/01/2014 – 31/07/2014 | 0.0052 |

The monitored value at the combination point of wastewater leaving the digesters.

| Monitoring period | ID 8 |
|---|---|
| | Average value (tCOD/$m^3$) |
| 18/10/2011 – 31/12/2011 | 0.0071 |
| 01/01/2012 – 31/12/2012 | 0.0027 |
| 01/01/2013 – 31/12/2013 | 0.0040 |
| 01/01/2014 – 31/07/2014 | 0.0029 |

Monitoring equipment:

| | |
|---|---|
| Tag no. | n/a |
| Equipment Type | Burette |
| Manufacturer | Mettler Toledo |
| Model | N/A |
| Maximum permissible error | +/- 0.20 % |
| Serial No. | 399004802 |
| Calibration Frequency | Not specified in the guideline. |
| Date of previous calibration | 17/10/2011<br>27/09/2012<br>10/09/2013 |
| Date of latest calibration | 15/09/2014 |
| Validity | 15/09/2015 |

Measuring/ Reading/ Recording frequency:

The measurement was conducted onsite laboratory. The COD content was analysed in compliance with the closed-reflux method. The analysis method applied is international standard. The results were logged in the plant operation report on a daily basis. The measurement shall ensure a 90/10-confidence level.

| | |
|---|---|
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The monitoring equipment was calibrated at regular interval based on manufacturer specification from a certified testing agency or institution. Furthermore, monthly samples were collected and analyzed by accredited laboratory using the similar or equal standard in order to obtain the accuracy of the crosschecked results. |
| Purpose of data: | Calculation of baseline emissions |
| Additional comment: | • The value of each monitoring point is considered as per the condition of treatment system as following;<br>ID 3 is for aerobic poor managed condition (cooling pond)<br>ID 4, 5, 6 are for anaerobic digester<br>ID 8 is for aerobic poor managed condition (facultative pond 1&2, oxidation pond and polishing pond in the post treatment system)<br>• This parameter is used for the determination of $COD_{y,removed,j}$.<br>• Since, the operation manual of equipment does not specify the calibration frequency. The equipment shall be calibrated at least once a year. The calibration was conducted before the end of validity. The calibration gap was considered only during the time of equipment calibration. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The lower value is taken into account for conservativeness of emission reduction calculation. |

| **Data / Parameter:** | **$COD_{ww, discharged, PJ,y}$** |
|---|---|
| Unit: | $tCOD/m^3$ |
| Description: | Chemical oxygen demand of the final treated wastewater discharged into the plantation area in the project activity |
| Measured/ Calculated / Default: | Measured |
| Source of data: | Plant data |
| Value(s) of monitored parameter: | |

| **Monitoring period** | **ID-9** |
|---|---|
| | **Average value ($tCOD/m^3$)** |
| 10/08/2011 – 31/12/2011 | 0.0071 |
| 01/01/2012 – 31/12/2012 | 0.0027 |
| 01/01/2013 – 31/12/2013 | 0.0040 |
| 01/01/2014 – 31/07/2014 | 0.0029 |

| | |
|---|---|
| Monitoring equipment: | <table><tr><td>Tag no.</td><td>n/a</td></tr><tr><td>Equipment Type</td><td>Burette</td></tr><tr><td>Manufacturer</td><td>Mettler Toledo</td></tr><tr><td>Model</td><td>N/A</td></tr><tr><td>Maximum permissible error</td><td>±0.20 %</td></tr><tr><td>Serial No.</td><td>399004802</td></tr><tr><td>Calibration Frequency</td><td>Not specified in the guideline.</td></tr><tr><td>Date of previous calibration</td><td>• 17/10/2011<br>• 27/09/2012<br>• 10/09/2013</td></tr><tr><td>Date of latest calibration</td><td>15/09/2014</td></tr><tr><td>Validity</td><td>15/09/2015</td></tr></table> |
| Measuring/ Reading/ Recording frequency: | The measurement was conducted onsite laboratory. The COD content was analysed in comply with closed-reflux method. The analysis method applied is international standard. The results were logged in the plant operation report on a daily basis. The measurement shall ensure a 90/10-confidence level. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The monitoring equipment was calibrated at regular interval based on manufacturer specification from a certified testing agency or institution. Furthermore, monthly samples were collected and analyzed by accredited laboratory using the similar or equal standard in order to obtain the accuracy of the crosschecked results. |
| Purpose of data: | Calculation of project emission |
| Additional comment: | Since, the operation manual of equipment does not specify the calibration frequency. The equipment shall be calibrated at least once a year. The calibration was conducted before the end of validity. The calibration gap was considered only during the time of equipment calibration. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The higher value is taken into account for conservativeness of emission reduction calculation. |

| | |
|---|---|
| **Data / Parameter:** | $Q_{discharge,y\ (outlet)}$ |
| Unit: | $m^3$/year |
| Description: | Volume of wastewater treated discharged in year y |
| Measured/ Calculated / Default: | Measured by the flow meter |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | <table><tr><th>Monitoring period</th><th>Total value ($m^3$)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>21,231</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>92,302</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>95,309</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>75,564</td></tr></table> |

| | |
|---|---|
| Monitoring equipment: | Please see detail in parameter of $Q_{ww,y}$ (ID1b) |
| Measuring/ Reading/ Recording frequency: | The data was measured continuously using magnetic flow meters. The measurement was conducted hourly. The data monitored was recorded in the data logger and the log sheets. The data were recorded hourly into the log-sheets during this monitoring period. The daily data were summarised and integrated into electronic spreadsheets monthly. The daily data were applied in the calculation of emission reductions. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The magnetic flow meter was calibrated periodically based on manufacturer's specification from a certified testing agency but at least once per year. |
| Purpose of data: | Calculation of project emission |
| Additional comment: | In order to consider conservativeness of ER calculation, the amount of $Q_{discharge,y\ (outlet)}$ at ID-7 is based on the monitored value of $Q_{ww,y,}$ at ID-1b. |

| **Data / Parameter:** | **$S_{final,PJ,y}$** |
|---|---|
| Unit: | t (tonnes) / year |
| Description: | Amount of dry matter in final sludge generated by the project wastewater treatment in the year y |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | |

| Monitoring period | Total value (tonnes) |
|---|---|
| 10/08/2011 – 31/12/2011 | 0 |
| 01/01/2012 – 31/12/2012 | 0 |
| 01/01/2013 – 31/12/2013 | 0 |
| 01/01/2014 – 31/07/2014 | 0 |

Monitoring equipment:

| | |
|---|---|
| Tag no. | - |
| Equipment Type | Weight bridge |
| Manufacturer | n/a |
| Model | n/a |
| Maximum permissible error | n/a |
| Serial No. | n/a |
| Calibration Frequency | n/a |
| Date of previous calibration | n/a |
| Date of latest calibration | n/a |
| Validity | n/a |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | The practice of final disposal of the sludge shall be documented in the plant operation log sheets and documented with additional evidence such as pictures. Data will be archived electronically, for at least 2 years after last issuance of CERs. |

| | |
|---|---|
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | n/a |
| Purpose of data: | The calculation of project emissions |
| Additional comment: | There was none of excess sludge generated during this monitoring period. |

| **Data / Parameter:** | **$FV_{digester\ y}$** |
|---|---|
| Unit: | $Nm^3$ in year *y* |
| Description: | Volumetric flow rate of biogas on dry basis leaving the digester in year *y* ($BG_{burnt,y}$) |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | |

| **Monitoring period** | **Total value ($Nm^3$)** |
|---|---|
| 18/10/2011 – 31/12/2011 | 617,144 |
| 01/01/2012 – 31/12/2012 | 2,692,668 |
| 01/01/2013 – 31/12/2013 | 3,083,443 |
| 01/01/2014 – 31/07/2014 | 2,688,513 |

Monitoring equipment:

| | |
|---|---|
| Tag no. | ID-10 |
| Equipment Type | Gas flow meter |
| Manufacturer | Kobold |
| Model | DOG-1120 |
| Maximum permissible error | +/- 1.5% |
| Serial No. | 5843 |
| Calibration Frequency | Annually |
| Date of previous calibration | • 01/03/2011<br>• 06/03/2012 |
| Date of latest calibration | 12/12/2013 |
| Validity | 11/12/2014 |

| | |
|---|---|
| Tag no. | ID-10 (FC1) |
| Equipment Type | Flow computing |
| Manufacturer | Fuji Electric |
| Model | PXH9A211-5V000 |
| Maximum permissible error | +/- 0.1% |
| Serial No. | 8623676T |
| Calibration Frequency | Annually |
| Date of previous calibration | • 01/03/2011<br>• 06/03/2012 |
| Date of latest calibration | 12/12/2013 |
| Validity | 11/12/2014 |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | The monitoring equipment set of biogas quantity consists of a gas flow meter and a flow computing. The measurement has been taken on an hourly basis. Using gas flow meter, it can monitor the amount of biogas in m3/hour unit. Then the conversion of monitored unit to normal |

| | |
|---|---|
| | condition unit in Nm3/hour was done by the flow computing. The values received were integrated with data logger to have real time data monitoring and control. The normalized flow of biogas was shown on the display.<br>The daily data monitored were recorded into log-sheets. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The monitoring devices were calibrated at regular intervals based on manufacturer specification from a certified testing agency or institution. The calibration was done at least once a year. |
| Purpose of data: | The calculation of baseline emissions. |
| Additional comment: | The monitoring equipment was calibrated annually. However, the daily data monitored were not recorded properly into the log-sheets. The value applied of this parameter is calculated based on the amount of biogas sent to gas engines plus the amount of biogas sent to flare. |

| **Data / Parameter:** | $w_{CH4,y}$ |
|---|---|
| Unit: | fraction |
| Description: | Methane content in the biogas in the year y (volume fraction) |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | Lower value<br>**Monitoring period** / **Total value (%)**<br>18/10/2011 – 31/12/2011 / 55.91%<br>01/01/2012 – 31/12/2012 / 57.53%<br>01/01/2013 – 31/12/2013 / 53.36%<br>01/01/2014 – 31/07/2014 / 54.81%<br><br>Upper value<br>**Monitoring period** / **Total value (%)**<br>18/10/2011 – 31/12/2011 / 57.62%<br>01/01/2012 – 31/12/2012 / 58.32%<br>01/01/2013 – 31/12/2013 / 60.18%<br>01/01/2014 – 31/07/2014 / 55.41% |

Monitoring equipment:

| | |
|---|---|
| Tag no. | ID 20.1 (at the generator no.1) |
| Equipment Type | Continuous gas analyser (IR sensor) |
| Manufacturer | JE gas sensor |
| Model | MJE |
| Maximum permissible error | +/- 0.8% (The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | 28960 (Previous installation: 18/10/2014 to 20/04/2014) |
| Calibration Frequency | Once a year |
| Date of previous calibration | 21/11/2013 |
| Date of latest calibration | 21/11/2013 |
| Validity | 20/11/2014 |

| | |
|---|---|
| Tag no. | ID 20.1 (at the generator no.1) |
| Equipment Type | Continuous gas analyser (IR sensor) |
| Manufacturer | Ambetronics |
| Model | IR-5000 WP |
| Maximum permissible error | Not specify |
| Serial No. | No2: 2160913 (New installation: 21/04/2014 to present) |
| Calibration Frequency | Once a year |
| Date of previous calibration | N/A |
| Date of latest calibration | N/A |
| Validity | N/A |

| | |
|---|---|
| Tag no. | ID 20.2 (at the generator no.2) |
| Equipment Type | Continuous gas analyser (IR sensor) |
| Manufacturer | JE gas sensor |
| Model | MJE |
| Maximum permissible error | +/- 6.80% (The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | 2193 |
| Calibration Frequency | Once a year |
| Date of previous calibration | 13/03/2012 |
| Date of latest calibration | 14/12/2013 |
| Validity | 13/12/2014 |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | At the monitoring point of biogas consumed in the generator no.1 and no.2 were measured by continuous gas analyzers (ID 20.1 and ID 20.2). The data were recorded hourly into the log-sheets. The measurement of this parameter ensures 90/10 confidence/precision level. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The gas analyser was periodically calibrated according to manufacturer's specifications/recommendation or once a year |
| Purpose of data: | The calculation of baseline and project emissions. |
| Additional comment: | • At the monitoring of methane in biogas at generator no.1, the analyser with S/N was replaced by a new one with S/N 2160913. All of the gas analysers are infrared sensor type.<br><br>• In order to adjust monitoring value during the calibration gap, the monitored data are applied with the maximum value identified in the calibration test report. The gap of calibration was considered during the delay of validity scheduled to the date of calibration. All of the monitored value are averaged and ensured 90/10-confidence/precision levels. The higher average value is applied for project emission calculation. The lower average value is applied for baseline emission calculation. |

| **Data / Parameter:** | **$T_{biogas}$ and $P_{biogas}$** |
|---|---|
| Unit: | °C and bar |
| Description: | Temperature and pressure of produced biogas |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | Detailed in data log-sheets. |

Monitoring equipment:

| | |
|---|---|
| Tag no. | ID-12 (T) at the digester |
| Equipment Type | Temperature sensor |
| Manufacturer | Kobold |
| Model | TWD-B9410213BY |
| Maximum permissible error | ±0.11%<br>(The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | Not specified |
| Calibration Frequency | Not specified in the guideline |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-13 (T) at the flaring system |
| Equipment Type | Temperature sensor |
| Manufacturer | Kobold |
| Model | n/a |
| Maximum permissible error | +/- 1.36%<br>(The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | Not specified |
| Calibration Frequency | Not specified in the guideline |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-18.1 (T) at the generator no.1 |
| Equipment Type | Temperature sensor |
| Manufacturer | Kobold |
| Model | TWD-B9410213BY |
| Maximum permissible error | +/- 0.53%<br>(The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | Not specified |
| Calibration Frequency | Not specified in the guideline |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-18.2 (T) at the generator no.2 |

| | |
|---|---|
| Equipment Type | Temperature sensor |
| Manufacturer | Kobold |
| Model | TWD-B9410213BY |
| Maximum permissible error | +/- 0.24%<br>(The error value is not specified in the guideline. This value is based on the latest calibration report.) |
| Serial No. | Not specified |
| Calibration Frequency | Not specified in the guideline |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-12 (P) at the digester |
| Equipment Type | Pressure transmitter |
| Manufacturer | Honeywell |
| Model | ST 3000 |
| Maximum permissible error | +/- 1.00 % |
| Serial No. | 1006 800278800002 |
| Calibration Frequency | Not specify in the guideline |
| Date of previous calibration | 02/03/2011<br>07/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-13 (P) at the flaring system |
| Equipment Type | Pressure transmitter |
| Manufacturer | Kobold |
| Model | SEN3251 |
| Maximum permissible error | +/- 1.00 % |
| Serial No. | 260 0 422 |
| Calibration Frequency | Not specify in the guideline |
| Date of previous calibration | 02/02/2011 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-18.1 (P) at the generator no.1 |
| Equipment Type | Pressure transmitter |
| Manufacturer | Kobold |
| Model | SEN3251 |
| Maximum permissible error | +/- 1.00 % |
| Serial No. | 260 0 502 |
| Calibration Frequency | Not specify in the guideline |
| Date of previous calibration | 02/02/2011 |
| Date of latest calibration | 12/12/2013 |
| Validity | 16/02/2015 |

| | |
|---|---|
| Tag no. | ID-18.2 (P) at the generator no2 |

| | |
|---|---|
| | <table><tr><td>Equipment Type</td><td>Pressure transmitter</td></tr><tr><td>Manufacturer</td><td>Kobold</td></tr><tr><td>Model</td><td>SEN3251</td></tr><tr><td>Maximum permissible error</td><td>+/- 1.00 %</td></tr><tr><td>Serial No.</td><td>260TZXA</td></tr><tr><td>Calibration Frequency</td><td>Not specify in the guideline</td></tr><tr><td>Date of previous calibration</td><td>02/02/2011</td></tr><tr><td>Date of latest calibration</td><td>10/12/2013</td></tr><tr><td>Validity</td><td>09/12/2014</td></tr></table> |
| Measuring/ Reading/ Recording frequency: | The temperature and pressure of the produced biogas were measured continuously with the volume to allow for normalization. The measurements are conducted at four monitoring points of the biogas outlet; at digester, at the flaring system, at the generator no.1 and at generator no.2. The conversion unit to $Nm^3$ is made directly and the flow rates unit is recorded in Nm3 unit. The data was recorded hourly into the log-sheet. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | Calibration as per manufacturer's recommendations or at least once per year is conducted. Maintenance was performed as per the guideline/maintenance schedule recommended by. The uncertainty level of the data is expected to be low. The records of calibration were kept at site. |
| Purpose of data: | The calculation of baseline emissions and project emission. |
| Additional comment: | n/a |

| **Data / Parameter:** | **$FV_{RG,h}$** |
|---|---|
| Unit: | $Nm^3$ in year *y* |
| Description: | Volumetric flow rate of the biogas to the flare in dry basis at normal condition in hour h ($BG_{flare,y}$) |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | <table><tr><th>Monitoring period</th><th>Total value ($Nm^3$)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>0</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>0</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>0</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>0</td></tr></table> |

<table>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Tag no.</td><td>ID-13</td></tr>
<tr><td>Equipment Type</td><td>Gas flow meter</td></tr>
<tr><td>Manufacturer</td><td>Kobold</td></tr>
<tr><td>Model</td><td>DOG-1120</td></tr>
<tr><td>Maximum permissible error</td><td>+/- 1.5%</td></tr>
<tr><td>Serial No.</td><td>5594</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of previous calibration</td><td>01/03/2011<br>06/03/2012</td></tr>
<tr><td>Date of latest calibration</td><td>10/12/2013</td></tr>
<tr><td>Validity</td><td>09/12/2014</td></tr>
</table>
<table>
<tr><td>Tag no.</td><td>ID-9 (FC3)</td></tr>
<tr><td>Equipment Type</td><td>Flow computing</td></tr>
<tr><td>Manufacturer</td><td>Fuji Electric</td></tr>
<tr><td>Model</td><td>PXH9A211-5V000</td></tr>
<tr><td>Maximum permissible error</td><td>+/- 0.1%</td></tr>
<tr><td>Serial No.</td><td>9422144T</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of previous calibration</td><td>01/03/2011<br>06/03/2012</td></tr>
<tr><td>Date of latest calibration</td><td>10/12/2013</td></tr>
<tr><td>Validity</td><td>09/12/2014</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>The monitoring equipment set of biogas quantity consists of a gas flow meter and a flow computing. The measurement has been taken on an hourly basis. Using gas flow meter, it can monitor the amount of biogas in m3/hour unit. Then the conversion of monitored unit to normal condition in Nm3/hour was done by the flow computing. The values received were integrated with data logger in order to have real time data monitoring and control. The normalized flow of biogas flared was shown on the display. The daily data monitored were recorded into log-sheets and applied in the ER calculation.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The monitoring devices were calibrated at regular intervals based on manufacturer specification from a certified testing agency or institution. The calibration was done at least once a year.</td></tr>
<tr><td>Purpose of data:</td><td>The calculation of project emissions.</td></tr>
<tr><td>Additional comment:</td><td>• The daily data was summarised and integrated into electronic spreadsheets monthly.<br>• Due to the maximum permissible error of gas flow meter is higher than the flow computing, therefore this value are considered for applying with the monitored data. The calibration shall be done at least once in a year as per the registered PDD. Thus, the calibration gap was considered during; 29/02/2012 to 06/03/2013, and 05/03/2013 to 10/12/2013. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The lower value is taken into account for conservativeness of emission reduction calculation.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$fv_{CH4,y}$</td></tr>
<tr><td>Unit:</td><td>fraction</td></tr>
<tr><td>Description:</td><td>Volumetric fraction of component i in the residual gas in the hour h where i=CH4 and N2 of the residual gas in dry basis at normal conditions in the hour h</td></tr>
<tr><td>Measured/ Calculated / Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Plant records</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Lower value<br><table><tr><th>Monitoring period</th><th>Total value (%)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>55.91%</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>57.53%</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>53.36%</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>54.81%</td></tr></table><br>Upper value<br><table><tr><th>Monitoring period</th><th>Total value (%)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>57.62%</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>58.32%</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>60.18%</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>55.41%</td></tr></table></td></tr>
<tr><td>Monitoring equipment:</td><td><table><tr><td>Tag no.</td><td>n/a</td></tr><tr><td>Equipment Type</td><td>n/a</td></tr><tr><td>Manufacturer</td><td>n/a</td></tr><tr><td>Model</td><td>n/a</td></tr><tr><td>Maximum permissible error</td><td>n/a</td></tr><tr><td>Serial No.</td><td>n/a</td></tr><tr><td>Calibration Frequency</td><td>n/a</td></tr><tr><td>Date of previous calibration</td><td>n/a</td></tr><tr><td>Date of latest calibration</td><td>n/a</td></tr><tr><td>Validity</td><td>n/a</td></tr></table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>The data were recorded hourly into the log-sheets. The average value data per data were transferred to the spreadsheets. The measurement of this parameter ensures 90/10-confidence/precision levels.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The gas analyser was periodically calibrated according to manufacturer’s specifications/recommendation or once a year.</td></tr>
<tr><td>Purpose of data:</td><td>The calculation of baseline and project emissions.</td></tr>
<tr><td>Additional comment:</td><td>Data recording of this parameter during this monitoring period was not conducted properly. The monitoring data was not fully available for emission reduction calculation. Therefore, the methane fraction that is applied for project emission in flaring activity is based on the parameter ID 20.1 and ID 20.2 mentioned above. The upper value has been applied for project emission.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$T_{flare}$</td></tr>
<tr><td>Unit:</td><td>°C</td></tr>
<tr><td>Description:</td><td>Temperature of methane flare used for flame detection</td></tr>
<tr><td>Measured/<br>Calculated /<br>Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Plant records</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Monitoring period</th><th>Total value (°C)</th></tr>
<tr><td>18/10/2011 – 31/12/2011</td><td>n/a</td></tr>
<tr><td>01/01/2012 – 31/12/2012</td><td>n/a</td></tr>
<tr><td>01/01/2013 – 31/12/2013</td><td>n/a</td></tr>
<tr><td>01/01/2014 – 31/07/2014</td><td>n/a</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Tag no.</td><td>n/a</td></tr>
<tr><td>Equipment Type</td><td>n/a</td></tr>
<tr><td>Manufacturer</td><td>n/a</td></tr>
<tr><td>Model</td><td>n/a</td></tr>
<tr><td>Maximum permissible error</td><td>n/a</td></tr>
<tr><td>Serial No.</td><td>n/a</td></tr>
<tr><td>Calibration Frequency</td><td>n/a</td></tr>
<tr><td>Date of previous calibration</td><td>n/a</td></tr>
<tr><td>Date of latest calibration</td><td>n/a</td></tr>
<tr><td>Validity</td><td>n/a</td></tr>
</table>
</td></tr>
<tr><td>Measuring/<br>Reading/<br>Recording frequency:</td><td>The flare temperature was measured with a type N thermocouple continuously and data will be logged digitally and stored (1 min aggregated average value) in an easily accessible and transparent format. A temperature above 500 $^{o}$C indicated that a significant amount of gases are still being burnt and that the flare is operating.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The temperature sensor will undergo maintenance / calibration subject to appropriate industry standards, or as per recommendation of supplier, or at least once per year. Data shall be archived for at least 2 years after crediting period ends. Level of uncertainty for data is expected to be low.</td></tr>
<tr><td>Purpose of data:</td><td>The calculation of project emissions.</td></tr>
<tr><td>Additional comment:</td><td>The monitored data were not recorded properly. The data package of considering flare efficiency is incomplete. The value of flare efficiency is assumed as zero % in order to calculate the project emission. This is conservative.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$T_{flare\ operation}$</td></tr>
<tr><td>Unit:</td><td>hours</td></tr>
<tr><td>Description:</td><td>Operation time of the flare per year y</td></tr>
<tr><td>Measured/ Calculated / Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Plant records</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Monitoring period</th><th>Total value (hours)</th></tr>
<tr><td>18/10/2011 – 31/12/2011</td><td>n/a</td></tr>
<tr><td>01/01/2012 – 31/12/2012</td><td>n/a</td></tr>
<tr><td>01/01/2013 – 31/12/2013</td><td>n/a</td></tr>
<tr><td>01/01/2014 – 31/07/2014</td><td>n/a</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Tag no.</td><td>n/a</td></tr>
<tr><td>Equipment Type</td><td>n/a</td></tr>
<tr><td>Manufacturer</td><td>n/a</td></tr>
<tr><td>Model</td><td>n/a</td></tr>
<tr><td>Maximum permissible error</td><td>n/a</td></tr>
<tr><td>Serial No.</td><td>n/a</td></tr>
<tr><td>Calibration Frequency</td><td>n/a</td></tr>
<tr><td>Date of previous calibration</td><td>n/a</td></tr>
<tr><td>Date of latest calibration</td><td>n/a</td></tr>
<tr><td>Validity</td><td>n/a</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>This parameter was measured continuously with the flow rate during the operation of flaring.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The calibration was conducted as per manufacture’s recommendations, or at least once per year.</td></tr>
<tr><td>Purpose of data:</td><td>The calculation of project emissions.</td></tr>
<tr><td>Additional comment:</td><td>The monitored data were not recorded properly. The data package of considering flare efficiency is incomplete. The value of flare efficiency is assumed as zero % in order to calculate the project emission. This is conservative.</td></tr>
</table>

| **Data / Parameter:** | **$FV_{electricity,y}$** |
|---|---|
| Unit: | $Nm^3$ in year *y* |
| Description: | Volumetric flow rate of biogas on dry basis entering for power generation ($BG_{electricity,y}$) |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | |

| **Monitoring period** | **Total value ($Nm^3$)** |
|---|---|
| 18/10/2011 – 31/12/2011 | 617,144 |
| 01/01/2012 – 31/12/2012 | 2,692,668 |
| 01/01/2013 – 31/12/2013 | 3,083,443 |
| 01/01/2014 – 31/07/2014 | 2,688,513 |

Monitoring equipment:

| | |
|---|---|
| Tag no. | ID-19.1 at generator no.1 |
| Equipment Type | Gas flow meter |
| Manufacturer | Kobold |
| Model | DOG-1120 |
| Maximum permissible error | +/- 1.5% |
| Serial No. | 5592 |
| Calibration Frequency | Annually |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 12/12/2013 |
| Validity | 11/12/2014 |

| | |
|---|---|
| Tag no. | ID-19.1 (FC) at generator no.1 |
| Equipment Type | Flow computing |
| Manufacturer | Fuji Electric |
| Model | PXH9A211-5V000 |
| Maximum permissible error | +/- 0.1% |
| Serial No. | 8623677T |
| Calibration Frequency | Annually |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 12/12/2013 |
| Validity | 11/12/2014 |

| | |
|---|---|
| Tag no. | ID-19.2 at generator no.2 |
| Equipment Type | Gas flow meter |
| Manufacturer | Kobold |
| Model | DOG-1120 |
| Maximum permissible error | +/- 1.5% |
| Serial No. | 5593 |
| Calibration Frequency | Annually |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Tag no. | ID-19.2 (FC) at generator no.2 |
| Equipment Type | Flow computing |
| Manufacturer | Fuji Electric |
| Model | PXH9A211-5V000 |
| Maximum permissible error | +/- 0.1% |
| Serial No. | 8623675T |
| Calibration Frequency | Annually |
| Date of previous calibration | 01/03/2011<br>06/03/2012 |
| Date of latest calibration | 10/12/2013 |
| Validity | 09/12/2014 |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | The monitoring equipment set of biogas quantity consists of a gas flow meter and a flow computing. The measurement has been taken on an hourly basis. Using gas flow meter, it can monitor the amount of biogas in m3/hour unit. Then the conversion of monitored unit to normal condition unit in Nm3/hour was done by the flow computing. The values received were integrated with data logger to have real time data monitoring and control. The normalized flow of biogas was shown on the display. The daily data monitored were recorded into log-sheets. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The monitoring devices were calibrated at regular intervals based on manufacturer specification from a certified testing agency or institution. The calibration was done at least once a year. |
| Purpose of data: | The calculation of baseline emissions. |
| Additional comment: | • The daily data was summarised and integrated into electronic spreadsheets monthly.<br>• Due to the maximum permissible error of gas flow meter is higher than the flow computing, therefore this value are considered for applying with the monitored data. The calibration shall be done at least once in a year as per the registered PDD. Thus, the calibration gap was considered during; 29/02/2012 to 06/03/2012, 05/03/2013 to 10/12/2013. Either the maximum permissible error recommended by manufacturer or the error identified in the latest calibration report whichever is applied with the monitored data during the calibration gap. The lower value is taken into account for conservativeness of emission reduction calculation. |

| **Data / Parameter:** | **- ($EG_{total,y}$)** |
|---|---|
| Unit: | MWh |
| Description: | Total annual electricity generated from the project in year y |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | |

| Monitoring period | Total value (MWh) |
|---|---|
| 10/08/2011 – 31/12/2011 | 1,436 |
| 01/01/2012 – 31/12/2012 | 4,444 |
| 01/01/2013 – 31/12/2013 | 4,930 |
| 01/01/2014 – 31/07/2014 | 4,656 |

| | |
|---|---|
| Monitoring equipment: | |

| | |
|---|---|
| Tag no. | ID-21.1 at generator no.1 |
| Equipment Type | Power meter |
| Manufacturer | Carlo Gavazzi |
| Model | WM3-96 |
| Maximum permissible error | +/- 0.20% (Class 2) |
| Serial No. | BI1290012101P |
| Calibration Frequency | Annually |
| Date of previous calibration | N/A |
| Date of latest calibration | N/A |
| Validity | N/A |

| | |
|---|---|
| Tag no. | ID-21.2 at generator no.2 |
| Equipment Type | Power meter |
| Manufacturer | Carlo Gavazzi |
| Model | WM3-96 |
| Maximum permissible error | +/- 0.20% (Class 2) |
| Serial No. | BI0980037101I |
| Calibration Frequency | Annually |
| Date of previous calibration | N/A |
| Date of latest calibration | N/A |
| Validity | N/A |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | The total of electricity generated by the project was continuously measured using the energy meters. The monitored data were recorded hourly into the log-sheets. The daily data were summarised and integrated into the spreadsheets monthly. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The calibration of power meters shall be conducted annually by external laboratory. |
| Purpose of data: | The calculation of baseline emissions. |
| Additional comment: | n/a |

| | |
|---|---|
| **Data / Parameter:** | **$EC_{consumed,y}$** |
| Unit: | MWh |
| Description: | Annual electricity to operate the facilities or power auxiliary equipment |
| Measured/ Calculated / Default: | Measured. |
| Source of data: | Plant records |
| Value(s) of monitored parameter: | ID-21: Internal consumption |

| Monitoring period | Total value (MWh) |
|---|---|
| 18/10/2011 – 31/12/2011 | 52.62 |
| 01/01/2012 – 31/12/2012 | 176.01 |
| 01/01/2013 – 31/12/2013 | 189.13 |
| 01/01/2014 – 31/07/2014 | 153.94 |

<table>
<tr><td>Monitoring equipment:</td><td>ID-22: Grid consumption
<table>
<tr><th>Monitoring period</th><th>Total value (Mwh)</th></tr>
<tr><td>18/10/2011 – 31/12/2011</td><td>3.89</td></tr>
<tr><td>01/01/2012 – 31/12/2012</td><td>46.58</td></tr>
<tr><td>01/01/2013 – 31/12/2013</td><td>39.29</td></tr>
<tr><td>01/01/2014 – 31/07/2014</td><td>17.83</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td>Tag no.</td><td>ID-22 (Internal consumption)</td></tr>
<tr><td>Equipment Type</td><td>Power meter</td></tr>
<tr><td>Manufacturer</td><td>Merlin Gerin</td></tr>
<tr><td>Model</td><td>PM210</td></tr>
<tr><td>Maximum permissible error</td><td>+/- 1%</td></tr>
<tr><td>Serial No.</td><td>0058033222</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of previous calibration</td><td>N/A</td></tr>
<tr><td>Date of latest calibration</td><td>N/A</td></tr>
<tr><td>Validity</td><td>N/A</td></tr>
</table>
<table>
<tr><td>Tag no.</td><td>ID-23 (Grid consumption)</td></tr>
<tr><td>Equipment Type</td><td>Power meter</td></tr>
<tr><td>Manufacturer</td><td>Merlin Gerin</td></tr>
<tr><td>Model</td><td>PM210</td></tr>
<tr><td>Maximum permissible error</td><td>+/- 1%</td></tr>
<tr><td>Serial No.</td><td>0058010741</td></tr>
<tr><td>Calibration Frequency</td><td>Annually</td></tr>
<tr><td>Date of previous calibration</td><td>N/A</td></tr>
<tr><td>Date of latest calibration</td><td>N/A</td></tr>
<tr><td>Validity</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>The electricity consumed by the project activity was monitored continuously by two power meters. The internal power meter of ID-22 monitored the electricity consumption from the electricity production of project activity. The internal power meter of ID-23 monitored the electricity consumption of the project from grid. The monitored data were recorded hourly into the log-sheet. The daily data were summarised and integrated into the spreadsheets monthly.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>n/a</td></tr>
<tr><td>QA/QC procedures:</td><td>The calibration of the power meters was conducted at least once in a year.</td></tr>
<tr><td>Purpose of data:</td><td>The calculation of project emissions.</td></tr>
<tr><td>Additional comment:</td><td>The project emission is considered the electricity consumption from the gird (ID-23) only. Since, the electricity generated by the project (ID-21) is from renewable energy source, therefore none of emission from this activity is taken into the calculation.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>EG <sub>exported,y</sub></td></tr>
<tr><td>Unit:</td><td>MWh</td></tr>
<tr><td>Description:</td><td>Amount of electricity to substitute grid electricity by the project in year y</td></tr>
<tr><td>Measured/ Calculated / Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Plant records and PEA monthly invoice</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>ID-23: Supply to palm oil mill
<table>
<tr><th>Monitoring period</th><th>Total value (Mwh)</th></tr>
<tr><td>18/10/2011 – 31/12/2011</td><td>0</td></tr>
<tr><td>01/01/2012 – 31/12/2012</td><td>0</td></tr>
<tr><td>01/01/2013 – 31/12/2013</td><td>0</td></tr>
<tr><td>01/01/2014 – 31/07/2014</td><td>0</td></tr>
</table>
ID-24: Export to national grid
<table>
<tr><th>Monitoring period</th><th>Total value (Mwh)</th></tr>
<tr><td>18/10/2011 – 31/12/2011</td><td>1,284</td></tr>
<tr><td>01/01/2012 – 31/12/2012</td><td>3,182</td></tr>
<tr><td>01/01/2013 – 31/12/2013</td><td>3,839</td></tr>
<tr><td>01/01/2014 – 31/07/2014</td><td>3,319</td></tr>
</table></td></tr>
</table>

| | |
|---|---|
| Monitoring equipment: | |

| | |
|---|---|
| Tag no. | ID-24 (supply to CPO mill) |
| Equipment Type | Power meter |
| Manufacturer | Schneider |
| Model | PM710 |
| Maximum permissible error | +/- 1% |
| Serial No. | 4A943A98 |
| Calibration Frequency | Annually |
| Date of previous calibration | N/A |
| Date of latest calibration | N/A |
| Validity | N/A |

| | |
|---|---|
| Tag no. | ID-25 (export to grid) |
| Equipment Type | Power meter |
| Manufacturer | EDMI |
| Model | Mk6 |
| Maximum permissible error | +/- 1% |
| Serial No. | 206500126 |
| Calibration Frequency | Annually |
| Date of previous calibration | N/A |
| Date of latest calibration | 22/05/2014 |
| Validity | 21/05/2015 |

| | |
|---|---|
| Measuring/ Reading/ Recording frequency: | The electricity supplied to the palm oil mill was continuously monitored by the internal power meter own by the project participant (ID-24). The electricity exported to the grid was continuously measured by using the energy meter that is under the ownership of PEA (ID-25).<br><br>The monitored data of ID-24 are based on the hourly recorded into the log-sheet. In calculation of the emission reduction, the daily data were summarised and integrated into the spreadsheets monthly. The monitored data of ID-25 are referred to PEA power meter reading monthly report for emission reduction calculation. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | The internal power meter (ID-24) shall be calibrated at least once in a year. The calibration of power-exported meter (ID-25) is under the control of PEA. |
| Purpose of data: | The calculation of baseline emissions. |
| Additional comment: | - |

| | |
|---|---|
| **Data / Parameter:** | $D_{CH4}$ |
| Unit: | Tonnes/m3 |
| Description: | Density of methane at normal temperature and pressure |
| Measured/ Calculated / Default: | Default value |
| Source of data: | CDM EB as per EB28 Meeting report (Annex 13) |

| | |
|---|---|
| Value(s) of monitored parameter: | <table><tr><th>Monitoring period</th><th>Default value (tonnes/m3)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>0.716</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>0.716</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>0.716</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>0.716</td></tr></table> |
| Monitoring equipment: | Not applicable. |
| Measuring/ Reading/ Recording frequency: | Not applicable. |
| Calculation method (if applicable): | Not applicable. |
| QA/QC procedures: | Not applicable. |
| Purpose of data: | The calculation of baseline and project emissions. |
| Additional comment: | This is default value referred to CDM EB28 Meeting report (Annex 13). The value is applied with the calculation of baseline emission for MD approach and the project emission from flaring activity. |

| | |
|---|---|
| **Data / Parameter:** | $\eta_{flare-h}$ |
| Unit: | % |
| Description: | Flare efficiency |
| Measured/ Calculated / Default: | Default value |
| Source of data: | Tool to determine project emissions from flaring gases containing methane |
| Value(s) of monitored parameter: | <table><tr><th>Monitoring period</th><th>Total value (%)</th></tr><tr><td>18/10/2011 – 31/12/2011</td><td>0%</td></tr><tr><td>01/01/2012 – 31/12/2012</td><td>0%</td></tr><tr><td>01/01/2013 – 31/12/2013</td><td>0%</td></tr><tr><td>01/01/2014 – 31/07/2014</td><td>0%</td></tr></table> |

| | |
|---|---|
| Monitoring equipment: | n/a |
| Measuring/ Reading/ Recording frequency: | Default flare efficiency for enclosed flare is used as per step 6 "determination of the hourly flare efficiency" of the flaring tool:<br>• 0% if the temperature in the exhaust gas of the flare ($T_{flare}$) is below 500°C for more than 20 minutes during the hour h.<br>• 50%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h.<br>• 90%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.<br><br>Other flare specific parameters, which might be required to monitor whether the flare operates within the specified range of operating conditions shall be monitored according to the manufacturer's specifications. |
| Calculation method (if applicable): | n/a |
| QA/QC procedures: | Maintenance of the flare system was conducted periodically as per supplier's specifications in order to ensure optimal operation. |
| Purpose of data: | The calculation of project emissions. |
| Additional comment: | The data recorded of temperature in the exhaust gas of the flare and time duration during flaring were not available during the monitoring period. The value of flare efficiency is assumed as zero % in order to calculate the project emission. This is conservative. |

### D.3. Implementation of sampling plan

This section is not applicable.

## 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 emission reductions from the methane avoidance component of the project activity are calculated as per the guidance given in the methodology (version 15 of AMS.III.H). The emission reductions from thermal and electrical components are calculated as per the guidance given in the methodologies (version 16 of AMS.I.D). According to the registered PDD, the overall baseline calculation is determined as follows;

$BE_y = BE_{CH4,y} + BE_{power,y}$ Eq-1

Where:

| | |
|---|---|
| $BE_y$ | Baseline emission in year y ($tCO_{2e}$) |
| $BE_{CH4,y}$ | Baseline emission for methane avoidance component in year y ($tCO_{2e}$) |
| $BE_{power,y}$ | Baseline emission for electricity generation component in year y ($tCO_{2e}$) |

**I-Baseline emission for methane avoidance component (AMS.III-H):**
As per the registered PDD, baseline emission for methane avoidance component is given as:

$BE_{CH4,y} = BE_{ww,treatment,y} + BE_{ww,discharge,y}$ Eq-2

Where:

| | |
|---|---|
| $BE_{ww,treatment,y}$ | Baseline emissions of the wastewater treatment system affected by the project activity ($tCO_{2e}$) |
| $BE_{ww,discharge,y}$ | Baseline emissions of the wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into/lake/sea in year y (tCO2e) |

I-a Methane emissions from the baseline wastewater treatment affected by the project ($BE_{ww,treatment,y}$) are determined as following equation:

$B_{ww,treatment,y} = \sum(Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,\ BLi}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$ Eq-3

Where:

| | |
|---|---|
| $Q_{ww,i,y}$ | Volume of wastewater treated in baseline wastewater treatment system i in year y ($m^3$) |
| $COD_{removed,i,y}$ | Chemical oxygen demand removed by baseline treatment system i in year y (tonnes/m3) measured as the difference between inflow COD and the outflow COD in system *i* |
| $MCF_{ww,treatment,\ BLi}$ | Methane correction factor for the baseline anaerobic wastewater treatment i (MCF values as per table III.H.1) |
| i | Index for baseline wastewater treatment system |
| $B_{o,ww}$ | Methane producing capacity of the wastewater (IPCC value of 0.25 kg $CH_4$/kg COD) |
| $UF_{BL}$ | Model correction factor to account for model uncertainties (0.89)[1] |
| $GWP_{CH4}$ | Global warming potential (value of 21) |

As per the registered PDD, the determination of $COD_{removed,I,y}$ and $MCF_{ww,treatment,\ BLi}$ are considered according to the baseline situation prior the implementation of project activity. The functions of opened ponds in the baseline scenario were anaerobic/poor manage pond and aerobic/poor manage pond. Therefore, the calculations of baseline emission are determined from wastewater treatment types of anaerobic lagoon and aerobic treatment with poorly managed.

I-b Methane emission on account of inefficiencies in the baseline wastewater treatment systems and the presence of degradable organic carbon in the treated wastewater discharge into river/lake/sea. $BE_{ww,discharge,y}$ is determined as following equation:

$B_{ww,discharged,y} = \sum(Q_{ww,i,y} * COD_{ww,discharged,BL,y} * MCF_{ww,BL,discharge,y}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$ Eq-3

Where:

| | |
|---|---|
| $Q_{ww,i,y}$ | Volume of wastewater treated in baseline wastewater treatment system i in year y ($m^3$) |
| $COD_{ww,discharge,BL,y}$ | The chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in tonnes/$m^3$ |
| $MCF_{ww,discharge,\ BL}$ | Methane correction factor based on discharge pathway in the baseline situation (MCF values as per table III.H.1 of 0.1) |
| i | Index for baseline wastewater treatment system |
| $B_{o,ww}$ | Methane producing capacity of the wastewater (IPCC value of 0.25 kg $CH_4$/kg COD) |
| $UF_{BL}$ | Model correction factor to account for model uncertainties (0.89)[2] |

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

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

$GWP_{CH4}$ Global warming potential (value of 21)

**II-Baseline emission for electricity generation component (AMS-I.D)**

As per the registered PDD, the baseline emissions for electricity generation component is determined as follow;

$BE_{power,y,} = EG_{BL,y} * EF_{CO2,grid,y}$ Eq-6

Where:

$EG_{BL,y}$ The quantity of electricity exported to the grid by the project activity during the year *y* (MWh)

$EF_{CO2,grid,y}$ Thailand National Grid emission factor ($tCO_{2e}$/MWh)

**Table of calculation of baseline emissions**

| **Baseline emissions** | | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|
| | | **18/10 to 31/12** | **01/01 to 31/12** | **01/01 to 31/12** | **01/01 to 31/07** |
| *AMS-III.H: Methane avoidance component* | | | | | |
| $BE_{CH4}$ | **$tCO_2$** | 4,252 | 20,635 | 26,870 | 22,054 |
| $MD_y$ | **$tCO_2$** | 5,188 | 23,290 | 29,449 | 26,377 |
| | | | | | |
| *AMS-I.D: Electricity Generation Component* | | | | | |
| $BE_{elec,\ y}$ | **$tCO_2$** | 667 | 1,654 | 1,996 | 1,725 |

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

>>

According to the registered PDD, the overall project emissions are determined as following equation:

$PE_{y,} = PE_{CH4}$ Eq-7

Where:

$PE_y$ Project activity emissions from methane avoidance component in the year *y* ($tCO_2e$)

$PE_{CH4,y}$ Project activity emissions from methane avoidance component in the year *y* ($tCO_2e$)year *y* (MWh)

**IV. Project activity emission for methane avoidance component (AMS-III.H)**

The project activity emissions from the systems affected by the project activity are:

$PE_{CH4,y,} = PE_{power,y} + PE_{ww,treatment,y} + PE_{ww,discharge,y} + PE_{fugitive,y} + PE_{flaring,y}$ Eq-8

Where:

$PE_{power,y}$ Emissions from electricity or fuel consumption in the year *y* ($tCO_2e$). These emissions shall be calculated as per paragraph 20, for the situation of the project scenario, using energy consumption data of all equipment/devices used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring/gainful use

$PE_{ww,treatment,y}$ Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* ($tCO_2e$).

$PE_{ww,discharge,y}$ Methane emissions on account of inefficiency of the project activity wastewater treatment system and presence of degradable organic carbon in treated wastewater in year *y* ($tCO_2e$).

$PE_{fugitive,y}$ Methane emissions from biogas release in capture systems in year *y*,

calculated as per paragraph 28 ($tCO_2e$)

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

**IV.(a) $PE_{power,y}$ – Project emission from electricity consumption**

As per the registered PDD, the generic approach is used to calculate the project emissions as follows:

$$PE_{power,y} = PE_{EC} = \sum EC_{PJ,y} * EF_{EL,y} \quad \text{Eq-9}$$

Where:

| | |
|---|---|
| $PE_{power,y}$ , $PE_{EC}$ | Project emissions from grid electricity consumption in year y ($tCO_2$) |
| $EC_{PJ,y}$ | Quantity of grid electricity consumed by the project activity during the year y (MWh) |
| $EF_{EL,y}$ | Emission factor of Thai national grid in year y ($tCO_2$/MWh) |

**IV.(b) $PE_{ww,treatment,y}$ – Project emission from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation.**

As per the registered PDD, methane emissions from wastewater treatment systems affected by the project activity are calculated as per the equation 2 given in paragraph 21 of AMS III.H:

$$PE_{ww,treatment,y} = \sum(Q_{ww,k,y} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}) * B_{o,ww} * UF_{PJ} * GWP_{CH4} \quad \text{Eq-10}$$

Where:

| | |
|---|---|
| $Q_{ww,k,y}$ | Volume of wastewater treated in system affected by the project activity in year y ($m^3$) |
| $COD_{removed,PJ,k,y}$ | Chemical oxygen demand removed by project wastewater treatment system *k* in year *y* ($t/m^3$), measured as the difference between inflow COD and the outflow COD in system *k* |
| $MCF_{ww,treatment,PJ,k}$ | Methane correction factor for project wastewater treatment system *k* (MCF values as per Table III.H.1) |
| $B_{o,ww}$ | Methane producing capacity of the wastewater (IPCC default value of 0.25 kg $CH_4$/kg COD) |
| $UF_{PJ}$ | Model correction factor to account for model uncertainties (0.89)[3] |
| $GWP_{CH4}$ | Global Warming Potential for methane (value of 21) |

**IV.(c) $PE_{ww,\ discharge,y}$ – Project emissions on account of inefficiency of the project activity wastewater treatment system and presence of degradable organic carbon in treated wastewater**

As per the registered PDD, methane emissions from this parameter are calculated as following;

$$PE_{ww,treatment,y} = \sum(Q_{ww,k,y} * COD_{ww,discharge,PJ} * MCF_{ww,PJ,discharge}) * B_{o,ww} * UF_{PJ} * GWP_{CH4} \quad \text{Eq-11}$$

Where:

| | |
|---|---|
| $Q_{ww,k,y}$ | Volume of wastewater treated in system affected by the project activity in year y ($m^3$) |
| $COD_{ww,discharge,PJ}$ | Chemical oxygen demand of the treated wastewater discharged into sea, |

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

river or lake in the baseline situation in tonnes/$m^3$

| | |
|---|---|
| $MCF_{ww,PJ,discharge,}$ | Methane correction factor based on discharge pathway in the project situation (MCF values as per Table III.H.1) |
| $B_{o,ww}$ | Methane producing capacity of the wastewater (IPCC default value of 0.25 kg $CH_4$/kg COD) |
| $UF_{PJ}$ | Model correction factor to account for model uncertainties (0.89)[4] |
| $GWP_{CH4}$ | Global Warming Potential for methane (value of 21) |

**IV.(d) $PE_{fugitive,y}$ – Project emissions on account of inefficiencies in capture systems**

As per the registered PDD, project activity emissions from methane release in capture systems are determined as per paragraph 28 of AMS III.H as follows:

$$PE_{fugitive,y} = PE_{fugitive,ww,y} \quad \text{Eq-12}$$

Where:

| | |
|---|---|
| $PE_{fugitive,ww,y}$ | Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment in the year y ($tCO_{2e}$) |

**$PE_{fugitive,ww,y}$** is calculated as follows:

$$PE_{fugitive,ww,y} = (1-CEF_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \quad \text{Eq-13}$$

Where:

| | |
|---|---|
| $CEF_{ww}$ | Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used) |
| $MEP_{ww,treatment,y}$ | Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year *y* (t) |

**$MEP_{ww,treatment,y}$** is calculated as follows:

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} \quad \text{Eq-14}$$

Where:

| | |
|---|---|
| $Q_{ww,y}$ | Volume of wastewater treated in system affected by the project activity in year y ($m^3$) |
| $B_{o,ww}$ | Methane producing capacity of the wastewater (IPCC default value of 0.25 kg $CH_4$/kg COD) |
| $UF_{PJ}$ | Model correction factor to account for model uncertainties (1.12) |
| $COD_{removed,PJ,k,y}$ | The chemical oxygen demand removed[5] by the treatment system *k* of the project activity equipped with biogas recovery in the year *y* (t/$m^3$) |
| $MCF_{ww,treatment,PJ,k}$ | Methane correction factor for the project wastewater treatment system *k* equipped with biogas recovery equipment (MCF values as per Table III.H.1) |

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

[5] Difference between the inflow COD and the outflow COD.

**IV.(d) $PE_{flaring,y}$ – Methane emissions due to incomplete flaring**

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

$$PE_{flare,\,y} = \sum TM_{RG,h} * (1 - \eta_{flare\text{-}h}) * GW_{PCH4} / 1000 \qquad \text{Eg-15}$$

Where:

| | |
|---|---|
| $TM_{RG,h}$ | Mass flow rate of methane in the residual gas in the hour h (kg/h) |
| $\eta_{flare\text{-}h}$ | Flare efficiency in hour h |
| $GWP_{CH4}$ | Global Warming Potential of methane valid for the commitment period ($tCO_2e/tCH_4$) |

However, the monitored data of temperature in the exhaust gas flared and time duration during flaring were not available during this monitoring period. To be conservativeness, the value of flare efficiency is assumed as zero percentage. The calculation of project emission due to flaring are considered the annual amount of biogas flared and the flare efficiency of zero %.

**VI. Project emissions for electricity generation component (AMS-I.D):**

As per AMS I. D., paragraph 19, for the most renewable energy project activity, $PE_y = 0$. The project emission under AMS I.D are considered zero.

**Table of calculation of project emissions**

| **Project emissions** | | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|
| | | **10/08 to 31/12** | **01/01 to 31/12** | **01/01 to 31/12** | **01/01 to 31/07** |
| *AMS-III.H: Methane avoidance component* | | | | | |
| $PE_{EC,y}$ | **$tCO_2$** | 3 | 25 | 21 | 10 |
| $PE_{ww,\,treatment,\,y}$ | **$tCO_2$** | 749 | 3186 | 3609 | 3227 |
| $PE_{fugitive,\,y}$ | **$tCO_2$** | 394 | 2029 | 2690 | 2226 |
| $PE_{ww,discharge,y}$ | **$tCO_2$** | 20 | 99 | 169 | 120 |
| $PE_{flaring,\,y}$ | **$tCO_2$** | 0 | 0 | 0 | 0 |

**E.3. Calculation of leakage**

As per the registered PDD, leakage is assumed to be zero as no equipment is transferred from another activity.

## 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** | 79,853 | 18,577 | 0 | 61,276 |

## 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 $CO_2e$) | 52,506 | 61,276 |

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

The actual emission reduction achieved during this monitoring period is higher than the values estimated in ex-ante calculation of the registered PDD. Because the operation of biogas system performed well in 2013 and 2014, this can be seen from the removal efficiency of COD loading was more than 92%. In the registered PDD, the removal efficiency of the biogas system was determined as 90% by the technology provider. However, there was no change in the design of project activity. The biogas system was operated as per the registered PDD. In addition, the $GWP_{CH4}$ value of 25, effective on 01/01/2013, is applied in the ER calculation. The emission reduction calculation of the project activity is conducted with the conservative approach. Therefore, the increase in the actual GHG emission reduction achieved based on the applicable provision can be considered during this monitoring period.

## 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 $CO_2e$)** | 20,703 | 40,573 |

- - - - -

# Appendix 1. Contact information of project participants and responsible persons/ entities

| | |
|---|---|
| **Project participant and/or responsible person/ entity** | ☒ Project participant<br>☐ Responsible person/ entity for completing the CDM-MR-FORM |
| **Organization name** | United Palm Oil Industry PCL. |
| **Street/P.O. Box** | 236 Moo 4, Bangpoo Industrial Estate, Sukhumvit Road, Phraeksa Sub-district, Muang District. |
| **Building** | - |
| **City** | Sumutprakarn |
| **State/Region** | - |
| **Postcode** | 10280 |
| **Country** | Thailand |
| **Telephone** | +66 2 709-3610 Ext. 1802 |
| **Fax** | +66 2 324-0638 |
| **E-mail** | ampol@lamsoon.co.th, sawang@lamsoon.co.th |
| **Website** | www.lamsoon.co.th |
| **Contact person** | Ampol Simarojana |
| **Title** | Factory director |
| **Salutation** | Mr. |
| **Last name** | Simarojana |
| **Middle name** | - |
| **First name** | Ampol |
| **Department** | - |
| **Mobile** | - |
| **Direct fax** | - |
| **Direct tel.** | ampol@lamsoon.co.th |
| **Personal e-mail** | - |

| | |
|---|---|
| **Project participant and/or responsible person/ entity** | ☒ Project participant<br>☒ Responsible person/ entity for completing the CDM-MR-FORM |
| **Organization name** | Swiss Carbon Assets Ltd. |
| **Street/P.O. Box** | Technoparkstrass 1 |
| **Building** | - |
| **City** | Zürich |
| **State/Region** | - |
| **Postcode** | 8005 |
| **Country** | Switzerland |
| **Telephone** | +41 43 501 3350 |
| **Fax** | +41 43 501 3599 |
| **E-mail** | registration@southpolecarbon.com |
| **Website** | http://www.southpolecarbon.com/ |
| **Contact person** | Renat Heuberger |
| **Title** | Managing Partner |
| **Salutation** | Mr. |
| **Last name** | Heuberger |
| **Middle name** | - |
| **First name** | Renat |
| **Department** | - |
| **Mobile** | - |
| **Direct fax** | - |
| **Direct tel.** | - |
| **Personal e-mail** | - |