Monitoring report form

(Version 04.0)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT	
Title of the project activity	Chumporn applied biogas technology for advanced waste water management
Reference number of the project activity	UNFCCC Ref. No. 2148
Version number of the monitoring report	Version 04
Completion date of the monitoring report	02/02/2015
Registration date of the project activity	09/02/2009
Monitoring period number and duration of this monitoring period	Monitoring period no.1; Duration: 09/02/2009 to 31/08/2010 (first and last days included)
Project participant(s)	Private entity: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany Private entity: Chumporn Palm Oil Public Company Limited, Bangkok, Thailand
Host Party(ies)	Thailand
Sectoral scope and selected methodology(ies), and where applicable, applied standardized baseline(s)	Sectoral Scope: 13. Waste handling and disposal AM0013: Avoided methane emissions from organic waste-water treatment --- Version 4.0
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	43,857 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	34,893 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)	34,893 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	n.a.

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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(a) Purpose of the project activity and the measures taken for GHG emission reductions or net anthropogenic GHG removals by sinks;

The purpose of the *Chumporn applied biogas technology for advanced waste water management* is to treat the wastewater generated in the production of palm oil and to use the organic matter removed from the wastewater to produce heat from clean, renewable energy (biogas). The planned project activity consists of a wastewater treatment facility, i.e. a combination of anaerobic tank digesters, as well as a combustion system to generate heat from the produced biogas. Biogas is produced by the anaerobic digestion of organic matter in the tank reactors. The project activity involves the design, construction, installation, start-up and operation of the wastewater treatment and heat generation facilities.

Hence, the project leads to a shift from traditional waste water treatment in open, anaerobic ponds with uncontrolled release of methane to the atmosphere to a closed tank digester system with biogas capture and utilization. The ultimate purpose of the project activity is to reduce greenhouse gas emissions to the atmosphere and contribute to an environmentally and socially sustainable development of palm oil production at Chumporn Palm Oil Industry (CPI).

(b) Relevant dates for the project activity (e.g. construction, commissioning, continued operation periods, etc.);

Construction of the project began in February 2006
Commissioning and testing of the project began in March 2007
Project had started its operation from May 2007
Full operation since July 2007
Project was registered on 09/02/2009

(c) Total GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period.

Monitoring period: 09 February 2009 to 31 August 2010
Number of days during this monitoring period: 569 Days
Total Emission Reduction achieved during this monitoring period: **34,893 tCO_2e**

A.2. Location of project activity

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The project activity is located in the host country of Thailand.

CPI is located in Chumporn province in the uppermost part of the Southern region. The Gulf of Thailand is in the east, while the Union of Myanmar is in the west. The location is approximately 463 km south-south-west from Bangkok, close to the Tha Sae intersection about 15 km north of Chumporn City. The project activity is located within the existing site of the Chumporn Palm Oil Industry Complex, therefore no additional area is required.

The address of the project activity is:
296, Moo 2 Phetchkasem Road, Tambol Salui, Ampur Tasae, Chumporn.

The coordinates of the project activity (control room) are:
Latitude: 10°50'38.98"N and Longitude: 99°13'2.55"E.

Figure 1 visualizes the physical location of the project activity in Thailand.

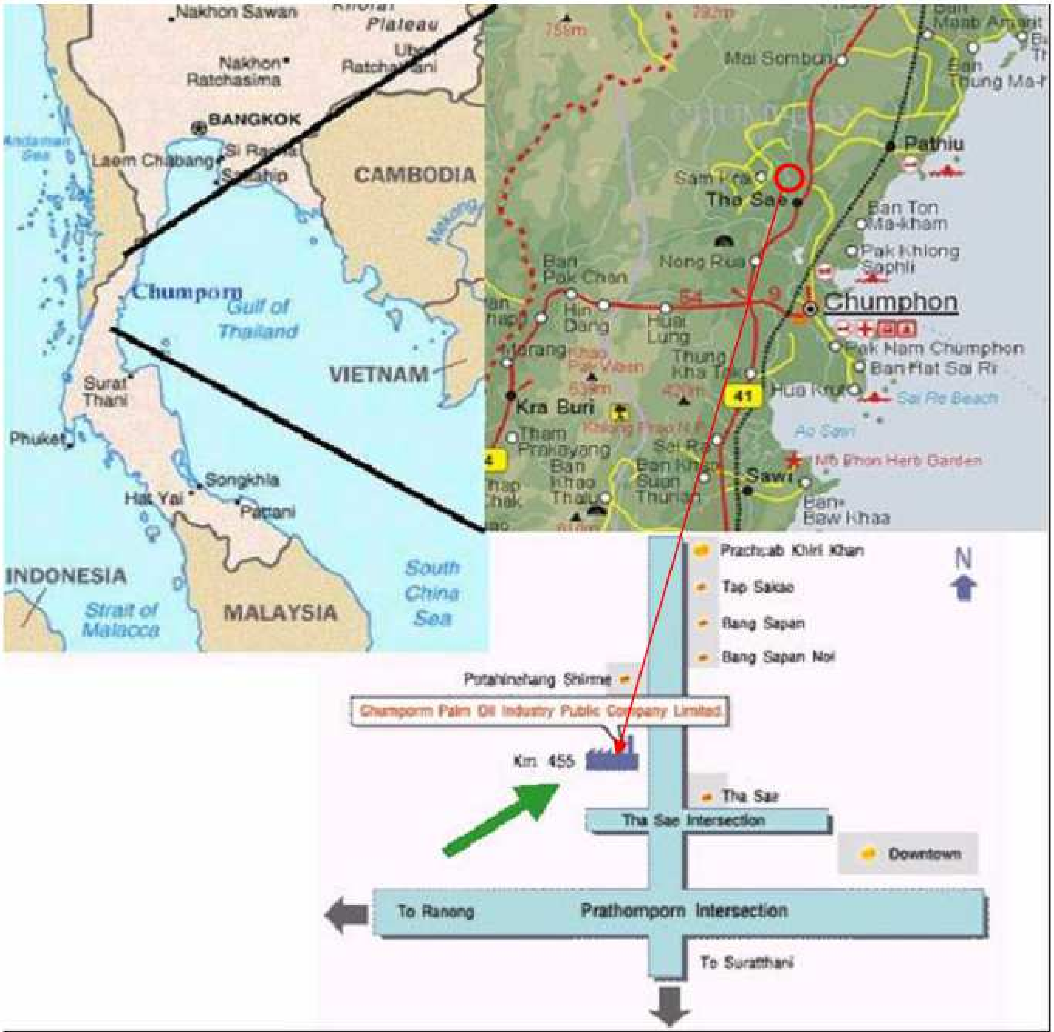

Figure 1: Physical location of the project activity

Chumporn Palm Oil Industry PCL (CPI) has been registered in Thailand in 1979. CPI had 748 employees in 2003 and 755 in 2004 (CPI Annual Report, 2004).

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)	Private entity: Chumporn Palm Oil Public Company Limited, Bangkok, Thailand	No
Germany	Private entity: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany	No

A.4. Reference of applied methodology and standardized baseline

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Approved Methodology AM0013 “Avoided methane emissions from organic waste-water treatment”, version 4, as of December 22nd, 2006 is applied. This methodology is based on the baseline approach from paragraph 48 of the CDM modalities and procedures “Existing actual or historical emissions as applicable”.

The calculation of the Thai grid emissions factor is based on the Approved Consolidated Methodology ACM002, version 6, as of May 19th, 2006 is applied.

The methodology also refers to the “Tool to determine project emissions from flaring gases containing Methane” (version as of December 2006) is applied. In addition, the “Tool for the demonstration and assessment of additionality” (version 03) is applied.

A.5. Crediting period of project activity

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10-years fixed crediting period, starting date is the 09/02/2009

A.6. Contact information of responsible persons/ entities

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The final draft of this CDM-MR-Form was completed by:

Company name:	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Address:	Dag-Hammarskjöld-Weg 1-5; P.O. Box 5180
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Local expert responsible for completing the CDM-MR-FORM:

Company name:	Pure Natural Power Co., Ltd.
Address:	110/6 Moo 5, Thambon Suthep, Amphoe Muang, Chiang Mai, Thailand
Contact person:	Dr. Bundit Na Lamphun
Telephone number:	+66-897001070
Fax number:	
E-mail:	bundit.nalamphun@gmail.com

PURE Natural Power Co.,Ltd provides carbon advisory services for CDM projects and is not a project participant listed in Annex 1.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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The project started in February 2006 by constructing the Anaerobic Digester System by Natural Power Co., Ltd. The construction period took 1 year and 1 month with the start of commissioning and testing in March 2007. The Project started up in May 2007 and came in to full operation in July 2007.

The monitoring of the CDM process started February 2009 with the registration of the project.

There were occasions of stoppages as a result of malfunction and maintenance, e.g. the replacement of the PVC cover foil in May 2010.

Brief description of the installed technology and equipment;

A modern waste water treatment technology was implemented at CPI. The existing simple wastewater treatment system in open, anaerobic lagoons has been replaced by a closed tank digester system to recover methane and produce biogas. The latter is being utilized in the production process at CPI to generate heat.

The building and operation of a completely stirred tank reactor (CSTR) is the central part of the project activity. A combined system of each CSTR and two UASB-reactors has been chosen as it is best suited for the underlying situation. Two tank reactors with a utilizable volume of 6,000 m^3 were established and operated. This allows a maximum daily load of approx. 800 m^3 waste water. The output of the plant has typically been 475 - 650 m^3/day. The system was designed to produce approximately 12,700 m^3 of biogas per day, which is used to substitute the utilization of heavy oil and of palm shells for heat generation. Due to an increase of wastewater from the CPO, the system has in the monitoring period been able to produce an average of 14,696 m3 of biogas per day. The methane content of the biogas reached an average of 55-57% after the operation had stabilized (approximately around Sept.'09), which is a bit lower than estimated before the start of the project (65%).

The two CSTR-tank reactors are composed of reinforced concrete in a half capsule channel shape that is partly underground. An outlet pipe is installed at the bottom of hopper shapes in the tank to drain digested sludge to the sludge treatment system. An overflow system allows the discharge of digested effluent with low COD and SS content. COD content in the effluent is reduced by about 80% and enters UASB reactors, before being released to the conventional open-pond post treatment process.

Some small adjustments in operation of the system were needed to be made during the early phase of operation.

It was planned and has been implemented as such that refinery waste water was supposed to be treated in the new biogas system. During the early stage of biogas system operation it became clear that the treatment of refinery waste water was difficult due to strong fluctuation in waste water composition, e.g. quickly changing COD and pH values. It was thereafter decided to abandon the treatment of refinery waste water and treat only CPO process waste water. The COD amount from refinery waste water makes up only 1.6% of the total estimated COD load to the new biogas system, or the baseline system respectable.

Regarding the utilization of biogas, the project was implemented as described in the registered PDD, with biogas utilised in the 2 CPO boilers. In January 2010, the utilisation of biogas in two high pressure boilers at the palm oil refinery was added to the project activity.

CPI has a treatment system for solid residues from the biogas digester system (called sludge treatment system), which consists of 4 concrete ponds with sand bed filter. It has been implemented and was planned to be operated as described in the registered PDD. The treatment of solid residues, with the aim to produce dry sludge in working very slow, so that for the first monitoring period no dewatering and land application of sludge was occurring. This can be regarded as a technical problem at project start which the project owner is continuously trying to improve.

The flow diagram in Figure 2 summarizes the described process.

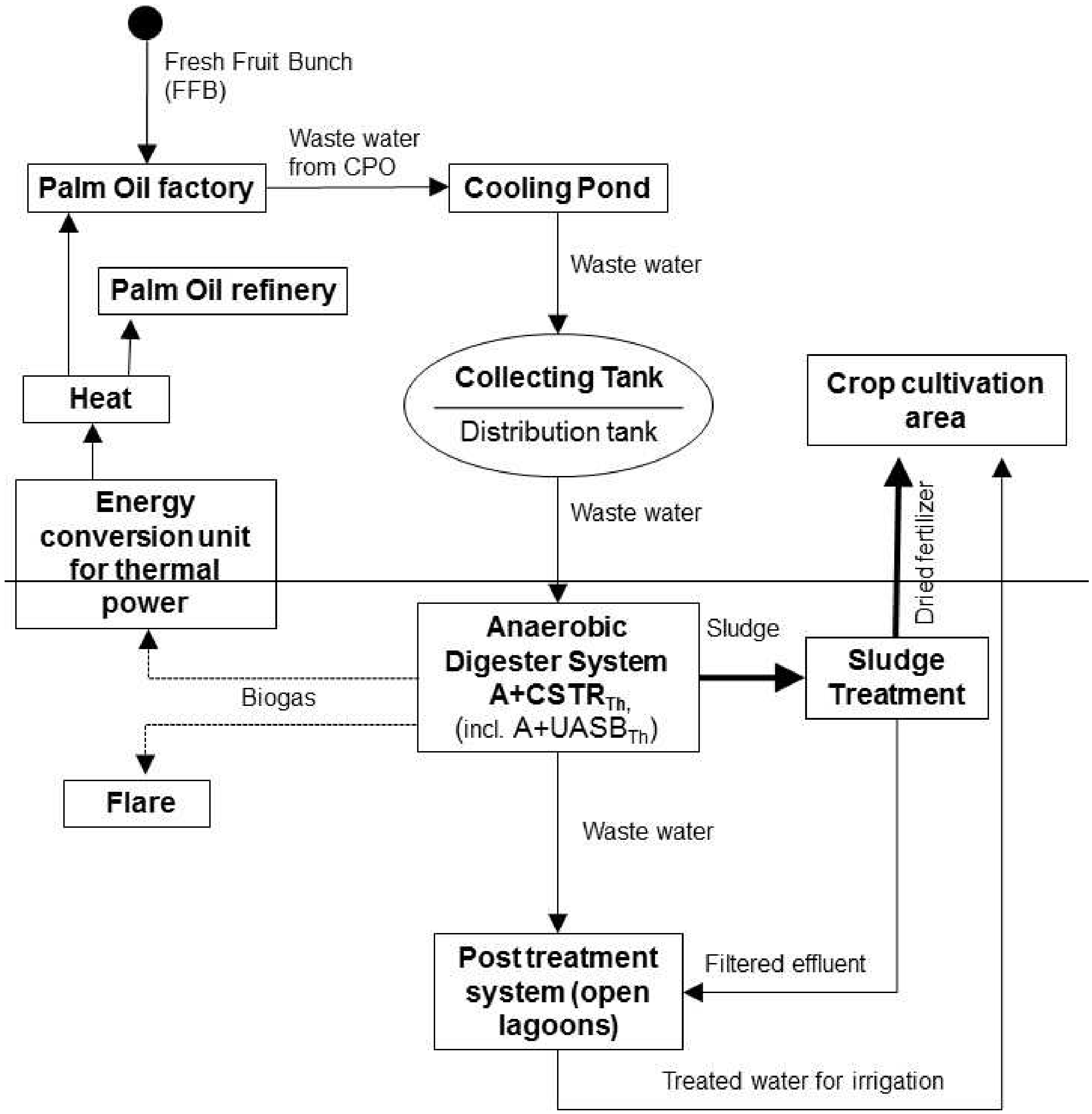

Figure 2: Flow diagram of improved waste water management system after project implementation

B.2. Post registration changes

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

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a) Project emissions from open lagoon (post treatment system). According to the approved monitoring plan, the depth of the lagoon needs to be measured daily to calculate a monthly average. Over the monitoring period covered by this report, the depth of the lagoon was only measured monthly. For the calculation of emission reduction for the lagoon, deepest measured depth during the monitoring period (2.70 m in January 2010) is applied, which coincidences with a depth factor of (fd) = 0.5 for medium depth (1-5 m). . This is conservative as all measured values are well below 5 m and sometimes even values lower than 1 m was measured.

b) Sampling (frequency) of COD analysis
Due to a misunderstanding of the registered monitoring plan during this monitoring period there was a deviation in the sampling frequency of COD analysis in the waste water (also see Section C, below). As per the registered MP, 4 samples per hour, 12 samples per day (weekly same say, same time), meaning practically 1 mixed sample on one day per week should have been collected for COD measurement. Actually, 2 samples per time mixed together and 2 times a week were collected for COD measurement by internal laboratory.
As a cross check with the own laboratory data, additionally once a month samples were taken and analysed by an external laboratory.
According to the methodology (AM0013 vers.4) COD measurements are to be taken at least monthly. PP believes that the current practice more than fulfils the required COD measurement frequency in the reported monitoring period. Furthermore, due to clarification, the PP has now adjusted the sampling procedure to the description in the registered PDD.
For conservativeness the lower set of sampling values (external laboratory) were chosen for calculation of the baseline emissions and the higher internal laboratory values for project emissions.

B.2.2. Corrections

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a) <u>Change of name of one project participant</u>: The name of the project participant has changed from GTZ (Gesellschaft fuer Technische Zusammenarbeit) to GIZ (Gesellschaft fuer Internationale Zusammenarbeit). A revised MoC has been submitted accordingly.

b) <u>Biogas system design</u>: The registered PDD did not mention UASB digesters, even though they have been an integral part of the system design from the beginning. The 2 CSTR digesters are the main biogas generation process reactors, whereas the following 2 UASB digesters have a post-treatment function of the low strength treated wastewater leaving the CSTRs. Contribution of the UASB digesters to the total biogas generation is low and had been included in the original biogas generation prediction of the technology provider.
While the 2 CSTR digesters were originally seen as the main components of the biogas system, the whole system is now explicitly described as a combination of (different) anaerobic digesters.

c) <u>Effluent/sludge handling</u>: While the old PDD mentions “Sand Bed Filter - Separation of solid and liquid parts of digested sludge from the bottom of the digester”, the corrected version refers to “Sludge Treatment system”. The treatment system will consist of sand bed filters or other technical solution (e.g. belt press), either way with the intention to produce sludge dry enough for transportation and land application.”
This paragraph has been added to the revised PDD as a result of difficulties with the original treatment system, implemented as per registered PDD. Since the sand bed filter so far did not deliver the expected dry sludge, to be used for land application, the addition simply reflects the

intention to introduce a new technical solution for the treatment of sludge if needed and should therefore give the project owner some flexibility in sludge treatment, without other changes to the project activity.

d) Addition of accuracy and frequency of monitoring: Due to the use of a new PDD template and additional requirements information about accuracy and frequency of monitoring has been added to the monitoring parameter tables

e) Change in baseline and project emissions: The estimated emission reduction based on ex ante parameters have changed from **23,448 to 28,133 tCO2 annually**. Main reasons for this change:
i) Baseline emission: 40,080 down to 39,385 tCO2 annually.
The decrease in baseline emission from the lagoon is caused by the exclusion of refinery waste water to the new waste water treatment plant. This refiner waste water has a small impact on lagoon baseline emissions due to the low COD load of this discharge. Furthermore the power/heat baseline emissions are slightly reduced due to a correction: the PDD states that the electricity consumption of existing waste water treatment system EGy = 0 MWh/yr, but in the old calculations still a value of 78.2 MWh/yr was applied. This is now removed.

ii) Project emissions: 16,632.49 down to 11,252 tCO2 annually.
According to the applied methodology AM0013ver04 and the registered PDD, the lagoon project emissions are calculated as per equation:

$$\underset{\text{(kg/yr)}}{CH_4 \text{ emissions from the lagoons}} = \underset{\text{(kg COD/yr)}}{COD_{dig\_out}} \times \underset{(\text{kg } CH_4/\text{kg COD})}{B_o} \times MCF_{dig\_out}$$

Where:
COD_{dig_out} Is Chemical Oxygen Demand of effluent entering lagoons (measured)

Other then for the baseline emission the methodology does not mention that carry over of COD in the lagoon has to be taken into account in this calculation. The carry over in the original calculation was therefore wrongly applied and has been removed (PE_{lagoon} 7,836.50 down to 5,111 tCO2 annually).
Furthermore, with regard to physical leakage from biogas digesters, the calculation in the registered PDD had been based on the biogas production of 13.370 kg/day. This is not explained and not in line with all other calculations based on an output of 12,700 m3/day (see table 12 in the revised PDD and parameter table FR_{Bio} at 300 days production per year). Since the proportion of methane in biogas is being expressed in ppm in the PDD, the calculation in the original ER calculation sheet, which is based on 65% of the 13.370 kg biogas/day is not correct. The new corrected calculation is based on volume percent ($PE_{leakage}$ 8,212.5 down to 5,606 tCO2 annually).

f) IRR calculation and sensitivity analysis: The changes to the project compared to the registered PDD may have affected the additionality of the project, therefore a revised IRR calculation and sensitivity analysis have been included in the revised PDD. The installation of high pressure boiler and technical adjustments at the palm oil refinery allows the utilization of biogas in replacement of bunker oil, which has an impact on the financial feasibility of the project.
The IRR calculation and sensitivity analysis demonstrated that the additionality of the project has at all time (for all steps of project implementation and adjustment) remained valid.

Corrections in the revised PDD (version 10) have been approved on 28/12/2014)

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

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a) Emissions from wastewater removed in the dewatering process: A provision to calculate and account for project emissions from the wastewater removed in the dewatering process has been included for times when dewatering of sludge is actually taking place. The parameter $Fc_{,dw}$ and $COD_{c,dw}$ were added to the monitoring plan.
Due to the technical difficulties, but still following the original intention of the project activity to produce dry sludge, this is again kind of a flexibility mechanism for the project owner. The idea is to treat sludge, either with the original sand bed filter, or with other technical solutions, In the case the treatment is operating and working, emissions from removed wastewater will be monitored; the monitoring system (e.g. flow meter and COD measurement) have been included in the project from the beginning but were wrongly not included in the PDD, which has now been corrected.
The project owner should still have the flexibility not to treat the sludge from the digester, e.g. when the system is not working or for other reasons, in which case the sludge would be treated the same way as wastewater effluent in open ponds, by monitoring flow and COD (sludge still has a very high water content) and account for project emissions accordingly.

b) Monitoring of flow rate of organic wastewater into and out of the digester (F_{Dig}, F_{Dig_out}): Instead of the vortex flow meter and hourly records, a magnetic flow meter with continuous measurements has been installed. The magnetic flow meter is the most common choice of flow meter for biogas systems and biogas project monitoring in Thailand. The vortex flow meter had been chosen in the early project design stage, not knowing of the limitations in availability and other difficulties. The magnetic flow had been installed from the beginning and deliver similarly accurate and reliable measurements as the vortex flow meter.
For practical reasons to keep the monitoring efforts for this small project (despite being large scale would easily fall under the small scale project threshold), the data back-up is being done on a monthly basis. Under normal operating conditions, this does not influence the accuracy and reliability of the data.

c) COD-measurements: In the registered PDD the method for COD measurements was planned as "Laboratory tests at CPI (monthly) – Method: AWWA 5220B.,P5-14,1998", which needed to be changed to "Laboratory tests at CPI (monthly) – Method: APHA 5220 D". This change is reflecting the change of laboratory equipment and method as compared to the original PDD.
The COD analyser is a very common choice of test equipment in biogas project monitoring in Thailand. The original method had been chosen in the early project design stage, but did not reflect the common practice at the project owner's laboratory. The Close Reflux Method has been used from the beginning and delivers similarly accurate and reliable COD values.

d) Biogas flow rate at digester outlet (FR_{Bio} / $FR_{f,inlet}$ and $P_{CH4,bio}$): Instead of the Coriolis mass flow meter a thermal mass flow meter has been installed. The thermal mass flow meter is the most common choice of flow meter for biogas systems and biogas project monitoring in Thailand. The Coriolis mass flow meter had been chosen by the first project CDM consultant in the early project design stage, not knowing of the limitations in availability (pressure of biogas in the pipes) and other difficulties. The thermal mass flow had been installed from the beginning and deliver similarly accurate and reliable measurements as the Coriolis mass flow meter.
Furthermore an editorial change was necessary. The registered PDD mentions two lines, but all biogas flow from the digesters are combined in one pipe, passing the monitoring equipment.

e) Monitoring of stack gas emissions: The stack gas emissions are measured for the environmental monitoring for Industrial department half yearly.
The continuous measurement of stack gas emissions, as mentioned in the register PDD was not possible due to the huge financial effort of the installation of flow meter with the radius of the stacks of the boilers.

For practical reasons to keep the monitoring efforts for this small project (despite being large scale would easily fall under the small scale project threshold), the gas emissions measurements required by law shall be applied.
While the measurements from the HP boilers, using only biogas are really related to project emissions, the measurements in the biomass boiler where biogas co-combusted with EFB does

not reflect real project emissions anyway, because it cannot be differentiated between methane from incomplete combustion of biogas and EFB (which would solely be burned in the baseline scenario). Installing very expensive monitoring equipment for the measurement would only appear to produce more accurate data. One has to keep in mind that the project owner would in any case be trying to optimize the combustion to operate most economic.
The stack gas emission flow rates (m^3/s) are measured for the environmental monitoring for Industrial department half yearly under normal operating conditions of the boilers (full load).
Based on the measured flow rate and the operation time of the boiler (which is continuously logged), the yearly flow of stack gas (m3/yr) will be calculated.

Permanent changes from the registered monitoring plan and applied methodology in the revised PDD (version 10) have been approved on 28/12/2014).

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

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a) Treatment of refinery waste water: It was planned and had been implemented as such that refinery waste water was supposed to be treated in the new biogas system. During the early stage of biogas system operation it became clear that the treatment of refinery waste water was difficult due to strong fluctuation in waste water composition, e.g. quickly changing COD and pH values. It was thereafter decided to abandon the treatment of refinery waste water and treat only CPO process waste water. The COD amount from refinery waste water makes up only 1.6% of the total estimated COD load to the new biogas system, or the baseline system respectable (please compare Table 10). The resulting changes in the potential emission reduction are almost negligible and the essential project activity is not affected.

b) Utilisation of biogas in biomass boiler in the CPO and HP boilers in the palm oil refinery: Post-registration, after proven reliable operation of the biogas system, some parts of the biogas were started to be diverted for use in 2 high pressure boilers in CPI’s palm oil refinery. The cleaned biogas is utilized in the steam boilers to generate heat. Two boilers are operated: a mid/high pressure boiler (60-90 bar, boiler type NUK-HP 930, dual-fuel burner type RGMS7/1-D ZMD, DN50) and a low pressure boiler (30 bar, AWG Series II dual-fuel burner from Hamworthy (AWG 15)).
Therefore, besides the biomass in the boilers of the CPO, bunker fuel in the HP boilers of the refinery has become another baseline under the adjusted project activity.
The HP boilers have been included under technology description in section A.4.3 (Combustion systems) of the revised PDD. The baseline information have been adjusted in section B.4. Further information on the impact on project additionality (IRR calculation) are given in section B.5.
For conservative reasons emission reductions for fossil fuel replacement from HP boilers have not been included in the project activity.

Changes to the project design in the revised PDD (version 10) have been approved on 28/12/2014)

B.2.5. Changes to start date of crediting period

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

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SECTION C. Description of monitoring system

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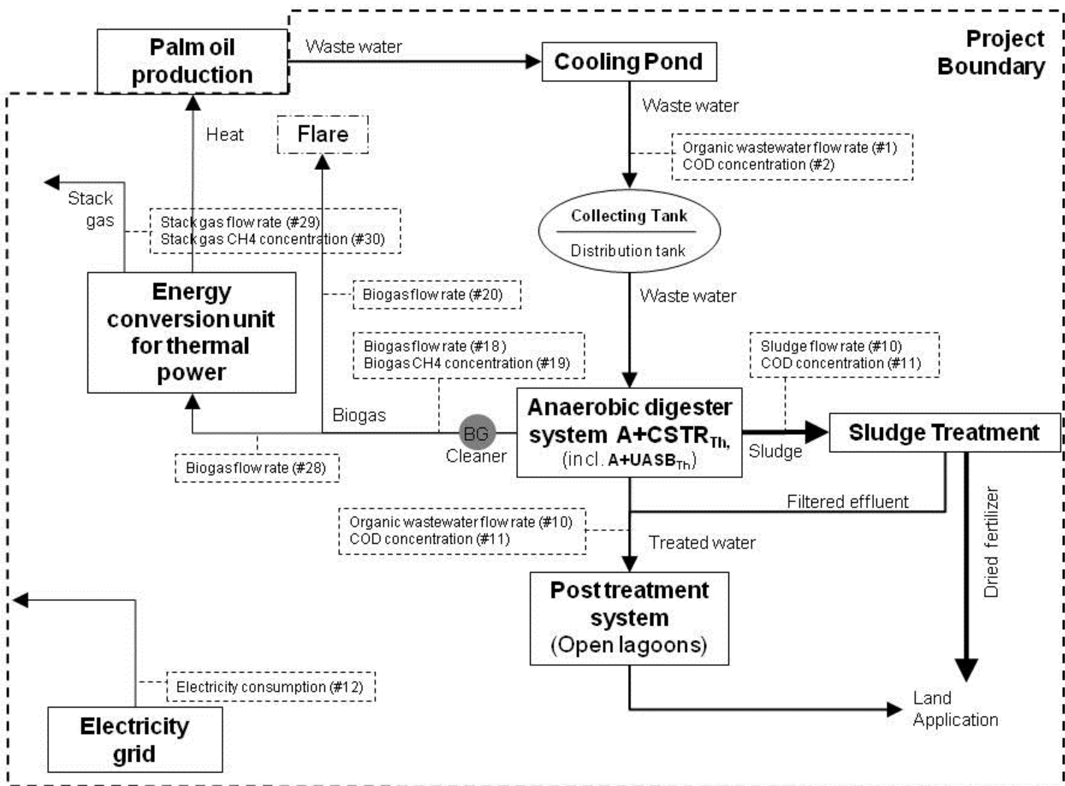
All data will be kept for at least two years following the end of the crediting period or the last issuance of CERs (whatever is the later). For all monitoring supervision, maintenance, data storage, data handling and plausibility check measures, standard operation procedures (SOP) are followed. These SOPs are integrated into the existing ISO 9001:2008 System.

Data Storage and processing

The control room for the biogas digester, adjacent to the Biogas plant is used for monitoring data record and processing facilities. The room is ventilated through AC system and provides shelter for the computer equipment and peripheral equipment (printer, modem).



In practical terms the following observations/small adjustment in the monitoring were needed:

a) COD measurements

Due to a misunderstanding of the monitoring plan (MP) (12 samples per day, weekly same day, were understood as 12 daily samples, every day, and this of all COD sampling point), it was found impossible to comply with the MP completely. As a result in the 1st monitoring period samples were taken as follows: 2 samples per time mixed together and 2 times a week are collected for COD measurement by internal laboratory. As a cross check with the own laboratory data, additionally once a month samples were taken and analysed by an external laboratory.

According to the methodology (AM0013 vers.4) COD measurements are to be taken at least monthly. PP believes that the current practice more than fulfils the required COD measurement frequency in the reported monitoring period. Furthermore, due to clarification, the PP has now adjusted the sampling procedure to the description in the registered PDD.

b) Measurement of wastewater flow

For technical reasons the flow meter to monitor the wastewater from the palm oil production, which

is to be treated in the new biogas digester system was installed before the cooling pond, which is an integrated part of the biogas system. Measurement of wastewater between the cooling pond and the first biogas digester would be difficult and require a design change of the system. The biogas system by Natural Power Co., Ltd. (Thailand) is designed with free gravity flow. This makes the system very economic (little electricity use) and avoids moving parts (pumps), which need more maintenance and can be broken, causing system downtime. Because of gravity flow design (low flow velocities and low pressure), a flow meter between cooling pond and CSTR digester would need an additional pump, thereby altering the design and eliminate the advantages of the system.

The project owner has decided to install the flow meter before the cooling pond, because of low retentions times (approx. 1 day) and little to no influence by the cooling pond.

Further information on the climatic balance of Chumporn (evaporation and precipitation effects of the cooling pond) demonstrates the very small effect of the cooling pond. If at all the impact of the cooling pond will lead to a slight underestimate of COD into the digester (which is conservative).

c) Efficiency of the open flare

In case of open flares a default efficiency of 50% is to be used provided it can be demonstrated that the flare is operational (through a flame detection system reporting electronically on continuous basis). Though flare was operational, it was not yet possible to demonstrate the continuous operation of the flare, necessary to demonstrate the destruction of methane, 0% flare efficiency has been chosen consequently to determine emission reductions conservatively.

Organizational and management structures

The management structure as well as implementation and operation management of the efficient monitoring system is as follows:

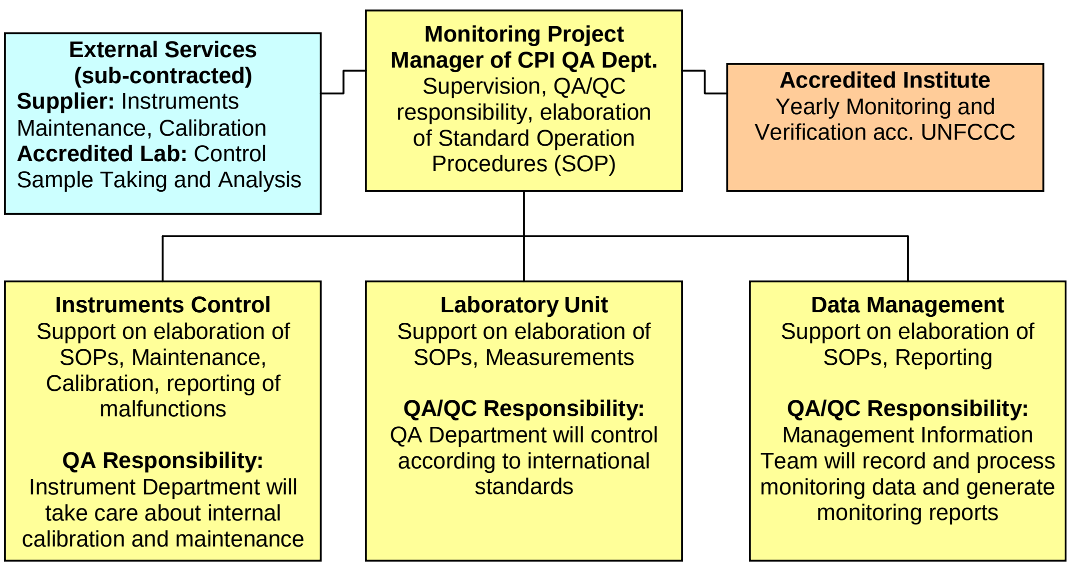
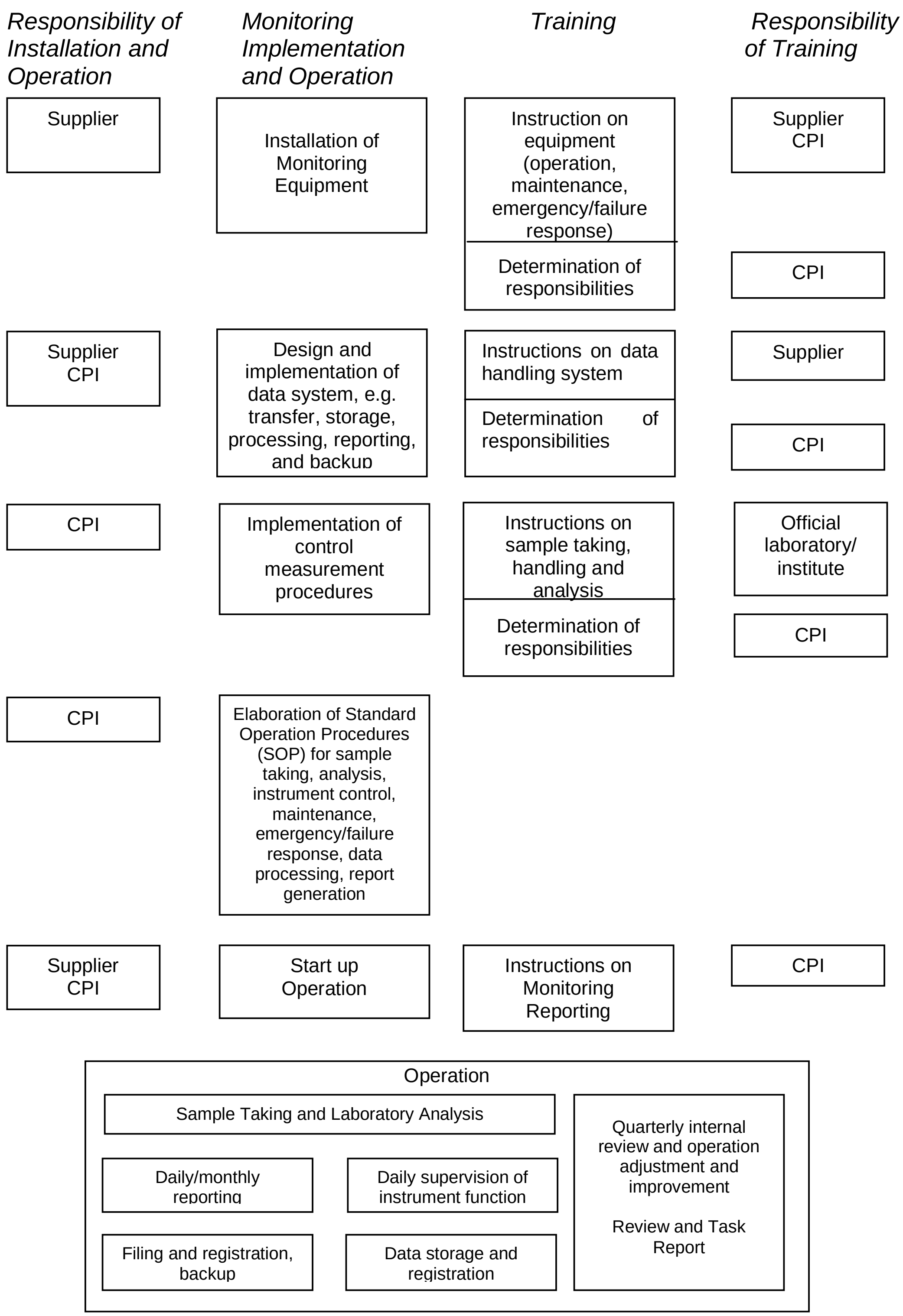


Figure 3: **Management Structure of Monitoring System**

Monitoring implementation and operation management and procedure

In order to implement, operate, maintain and control the monitoring system appropriately, the following operation procedure was implemented:

Figure 4: Monitoring Operation Procedure



<u>Reconstruction/calculation of data in case of instrument failure</u>

Missing monitoring data derived from instrument failure and during replacement of broken instruments will be reconstructed from former and subsequent series of measurement. Within the first month of monitoring, missing data will not be reconstructed and losses accepted accordingly.

After one month of monitoring and one month data record respectively, missing data will be reconstructed from the average of the lowest measured values of the previous and the following month, if the monitoring interruption is longer than one week

This method is appropriate and conservative, since the flow rates of waste water and biogas as well as the COD content in the waste water and CH_4 content in the biogas are not subject to huge variations in such production processes. To avoid suspicion referring bridging of complete production interruptions, corresponding data from parallel instruments and proved production data from the same period of the instrument failure will be recorded and documented in order to prove the continuity of the production process. Reconstructed values will be marked in the record and monitoring reports accordingly.

<u>Training</u>

To assure the correct handling of the equipment, correct monitoring, a comprehensive training of local stuff was organized. 16 staff members, which are responsible for operating and managing the system, were trained. Out of these 16 staff members, 8 staffs are from the operational level, 4 staffs (engineers) from the mid-management level and 4 staffs from the supervisory level. The training focused on:

- general knowledge about the applied equipment at the digesters and biogas utilization units;
- reading, recording and processing data and elaboration of monitoring reports;
- inspection and maintenance of equipment
- calibration methodology;
- emergency situation (complete exchange of equipment).

A first training phase already took place from February to May 2007 – focus: principals of anaerobic digestion and design parameters. A second training phase followed from May to July 2007, with a focus on start-up and operating procedure including gas utilization. A third phase currently takes place and will last until one year after the finalisation of construction – it focuses on the M&E concept and procedure.

The main course of the training were carried out by staff of the monitoring equipment supplier. CPI staff attended the installation of the equipment, calibration and start-up operation.

Guidebooks for the monitoring system and a handbook of the digester operation were provided in local or English language by the suppliers. The operator and the monitoring management team can find information about:

- operation and maintenance of the monitoring instruments
- operation manual of the digester;
- design parameters of the biogas composition, temperature, pressure, flow rate, etc..
- drawings;
- inspection, maintenance and simple emergency repair instructions;
- description of parts of the equipment;

The training was done in accordance with the already implemented ISO9001:2008 procedures at CPI and considered the above presented Monitoring Management Organization and staff assigned to the positions within this organization structure.

SECTION D. Data and parameters

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

Data / Parameter:	**Bo**
Unit:	%
Description:	Biogas producing capacity
Source of data:	Default value as specified in AM0013, based on IPCC default values
Value(s) applied):	0.21 kg CH_4/kg COD
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**Hu_PS**
Unit:	
Description:	Calorific value of palm shells
Source of data:	Desk Study on Palm Oil Industry in Thailand
Value(s) applied):	13.8 MJ/kg
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	**Hu_HeavyOil**
Unit:	MJ/litre
Description:	Calorific value of heavy oil
Source of data:	Standard default value: IPCC (1996), Module 1, Table 1-3.
Value(s) applied):	35.1 MJ/litre (40.19 MJ/t @ 0.86 t/litre)
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	**GWP_CH_4**
Unit:	Number
Description:	Global warming potential of CH_4
Source of data:	UNFCCC
Value(s) applied):	21
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**$CEF_{Bl, elec,y}$**
Unit:	t CO_2/MWh
Description:	CO_2 emission factor for electricity consumed at the project site in the absence of the project activity

Source of data:	Electricity Generation Authority of Thailand (EGAT), own calculations based on ACM0002 (simple operating margin, refer to PDD)
Value(s) applied):	0.523
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	$\mathbf{D_{lng}}$
Unit:	M
Description:	Depth of lagoon
Source of data:	Measurement at CPI
Value(s) applied):	> 5
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	$\mathbf{F_d}$
Unit:	%
Description:	Fraction of anaerobic degradation due to depth as per table 1 of AM0013
Source of data:	AM0013
Value(s) applied):	70%
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**E**
Unit:	Cal/mol
Description:	Activation energy constant
Source of data:	AM0013
Value(s) applied):	15,175
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	$\mathbf{COD_{a,in}}$
Unit:	kg COD/yr
Description:	COD that enters the lagoon
Source of data:	Laboratory tests at CPI (Method AWWA 5220B.,P5-14,1998)
Value(s) applied):	Monthly values as per table 8 of the revised registered PDD: Results of wastewater analysis 2006
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	$\mathbf{COD_{a,out}}$
Unit:	kg COD/yr
Description:	COD that leaves lagoon with the effluent

Source of data:	Laboratory tests at CPI
Value(s) applied):	Monthly values, as per table 8 of the revised registered PDD: Results of wastewater analysis 2006 Month / Value / Month / Value: January 6,016; July 5,338 February 9,856; August 13,777 March 27,826; September 4,530 April 18,466; October 29,630 May 5,800; November 3,383 June 14,574; December 16,461
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Month	Value	Month	Value
January	6,016	July	5,338
February	9,856	August	13,777
March	27,826	September	4,530
April	18,466	October	29,630
May	5,800	November	3,383
June	14,574	December	16,461

Data / Parameter:	**$COD_{available}$**
Unit:	kg COD
Description:	Monthly COD available for conversion which is equal to the monthly COD entering the digester or directed to land application $COD_{baseline,m}$ plus COD carried on from the previous month
Source of data:	Calculated in line with AM0013
Value(s) applied):	Monthly values, see table “COD Avail” in spread sheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**Uncertainty conservativeness factor**
Unit:	
Description:	Uncertainty conservativeness factor
Source of data:	AM0013
Value(s) applied):	0.89
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**T1**
Unit:	Kelvin
Description:	Temperature
Source of data:	AM0013
Value(s) applied):	303.16
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**R**
Unit:	Cal/K mol
Description:	Ideal gas constant

Source of data:	AM0013
Value(s) applied):	1.987
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**EGy**
Unit:	MWh
Description:	Electricity consumption of existing waste water treatment system
Source of data:	CPI
Value(s) applied):	0
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	**$CEF_{Bl,therm}$**
Unit:	CO_2 e/TJ
Description:	CO_2 emissions intensity for thermal energy generation
Source of data:	IPCC 1996 Guidelines – Residual Fuel Oil, Table 1-1
Value(s) applied):	77.37
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	**HG_{Bl}**
Unit:	MJ
Description:	Quantity of [additional] thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel
Source of data:	Information provided by CPI, calculation on the basis of energy content of the produced biogas.
Value(s) applied):	11,172,825
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	**HGp,y**
Unit:	MJ
Description:	Quantity of thermal energy that is consumed in year y at the project site due to the project activity using fossil fuel
Source of data:	Planning data of installation
Value(s) applied):	0
Purpose of data:	Calculation of project emissions
Additional comment:	

Data / Parameter:	**$CEF_{Pr,therm,y}$**

Unit:	tCO_2 e/TJ
Description:	CO_2 emissions intensity for thermal energy generation
Source of data:	AM0013
Value(s) applied):	0
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	**EF_{N2O}**
Unit:	Kg N_2O/ Kg N
Description:	Emission factor of nitrogen from sludge applied to land
Source of data:	AM0013
Value(s) applied):	0.016
Purpose of data:	Calculation of project emissions
Additional comment:	

Data / Parameter:	**COD_{dw}**
Unit:	kg COD/yr
Description:	Chemical Oxygen Demand in the wastewater from the dewatering process
Source of data:	Installation design
Value(s) applied):	0 (Not applicable for ex-ante)
Purpose of data:	Calculation of project emissions
Additional comment:	Is applicable at times when sludge treatment and dewatering takes place.

D.2. Data and parameters monitored

Data / Parameter:	**T2**
Unit:	K
Description:	Ambient temperature (Kelvin) for the climate
Measured/ Calculated / Default:	Measured.
Source of data:	Weather station Chumporn Information received upon request to the service of Thai Meteorological Department, Ministry of Information and Communication Technology of Thailand (info_service@tmd.go.th)
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02, table “Monitoring Data”
Monitoring equipment:	n.a.
Measuring/ Reading/ Recording frequency:	Monthly averages are obtained from the weather station at least annually.
Calculation method (if applicable):	n.a.
QA/QC procedures:	Internal double-check of using the correct values.
Purpose of data:	Calculation of baseline and project emissions

Additional comment:	According to the monitoring methodology in AM0013 vers.04, the temperature of the lagoon is monitored to calculate the proportion of organic matter that are biologically available for conversion to methane based upon the temperature of the system. The assumed temperature is equal to the ambient temperature.

Data / Parameter:	**$F_{Dig,}$**
Unit:	m^3 / yr
Description:	Flow rate of organic wastewater into the digester
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see table “Monitoring Data” in the spread sheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”
Monitoring equipment:	Flow rates are continuously recorded with a Magnetic Flow Meter. Continuously values are transferred online and recorded. Meter: Liquid flow meter Manufacturer: Yokogawa Model: AXFA14C Serial No.: S5H904107 834 ID No./Tag No.: FTBG001 Calibration dates: 15/09/2008, 17/09/2009 and 01/10/2010; Due date: 01/04/2011; (6 month validity of calibration); Accuracy: +/- 0.35 % of full scale
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded daily.
Calculation method (if applicable):	n.a.
QA/QC procedures:	Calibration: The flow meter was calibrated by an approved company at the time of installation. Frequency of subsequent calibration was appropriate to the application to ensure accuracy of < ± 1% at lowest plant specific flow rate. Each time the meter is calibrated, an On-Site-Calibration-Report is submitted to CPI. From the first calibration in Sept. 2008, there was a delay of calibration, which should have been performed in March 2009. From March to Sept. 2009, the maximum permissible error of the meter (+/- 1%) was applied (calibration error in September: 0.15 %. The following calibration should have been in April 2010 but was again delayed until 1/10/2010. This time the measured error of 3.9% was applied. Inspection and Maintenance: The Meter is installed such to enable easy inspection at least half-yearly and in a wayinstalled where it may not be submerged. Installation also facilitates separation valves for meter removal and repair and recalibration. For this purpose, a spare meter is held on stock, to avoid long time loss of data record. O&M staff of the digester was trained to maintain the meters in accordance with the manufacturer's requirements. Meters are daily inspected by CPI staff and repaired as necessary by a service provider approved by the manufacturer. Laboratory and QA/QC staff trained O&M staff for data reading in parallel to online data transfer. Data storage: Online transfer to computer. Monthly data backup to external data storage. Data Preparation and reporting: Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports are printed and filed at factory and headquarters respectively.
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	-

Data / Parameter:	**F_{Dig_out}**
Unit:	m^3 / yr
Description:	Flow rate of organic wastewater out of the digester
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement. **F_{Dig_out} = $F_{Dig,}$**
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	See description at **$F_{Dig,.}$**
Measuring/ Reading/ Recording frequency:	See description at **$F_{Dig,.}$**
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description $F_{Dig,in}$
Purpose of data:	Calculation of project emissions
Additional comment:	For this monitoring period, FDig,out = FDig,in (in line with the applied methodology). This value may be monitored separately in later monitoring periods, in the case sludge is removed from the digester for separate treatment.

Data / Parameter:	**$COD_{c,baseline}$**
Unit:	kg COD/m^3
Description:	COD - concentration of organic wastewater into the digester
Measured/ Calculated / Default:	Measured.
Source of data:	Laboratory tests at CPI (monthly) – Method: APHA 5220 D
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Sample points at digester inlets. Method: APHA 5220 D **Laboratory tests at CPI laboratory** Measure COD of Waste Water Sample by using Close Reflux Method. For COD analysis of water samples CPI is using the analyser: “DR 3800 sc VIS spectrophotometer” by HACH LANGE
Measuring/ Reading/ Recording frequency:	Due to a misunderstanding of the MP (12 samples per day, weekly same day, were understood as 12 daily samples, every day, and this of all COD sampling point), the PP found it impossible to comply with the MP completely. As a result samples were taken as follows: 2 samples per time mixed together and 2 times a week were collected for COD measurement by internal laboratory. The same was explained in the approved revised PDD. A temporary deviation was requested at the time of PRC submission and it was approved. As a cross check with the own laboratory data, additionally once a month samples were taken and analysed by an external laboratory. According to the methodology (AM0013 vers.4) COD measurements are to be taken at least monthly. PP believes that the current practice more than fulfils the required COD measurement frequency in the reported monitoring period. Furthermore, due to clarification, the PP has now adjusted the sampling procedure to the description in the registered PDD.
Calculation method (if applicable):	n.a.

QA/QC procedures:	• Sampling was carried out adhering to internationally recognized procedures: Manual sample and laboratory analysis. CPI runs its own laboratory with appropriate sampling and analysis equipment. CPI and its laboratory are certified ISO 9001:2008. CPI elaborates standard operation procedures (SOP) and QC/QA instructions according to ISO9001:2008 for sampling taking and laboratory practice. Equipment supplier and internal laboratory staff and QA staff provided training to O&M staff to take samples according international standard requirements. Sample and analyzing accuracy is < ± 3 %. Calibration: Automatic wavelength calibration. Data capture/storage: Monthly data backup on external data storage of CDM specific data was carried out by data management (MIS) staff. Data will be stored for 10 years of CDM project duration and 2 years afterwards. Data backup procedure valid for the overall monitoring. Data Preparation and reporting: Data plausibility routines check data reliability and data comparison automatically. Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports are printed – two copies are filed at factory and headquarters respectively. Monthly control sampling and analysis by accredited laboratory.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**$COD_{a,in}$**
Unit:	kg COD/yr
Description:	COD that enters the lagoon
Measured/ Calculated / Default:	1 year historic data.
Source of data:	Laboratory tests at CPI, Method: APHA 5220 D
Value(s) of monitored parameter:	MR CPI 1st period_CER Calculation_rev.2015-02-02" Ex ante date in the registered PDD.
Monitoring equipment:	n.a.
Measuring/ Reading/ Recording frequency:	n.a.
Calculation method (if applicable):	n.a.
QA/QC procedures:	n.a.
Purpose of data:	Calculation of baseline emissions (ex ante)
Additional comment:	-

Data / Parameter:	**$COD_{a,out}$**
Unit:	kg COD/yr
Description:	COD that leaves the lagoon
Measured/ Calculated / Default:	1 year historic data.
Source of data:	Laboratory tests at CPI, Method: APHA 5220 D
Value(s) of monitored parameter:	MR CPI 1st period_CER Calculation_rev.2015-02-02Ex ante date in the registered PDD.
Monitoring equipment:	n.a.
Measuring/ Reading/ Recording frequency:	n.a.

Calculation method (if applicable):	n.a.
QA/QC procedures:	n.a.
Purpose of data:	Calculation of project emissions (ex ante)
Additional comment:	-

Data / Parameter:	T_{lng}
Unit:	K
Description:	Temperature of the lagoon
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements by CPI and ambient temperature obtained from weather station
Source of data:	Calculation based on calorific values and quantity of biogas as well as standard calorific values of fossil fuels (heavy oil).
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Only the additional thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuels is relevant for the calculation of emission reductions. HGBl is calculated on the basis of the biogas production in the monitoring period (4,779,975 m3/yr), the calorific value of biogas (0.000023 TJ/Nm3), and the expectation that 15% of the generated biogas will be used to replace fossil fuel (oil).
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2008 scheme set up by CPI.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Also see monitoring procedure for biogas flow rates and methane content.

Data / Parameter:	COD_{c,dig_out}
Unit:	kg COD/m^3
Description:	COD-concentration in discharged effluent from digester
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements by CPI (monthly)
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	See description at $COD_{c,baseline}$.
Measuring/ Reading/ Recording frequency:	See description at $COD_{c,baseline}$.
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description at $COD_{c,baseline}$.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$EL_{P,y}$
Unit:	MWh/yr
Description:	Amount of electricity in the year y that is consumed at the project site for the project activity
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements at CPI
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Standard electricity meter (separate meter for waste water plant); A separate and officially calibrated electric meter is connected to the main electricity supply of the overall biogas plant. The meter is: Schneider Electric, Power Logic PM710 (63230-501-209A1)
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded daily.
Calculation method (if applicable):	n.a.
QA/QC procedures:	Yearly calibration by official organization or authorized company. No further steps are applicable due to external quality control (electricity provider). The instrument has the measurement accuracy of ±1%.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	F_{la}
Unit:	kg/yr
Description:	Quantity of sludge used for land application after dewatering
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements by CPI
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Weighing of trucks with standard industrial weighbridge. Quantity of sludge is measured on demand. Meter: Weight bridge Methler Toledo Model: 8530 coupr. Serial No.: 5159588-51413 and 4373963-4qw ID No./Tag No.: Weight bridge no.1 and no.2 Accuracy: +/- 10 kg
Measuring/ Reading/ Recording frequency:	Continuously when applicable. Not applicable during this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2008 scheme set up by CPI. The calibration frequency of the instrument is biannually (every 2 years). The accuracy is ±10 kg.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	COD_{la}
Unit:	kg COD/m^3

Description:	COD of the sludge used for land application after dewatering
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements by CPI (laboratory), Method: APHA 5220 D
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	See description at $COD_{c,baseline}$.
Measuring/ Reading/ Recording frequency:	Monthly (if applicable). Not applicable in this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	see description at $COD_{c,baseline}$.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**$Fc_{,dw}$**
Unit:	m^3/yr
Description:	Flow rate of organic wastewater from the dewatering process
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement by CPI (reading of flow meter and recording)
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Flow rates are continuously recorded with Magnetic Flow Meter AXFA14C from Yokogawa .
Measuring/ Reading/ Recording frequency:	Continuously when applicable. Not applicable during this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description under F_{Dig}
Purpose of data:	Calculation of project emissions
Additional comment:	Is applicable at times when sludge treatment and dewatering takes place.

Data / Parameter:	**$COD_{c,dw}$**
Unit:	kg COD/yr
Description:	COD of the wastewater from the dewatering process
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements by CPI (laboratory), Method: APHA 5220 D
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	See description at $COD_{c,baseline}$.
Measuring/ Reading/ Recording frequency:	Monthly (if applicable).). Not applicable in this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description at $COD_{c,baseline}$.

Purpose of data:	Calculation of project emissions
Additional comment:	Is applicable at times when sludge treatment and dewatering takes place.

Data / Parameter:	**FR_{Bio}**
Unit:	m^3/yr
Description:	Biogas flow rate at digester outlet.
Measured/ Calculated / Default:	Measured.
Source of data:	Measurements
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Measurement at the outlet of the biogas system, after the biogas cleaner, before utilization of the gas. Continuously values are transferred online and recorded. Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 6511 ID No./Tag No.: FTBG004 Calibration date: 28/08/2008 and 01/10/2010; Due date: 01/04/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	n.a.
QA/QC procedures:	<u>Regular Calibration</u> of Thermal Mass flow meter or similar by manufacturer or approved company (half-yearly) – calibration report to CPI. QC staff of CPI are trained on calibration control and on malfunction recognition. Subsequent calibration control every month is appropriate to the application to assure accuracy of ± 2%. Each time the meter is calibrated by approved companies, an On-Site-Calibration-Report will be supplied to CPI. Calibration control and adjustments by CPI-QC staff will be recorded. From the first calibration in August 2008, there was a delay of calibration, which should have been performed in February 2009. From February 2009 to August 2010 the measured error of 4.4% was applied. <u>QC of meter function</u>: One main flow meter for both outlet 1 and 2 is installed. Data of the meter is sent to a computer. Computer program cross-checks total digester outlet with Sum of flow to flare and energy conversion units. Flow meter malfunction or leakages can thus be detected. Daily flow meter function inspection. Cross-check accuracy set to ± 2 %. A spare flow meter is held on stock for immediate change if needed at any place of gas pipes. Separation valves allow deviation of gas flow through second line during exchange of meter. Range of meter allows to measure full flow. <u>Data recording and storage</u>: Online transfer to computer. Monthly data backup to external data storage. <u>Data preparation and reporting</u>: Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed and filed at factory
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**$P_{CH4,bio}$**
Unit:	ppm
Description:	Biogas CH_4 content at digester outlet

Measured/ Calculated / Default:	Measured.
Source of data:	Measurement (quarterly)
Value(s) of monitored parameter:	Please see "MR CPI 1st period_CER Calculation_rev.2015-02-02", table "Monitoring Data"
Monitoring equipment:	CH_4 content is determined through electronic probe and analysis: Non-Dispersion Infrared method (NDIR). Preferably application of portable analyzer (range 0 -100vol%). Meter: 4 Channel Handheld Gas Analyzer Manufacturer: Gasboard Model: GA-m2 Serial No.: 10830 Calibration date: 21/10/2008 and 21/09/2010; Due date: 30/03/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/ Reading/ Recording frequency:	Measurements and recording at 1 hr frequency (portable analyzer).
Calculation method (if applicable):	n.a.
QA/QC procedures:	Accuracy of equipment < ± 1 % at full scale. Accuracy of Method (portable analyzer): < ± 2 % due to relatively stable production process and low variation of CH_4 production. Regular calibration by manufacturer or by approved company (half-yearly or before each measurement period, if portable equipment are used) – calibration report to CPI. QC staff of CPI will be trained on calibration control and on malfunction recognition. From the first calibration in October 2008, there was a delay of calibration, which should have been performed in April 2009. From April 2009 to August 2010 the maximum permissible error of 2% was applied (measured < 1%). Data recording/storage: Data logger reading or online transfer to computer. Monthly data backup to external data storage.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**$FR_{f,inlet}$**
Unit:	m^3/hr
Description:	Biogas flow rate at flare inlet
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement / calculation
Value(s) of monitored parameter:	Please see "MR CPI 1st period_CER Calculation_rev.2015-02-02", table "Monitoring Data"
Monitoring equipment:	Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 6510 ID No./Tag No.: FTBG005 Calibration date: 21/08/2008 and 01/10/2010; Due date: 01/10/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/ Reading/ Recording frequency:	Continuously values are transferred online and recorded.

Calculation method (if applicable):	n.a.
QA/QC procedures:	See description at $FR_{Bio..}$ The minimum re-calibration interval is 2 years. From the first calibration in September 2008, there was a delay of calibration, which should have been performed in March 2009. From March 2009 to August 2010 the maximum measured error of 8,97 % was applied
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$\mathbf{T_{comb,f}}$
Unit:	hrs/yr
Description:	Fraction of time gas is combusted in the flare
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	The gas flow to the flare is controlled by a pressure control system: If gas flows to the boiler stops, pressure in biogas storage bag will raise. If this pressure exceeds a certain level, a signal will be send to gas blower which will switch on pump. This starts gas pumping to the flare. The ignition of the flare is being controlled by pressure. If pressure increases, a signal will be send to switch to ignite the flame. Thermal Mass Flow Meter Accuracy ± 1% of reading, ± 0.2 % of full scale.
Measuring/ Reading/ Recording frequency:	Continuously.
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2008 scheme set up by CPI. The minimum re-calibration interval of the gas flow meter is 2 years.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$\mathbf{PE_{flare,\,y}}$
Unit:	$t\ CO_{2e}$
Description:	Project emissions from flaring of the residual gas stream in year y
Measured/ Calculated / Default:	Calculated.
Source of data:	Calculation based on $FR_{f,inlet,,}$$PCH_{4,f,s,}$ and $T_{comb,f}$
Value(s) of monitored parameter:	7,322 $t\ CO_{2e}$ Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-

Calculation method (if applicable):	$PE_{flare,y}$ will be calculated as the annual amount of CH_4 being utilized in the flare [t/yr] times the standard flare efficiency of 0.5 times the GWP of CH_4 (21): $PE_{flare,y} = (M_{CH4,flare} * 0.5 * 21)/1000$ in [t/yr] The annual amount of CH_4 being utilized in the flare ($M_{CH4,flare}$) will be calculated as: $M_{CH4,flare} = V_{Bio,flare} * \rho_{Bio,flare} * P_{CH4,bio}$ in [kg/yr] Where $V_{Bio,flare}$ = Annual volumetric flow of biogas at norm conditions = ($FR_{f,inlet}$ * $T_{comb,f}$) * (1+27.3°C[1] / 273.15°C) $\rho_{Bio,flare}$ = Density of biogas at norm conditions = $P_{CH4,bio}$ * 0.717 kg/m³ + (1-$P_{CH4,bio}$) * 1.251 kg/ m³ Remarks: ▪ The calculation of the density of the biogas is based on the simplified assumption that the biogas consists of CH_4 and N_2 only. This is in line with the TME, page 5. ▪ 0.717 kg/m³ is the density of CH_4 at norm conditions, 1.251 kg/ m³ is the density of N_2 at norm conditions (http://www.biologie.de/biowiki/Liste_der_Dichte_gasf%C3%B6rmiger_Stoffe)
QA/QC procedures:	See $T_{comb,f}$ and $FR_{f,inlet}$.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**$FR_{e,inlet}$**
Unit:	m^3/yr
Description:	Flow rate of the biogas entering the heat generation equipment
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see "MR CPI 1st period_CER Calculation_rev.2015-02-02", table "Monitoring Data"

[1] 27.3 °C is the average annual temperature at the project site.

Monitoring equipment:	The valve at the biogas burner is controlled by UV detector (flame control) and/or pressure drop at gas storage. Thermal mass flow meter is installed at each biogas utilisation unit. 1) CPO boiler 3 Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 7714 ID No./Tag No.: FTBG006 Calibration date: 22/08/2008, 25/06/2009 and 01/10/2010; Due date: 01/10/2011 Accuracy: ± 1% of reading, ± 0.2 % of full scale 2) Burner RF1 at the High pressure boiler of the Refinery RF1 Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 7715 ID No./Tag No.: FTBG007 Calibration date: 22/08/2008, 25/06/2009 and 01/10/2010; Due date: 01/10/2011 Accuracy: ± 1% of reading, ± 0.2 % of full scale 3) Burner RF2 at the High pressure boiler of the Refinery RF2 Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 6509 ID No./Tag No.: FTBG008 Calibration date: 22/08/2008, 25/06/2009 and 01/10/2010; Due date: 01/10/2011 Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/ Reading/ Recording frequency:	Continuously values are transferred online and recorded.
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description at $FR_{Bio..}$ The minimum re-calibration interval is 2 years.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**$FR_{e,s}$**
Unit:	m^3/yr
Description:	Flow rate of the heat generation equipment stack gases
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”

Monitoring equipment:	The stack gas emission flow rates (m3/s) are measured for the environmental monitoring for Industrial department half yearly under normal operating conditions of the boilers (full load) by a certified company
Measuring/ Reading/ Recording frequency:	Half yearly.
Calculation method (if applicable):	Based on the measured flow rate and the operation time of the boiler (which is continuously logged), the yearly flow of stack gas (m3/yr) is calculated.
QA/QC procedures:	See description at $FR_{Bio.}$
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$\mathbf{P_{CH4,e,s}}$
Unit:	Ppm
Description:	Methane content in stack gas of heat generation stack gases.
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement (half yearly)
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	CH_4 content is determined through Measurement for the environmental monitoring for Industrial department half yearly. by a certified company
Measuring/ Reading/ Recording frequency:	Half yearly
Calculation method (if applicable):	n.a.
QA/QC procedures:	See description at $P_{CH4,bio.}$
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$\mathbf{T_{comb,e}}$
Unit:	hrs/yr
Description:	Fraction of time gas is combusted in the heat generation equipment.
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	The valve at the biogas burner is controlled by UV detector (flame control) and/or pressure drop at gas storage. Thermal mass flow meter by Fox Thermal Instruments, model FT2 serial no. 7714 is installed.
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2000 scheme set up by CPI.

Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**Sa**
Unit:	kg/yr
Description:	Amount of sludge applied to land
Measured/ Calculated / Default:	Measured.
Source of data:	Measurement
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Weighing of trucks with standard industrial weighbridge. Quantity of sludge is measured on demand. Meter: Weight bridge Methler Toledo Model: 8530 coupr. Serial No.: 5159588-51413 and 4373963-4qw ID No./Tag No.: Weight bridge no.1 and no.2 Accuracy: +/- 10 kg
Measuring/ Reading/ Recording frequency:	Continuously when applicable. Not applicable during this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2000 scheme set up by CPI.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**NC**
Unit:	kg N/kg sludge
Description:	Nitrogen content in the sludge
Measured/ Calculated / Default:	Measured.
Source of data:	Monthly measurements
Value(s) of monitored parameter:	Please see “MR CPI 1st period_CER Calculation_rev.2015-02-02”, table “Monitoring Data”
Monitoring equipment:	Laboratory tests at CPI laboratory – Kjeidahl Method (Total Kjeldahl Nitrogen 3094 mg/L as N)
Measuring/ Reading/ Recording frequency:	When applicable. Not applicable in this monitoring period.
Calculation method (if applicable):	n.a.
QA/QC procedures:	QS/QA procedures according to ISO 9000:2000 scheme set up by CPI.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	**EGy**
Unit:	MWh
Description:	Amount of electricity in the year y that would be consumed at the project site in the absence of the project activity

Measured/ Calculated / Default:	Default.
Source of data:	Historical data provided by CPI
Value(s) of monitored parameter:	0 (zero); (the historic consumption is 78.2225 MWh, but no emission reduction are claimed for this)
Monitoring equipment:	Standard industrial electrical metering meters (accuracies: Power ± 0.5%, Current± 0.3, %Energy ± 1%, Power factor± 0.5%,Frequency± 0.1%)
Measuring/ Reading/ Recording frequency:	n.a.
Calculation method (if applicable):	n.a.
QA/QC procedures:	External control by electricity provider.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**NCV_BG**
Unit:	MJ/m^3
Description:	Net calorific value of biogas (dry)
Measured/ Calculated / Default:	Default.
Source of data:	Measurement by PTT chemical public company limited.
Value(s) of monitored parameter:	MR CPI 1st period_CER Calculation_rev.2015-02-02” 23 MJ/m^3
Monitoring equipment:	Laboratory tests at PTT chemical public company limited Methane Method ASTM D 1945-91 Total Hydrocarbons(C2-C5) Method ASTM D 2712-91
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	n.a.
QA/QC procedures:	n.a.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$\mathbf{T_{Fl}}$
Unit:	K
Description:	Temperature of Flare
Measured/ Calculated / Default:	Measured.
Source of data:	Automatic measurement
Value(s) of monitored parameter:	MR CPI 1st period_CER Calculation_rev.2015-02-02” The operation of the flare was not monitored properly and therefore flare efficiency is taken zero
Monitoring equipment:	Measurement temperature by Thermocouple transmitter type S . Accuracy ± 0.3% of FS.
Measuring/ Reading/ Recording frequency:	Continuously

Calculation method (if applicable):	n.a.
QA/QC procedures:	n.a.
Purpose of data:	Calculation of project emissions
Additional comment:	

D.3. Implementation of sampling plan

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The section is left blank intentionally.

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

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

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Emission reductions are calculated as the difference between baseline emissions and project emissions strictly in line with the provisions and formulas defined in AM0013.

<u>Baseline emissions include:</u>

- Lagoon baseline emissions
- Electricity/heat baseline emissions

Baseline emission is calculated in the following manner:

$BE_y = BE_{lagoon,y} + BE_{heat,y}$

$= MIN\{BE_{lagoon,theoretical,y} : BE_{lagoon,monitored,y}\} + BE_{heat\_oil,y}$

A) $BE_{lagoon,y}$

As described in AM0013 version 04, the lower of the two shall be assumed as the baseline emissions:

(i) baseline methane emission less the physical leakage, hereafter referred as "$BE_{lagoon,theoretical,y}$"; and

(ii) actual methane captured and flared/used for energy generation, hereafter referred as "$BE_{lagoon,monitored, y}$"

<u>(i) Lagoon Baseline Emissions - theoretical</u>

$$\underset{(kg/yr)}{CH_4\ emissions} = \underset{(kg\ COD/month)}{Total\ COD_{available,m}} \times \underset{(kg\ CH_4/kg\ COD)}{B_o} \times MCF_{baseline}$$

where:

$COD_{available,m}$	Is the monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD entering the digester or directed to land application $COD_{baseline,m}$ plus COD carried on from the previous month.
$COD_{baseline,m}$	Is the monthly Chemical Oxygen Demand of effluent entering lagoons or directed to land application (measured)
B_o	Is the maximum methane producing capacity
$MCF_{baseline}$	Is the monthly methane conversion factor (fraction)

As there is effluent from the lagoons in the baseline, $COD_{baseline}$ is multiplied by the factor AD:

$$AD = 1 - \left(\frac{COD_{a,out}}{COD_{a,in}} \right)$$

where:

$COD_{a,out}$	is the COD that leaves the lagoon with the effluent
$COD_{a,in}$	is the COD that enters the lagoon

Lagoon baseline emissions are calculated based on the chemical oxygen demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (B_o) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons:

$$CH_4\ emissions = Total\ COD_{available,m} \times B_o \times MCF_{baseline}$$

$$= 3{,}619{,}961 kg\ CH_4$$

Monthly calculation of CH_4 emissions from baseline lagoon are shown in the spreadsheet "MR CPI 1st period_CER Calculation_rev.2015-02-02"

In line with AM0013, the total baseline CH_4 emissions are translated into CO_2 equivalent emissions by multiplying by its global warming potential (GWP) of 21.

BE_L = 76,019t CO_2-e

$BE_{lagoon,theoretical,y} = BE_L - PE_{leakage\ digester}$

$= (76{,}019 – 6{,}285)\ t\ CO_2\text{-e}$

$= 69{,}734\ t\ CO_2\text{-e}$

(ii) Lagoon Baseline Emissions - monitored

$BE_{lagoon,\ monitored,y} = (BE_{biogas,boiler,y} + BE_{biogas,flare,y}) - PE_{flare}$

$= ((41{,}087 + 7{,}322) – 7{,}322))\ t\ CO_2\text{-e}$

$= 41{,}087\ t\ CO_2\text{-e}$

Monthly caluculation of CH_4 emissions from baseline lagoon (biogas to boiler and flare) are shown in the spreadsheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”

B) Electricity/heat baseline emissions

Electricity baseline emissions are not relevant for the underlying project, as it does not involve generation of electricity.

Heat baseline emissions are calculated as:

BE_{heat} = $HG_{Bl,y} * CEF_{Bl,therm,y}$

where $HG_{Bl,y}$ is the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) using fossil fuel.
$CEF_{Bl,\ therm}$ is the CO_2 emissions intensity for thermal energy generation (tCO_2 e/MJ).

BE_{heat} = 14.93 TJ * 77.37 tCO2 / TJ

BE_{heat} = 1,155 tCO_2-e

Monthly caluculation of CH_4 emissions from baseline heat generation are shown in the spreadsheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”

C) Total baseline emissions

In accordance with AM0013, a comparison between

(i) baseline methane emission less the physical leakage ($BE_{lagoon,theoretical,y}$), and

(ii) the actual methane captured and flared/used for energy generation ($BE_{lagoon,monitored,y}$)

have been made as shown in table below:

Table 1: Comparison of theoretical and monitored baseline emissions

	“$BE_{lagoon,theoretical,y}$” (t CO_2-e)	“$BE_{lagoon,monitored,\ y}$” (t CO_2-e)
Total	76 019	**48 410**

The actual methane captured and flare used for energy generation ($BE_{lagoon,monitored,y}$) is lower and therefore has to be used as baseline methane emission from open lagoon.
($BE_{lagoon,\ y} = BE_{lagoon,monitored,y}$ = 48,410 tCO_2-e)

$BE_{total,y}$ = $BE_{lagoon,y} + BE_{heat,y}$

= 48,410t CO_2-e + 1,155tCO_2-e

$BE_{total,y}$ = 49,565tCO_2-e

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

>>

The physical delineation of the project is defined as the plant site. Project emissions mainly consist of methane emissions from the lagoons, physical leakage from the digester system, stack emissions from flaring and energy generating equipment, emissions related with the consumption of electricity in the digester auxiliary equipment, emissions from land application of sludge, and emissions from wastewater removed in the dewatering process.

(i) Methane emissions from lagoons

After the majority of the COD is treated and reduced by anaerobic digestion, the effluent will pass through the ponds prior to release. A significant majority of the COD load will have been reduced by anaerobic digestion and the ponds are expected to operate under largely aerobic conditions. The MCF value for fully aerobic systems is 0, as no methane is produced.

However, due to the uncertainty regarding the exact extent of aerobic/anaerobic digestion after project implementation, the calculation of these CH_4 emissions is conservatively carried out in the same way as for the baseline, using the same values for B_o and the methane conversion factor (MCF):

Formula for the calculation of project methane emissions from lagoons as in AM0013:

$$\underset{(kg/yr)}{CH_4 \text{ emissions from the lagoons}} = \underset{(kg\ COD/yr)}{COD_{dig\_out}} \times \underset{(kg\ CH_4/kg\ COD)}{B_o} \times MCF_{dig\_out}$$

Where:

COD_{dig_out}	Is Chemical Oxygen Demand of effluent entering lagoons (measured)
B_o	Is maximum methane producing capacity
MCF_{dig_out}	Is methane conversion factor (fraction) estimated as described in the baseline section above

CH_4 emissions = 339,088 kg CH_4

Monthly calculations of CH_4 emissions from lagoon are shown in the spreadsheet "MR CPI 1st period_CER Calculation_rev.2015-02-02"

In line with AM0013, the total baseline CH_4 emissions are translated into CO_2 equivalent emissions by multiplying by its global warming potential (GWP) of 21.

PE_{lagoon} = 7,121 t CO_2-e

(ii) Physical Leakage from biodigesters

The emissions directly associated with the digesters involve the physical leakage from the digester system. IPCC guidelines specify physical leakage from anaerobic digesters as being 15% of total biogas production.

Physical leakage from the biodigesters has been calculated based on the total amount of biogas produced (5,090,900 m^3) and the methane fraction of biogas (average P_{CH4} = 53,21%).

$PE_{leakage\ digester}$ = 6,285t CO_2-e

Monthly calculations of CH_4 emissions from biodigersters are shown in the spreadsheet "MR CPI 1st period_CER Calculation_rev.2015-02-02"

(iii) Stack emissions from the flare or energy generation

Methane may be released as a result of incomplete combustion either in the flaring option or in case of biogas use for electricity and/or heat production.

Project Emission from stack gas of flare and energy generation has been calculated based on the amount of biogas into the energy generation equipment and flare.

$PE_{flare,\ y}$ is calculated as the annual amount of CH_4 being utilized in the flare [t/yr] times the standard flare efficiency of 0.5 times the GWP of CH_4 (21):

$$PE_{flare,\ y} = (M_{CH4,\ flare} * 0 * 21)/1000 \quad \text{in [t/yr]}$$

The annual amount of CH_4 being utilized in the flare ($M_{CH4,\ flare}$) will be calculated as:
$M_{CH4,\ flare} = V_{Bio,\ flare} * \rho_{Bio,\ flare} * P_{CH4,bio}$ in [kg/yr]

Where

$V_{Bio,\ flare}$ = Annual volumetric flow of biogas at norm conditions = ($FR_{f,inlet}$ * $T_{comb,f}$) * (1+27.3°C[2] / 273.15°C)

$\rho_{Bio,\ flare}$ = Density of biogas at norm conditions = $P_{CH4,bio}$ * 0.717 kg/m³ + (1- $P_{CH4,bio}$) * 1.251 kg/m³

$PE_{flare,\ y}$ = 7,322 t CO_2-e

Monthly calculations of CH_4 emissions from flaring are shown in the spreadsheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”

PE_{stack} = 76.12 t CO_2-e

Monthly calculations of CH_4 emissions from stack gas are shown in the spreadsheet “MR CPI 1st period_CER Calculation_rev.2015-02-02”

(iv) Emissions from heat use and electricity use due to the project activity (PEelec/heat):

$$PE_{elec/heat} = EL_y * CEF_d + HG_{Pr,y} * CEF_{Pr,therm,y}$$

where,

$EL_{P,y}$	is the amount of electricity in the year y that is consumed at the project site for the project activity (MWh).
$CEFd$	is the CO_2 emissions factor for electricity consumed at the project site during the project activity (tCO_2/MWh), estimated as described below. Factor is zero if biogas is used to produce electricity.
$HG_{Pr,y}$	is the quantity of thermal energy consumed in year y at the project site due to the project activity (MJ).
$CEF_{Pr,\ therm,y}$	is the CO_2 emissions intensity for thermal energy generation (tCO2e/MJ), estimated as per method described for baseline thermal energy use. Factor is zero if biogas is used for generating thermal energy.

CEF_d is calculated in line with ACM002. PE_{heat} is not relevant for the underlying project, as no additional heat is consumed due to the project activity.

PE_{elec} = $El_y * CEF_d$

= 290 MWh * 0.523 t CO_2-e/MWh

PE_{elec} = 152 tCO_2-e

[2] 27.3 °C is the average annual temperature at the project site.

(v) Emissions from land application of sludge

For conservativeness, an MCF of 0.05 is to be used to estimate possible methane emissions from the land application treatment process to account for any possible anaerobic pockets. These emissions are to be estimated from the following equation:

CH_4 emissions (kg/yr)	=	Total COD_{la} (kg COD/yr)	x	B_o (kg CH_4/kg COD)	x	MCF_{la}

Where:

COD_{la}	Is Chemical Oxygen Demand of the sludge used for land application after dewatering (measured)
B_o	Is maximum methane producing capacity
MCF_{la}	Is methane conversion factor (fraction) assumed to be equal to 0.05

And

N_2O emissions (kg/yr)	=	S_a (kg sludge/yr)	x	NC (kg N/kg sludge)	x	EF_{N2O}

Where:

S_a	Is the amount of sludge applied to land in kg per year
NC	Is the nitrogen content in the sludge in (Kg N/Kg sludge)
EF_{N2O}	Is the emission factor of nitrogen from sludge applied to land to be assumed 0.016 kg N_2O/ Kg N

No sludge application has taken place during the monitoring period (S_a = 0).

PE_{sludge} = 0 t CO_2-e

(v) Emissions from wastewater removed in the dewatering process

The wastewater removed from the dewatering process may contain some organic matter that has not been degraded/removed. Emissions from such wastewater should be estimated from the following equation:

CH_4 emissions (kg/yr)	=	Total COD_{dw} (kg COD/yr)	x	B_o (kg CH_4/kg COD)	x	MCF_{dw}

Where:

COD_{dw}	Is Chemical Oxygen Demand in the wastewater from the dewatering process (measured)
Bo	Is maximum methane producing capacity
MCF_{dw}	Is methane conversion factor (fraction) estimated as described in the baseline section above

Emissions of wastewater removed in the dewatering process may be relevant to the project activity at times when sludge treatment and dewatering takes place. At times when no sludge treatment and dewatering is taking place, solid residues from the biogas digester system will be discharged in open ponds and project emissions of methane from lagoons will be accounted for instead.

No dewatering has taken place in the sludge treatment during the monitoring period (S_a = 0).

$PE_{dewatering}$ = 0 t CO_{2}-e

Table 2: Summary of Project Emissions

Year	PE Lagoon (tCO_2)	PE Stack (tCO_2)	PE Physical Leakage (tCO_2)[1]	PE Sludge application (tCO_2)	PE Dewatering (tCO_2)	PE Electricity (tCO_2)	PE total (tCO_2)
Feb-09	26	0	0	0	0	1	27
Mar-09	129	2	0	0	0	6	137
Apr-09	107	2	0	0	0	5	114
May-09	149	3	0	0	0	7	158
Jun-09	424	1.017	0	0	0	8	1.450
Jul-09	216	418	0	0	0	5	639
Aug-09	505	1.136	0	0	0	10	1.651
Sep-09	578	852	0	0	0	11	1.441
Oct-09	455	229	0	0	0	9	694
Nov-09	365	676	0	0	0	9	1.050
Dec-09	233	157	0	0	0	10	399
Jan-10	254	750	0	0	0	9	1.013
Feb-10	203	126	0	0	0	8	338
Mar-10	311	869	0	0	0	9	1.190
Apr-10	481	364	0	0	0	8	852
May-10	694	251	0	0	0	10	955
Jun-10	588	5	0	0	0	8	602
Jul-10	533	5	0	0	0	9	547
Aug-10	869	535	0	0	0	11	1.415
Total	**7121**	**7398**	**0**	**0**	**0**	**152**	**14671**

1) The baseline case (ii) is applicable (actual methane captured and flared/used for energy generation), therefore the physical leakage from anaerobic digester for estimating emissions reduction shall be taken as zero.

E.3. Calculation of leakage

>>

No leakage is associated with the project 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	**49 565**	**14 671**		**34 893**

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

The emission reduction estimated in the registered PDD (revised with PRCs) amount to 28,133 tonnes of CO2e annually. The number of days during the monitoring period covered by this monitoring report (MP1, first monitoring period) is 569 days. Correspondingly the total emission reduction of 43,857 tCO_2 would be estimated for the first monitoring period.

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)	43 857	**34 893**

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

>>

Compared to the registered PDD, more biogas was flared. (Assumption of flare operation time: 16 hours / year, i.e. 25,300 m^3 biogas / year. The actual flaring of biogas was 921,753 m^3 biogas /yr). Because of the difficulties in monitoring the flaring operations, the biogas sent to the flare considered with a flare efficiency of zero in the calculation of emission reduction (i.e. emission reduction for destruction of biogas in the flare was not accounted for). This constitutes a loss of accountable emission reductions of approximately 7,322 t CO2. The remaining difference of approximately 2,500 t CO2 emission reduction are subject to the permanently changing amounts of waste water, COD of wastewater and a lower methane concentration in the biogas (approximately averaged 48% compared to estimated 65% in the registered PDD. Looking at the methane content in the biogas, it is obvious that the system only reached a stable performance in September 2009 (with then approximately 56%).

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)	**34 893**	n.a.

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

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for completing the CDM-MR-FORM
Organization name	Deutsche Gesellschaft für Internationale Zusammenarbeit (GTZ) GmbH
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Document information

Version	*Date*	*Description*
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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