Monitoring report form for CDM project activity
(Version 06.0)

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

MONITORING REPORT		
Title of the project activity	Chumporn applied biogas technology for advanced waste water management	
UNFCCC reference number of the project activity	2148	
Version number of the PDD applicable to this monitoring report	12	
Version number of this monitoring report	5.0	
Completion date of this monitoring report	16/10/2018	
Monitoring period number	Monitoring period no.2	
Duration of this monitoring period	Duration: 01/09/2010 to 30/09/2011 (first and last days included)	
Monitoring report number for this monitoring report	-	
Project participants	Private entity: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany Private entity: Chumporn Palm Oil Industry Public Company Limited	
Host Party	Thailand	
Sectoral scopes	13. Waste handling and disposal	
Applied methodologies and standardized baselines	AM0013: Avoided methane emissions from organic waste-water treatment --- Version 4.0	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	39,819t CO_2e	
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	30,445 t CO_2e	

SECTION A. Description of project activity

A.1. 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 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) Brief description of the installed technology and equipment;

Two CSTR and two UASB-reactors have been constructed to treat wastewater from the palm oil production at CPI, before being released to the conventional open-pond post treatment process. Biogas is being utilised in the palm oil production process and palm oil refinery for heat production. Biogas that can for any reason not be utilized is being flared in an open flare. A treatment system for sludge produced in the biogas digesters is in place, consisting 4 concrete ponds with sand bed filter.

(c) 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

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

Monitoring period: 01 September 2010 to 30 Sept 2011
Number of days during this monitoring period: 395 Days
Total Emission Reduction achieved during this monitoring period: **39,819tCO2e**

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.

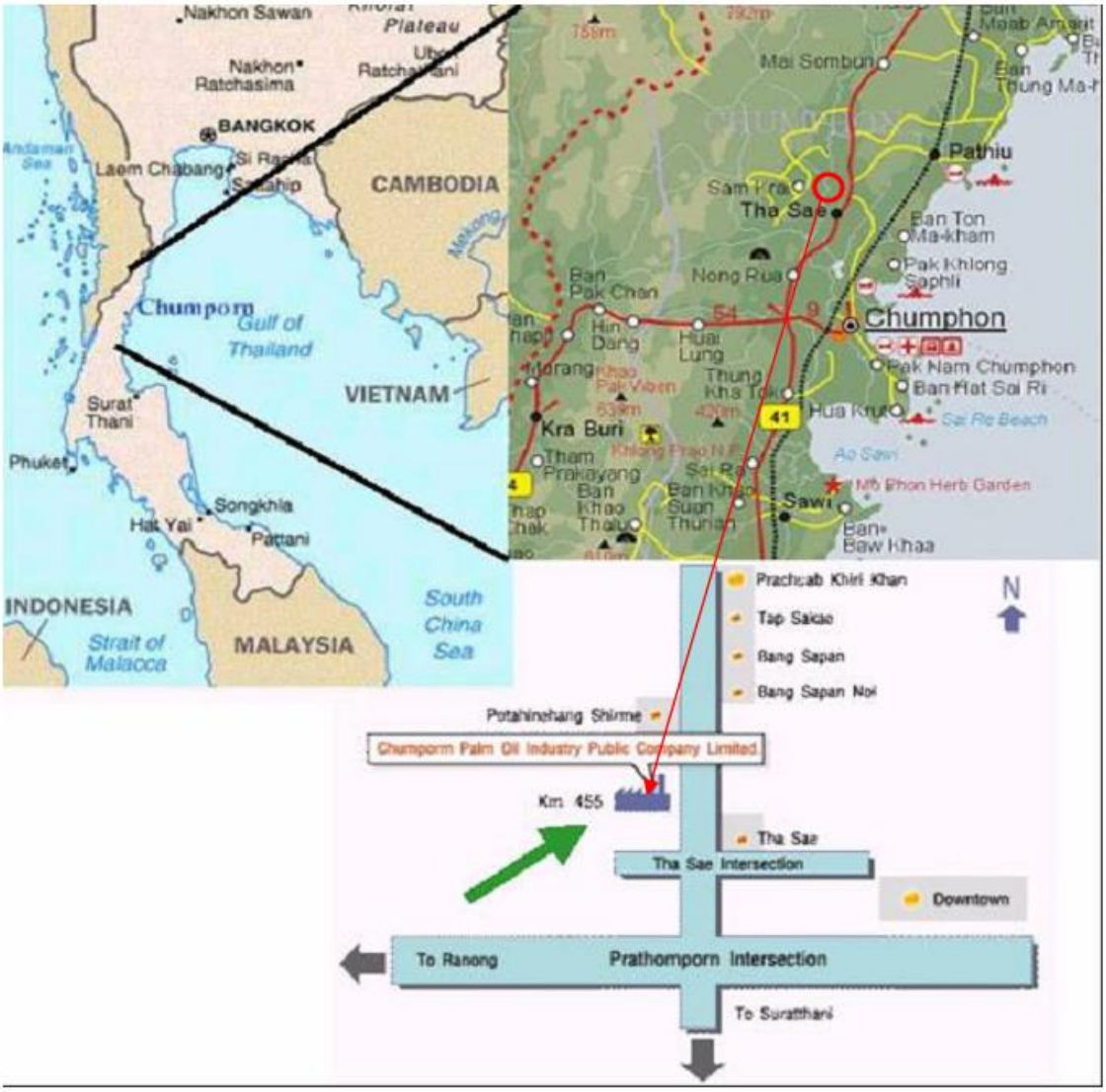

Figure 1: Physical location of the project activity

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 participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Private entity: Chumporn Palm Oil Industry Public Company Limited	No

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Germany	Private entity: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany	No
…	…	

A.4. Reference to applied methodologies and standardized baselines

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Approved Methodology AM0013 "Avoided methane emissions from organic waste-water treatment", version 4, as of 22/12/2006 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 ACM0002, version 6, as of 18/05/2006 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 type and duration

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

SECTION B. Implementation of project activity

B.1. Description of implemented 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.

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 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 15,531 m^3 of biogas per day. The methane content of the biogas reached an average of 59%, 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.

Biogas is being utilised in the 2 CPO boilers and since 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 this monitoring period no dewatering and land application of sludge was occurring.

No particular events or situations occurred during the monitoring period that impacted the applicability of the applied methodology.
Maintenance and replacements of parts were done on a regular basis, but no major system down times occurred.

Changes in monitoring equipment occurred during the monitoring period as follows:

Table 1: Changes in the monitoring system

Monitoring component / date of change	Original equipment	Equipment type after change
COD measurement / 4 November 2011	Manufacturer: HACH Model: DR/890 Serial No.: HAC070790C64568	Manufacturer: HACH LANGE Model: DR 3800 Serial No.: 1308841
	Schneider Electric, Power Logic PM710MG .Serial Number: 4D6EF3F2 Calibration date: 03/02/2011	

The flow diagram in **Error! Reference source not found.** summarizes the described process.

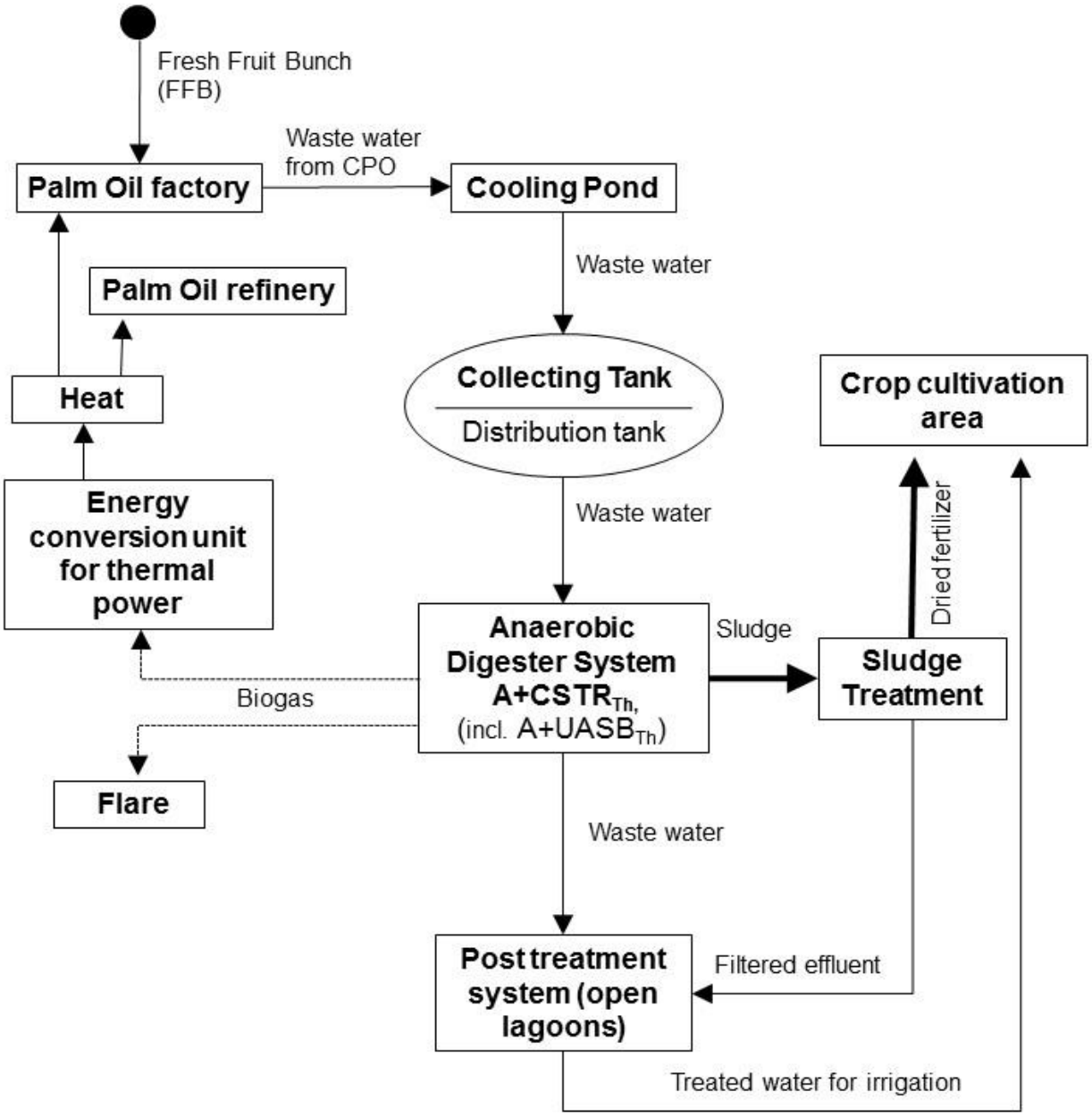

Figure 2: Flow diagram of improved waste water management system after project implementation

Table 2: Main project equipment

Equipment	Type	Manufacturer
Biogas digester	2 A+CSTR$_{Th}$ digesters (capacity each 3,000 m^3) 2 A+ UASB$_{Th}$ digesters (capacity each 200 m^3)	Natural Power Co., Ltd
Energy conversion units (biogas boiler)	2 biomass boiler (CPO): 30 bar, AWG Series II dual-fuel burner from (AWG 15) 2 mid/high pressure boiler (60-90 bar, boiler type NUK-HP 930, dual-fuel burner type RGMS7/1-D ZMD, DN50)	Hamworthy GekaKonus GmbH Weishaupt
Flare	Operating Pressure: 50-200 mbar; open flare system Biogas Flow Rate: 900 Nm3/h at Pressure 200 mbar Flare's Height: 6 Meters Materials: Stainless Steel for Biogas Pipe and Fire Tube Carbon Steel for Main Structure	BKE Combustion Controls Co., Ltd.

B.2. Post-registration changes

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

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Following are the temporary deviations applied for the first monitoring period PRC-2148-001, approved 28/12/2014.

2.1.1 Sampling frequency for COD analysis

For the COD related parameters (CODc,baseline, CODa,in, CODa,out and CODc,dig,out), as per the registered monitoring plan, it was proposed that 4 samples per hour, 12 samples per day (weekly same say, same time) are collected for COD measurement. However, during the first monitoring period, 2 samples per time mixed together and 2 times a week were collected for COD measurement. Besides that, COD samples were also sent to external laboratory once a month for COD analysis. It is assessed during the course of the verification that PP wrongly understood the requirement of the registered monitoring plan (12 samples per day, weekly same day, were understood as 12 daily samples, every day, and this of all COD sampling points) and therefore the PP found it is not possible to comply with the registered monitoring plan completely. As a result, samples were taken as mentioned above (2 samples are collected and mixed together and is done twice a week) and as a crosscheck with the internal laboratory data, samples were taken and analysed by an external laboratory additionally once a month.

PP adjusted the sampling procedure to th e description in the registered monitoring plan after the onsite verification. Therefore, a temporary deviation was requested by the PP for the first monitoring period. The DoE assessment team was of the opinion that the deviation can be accepted considering the fact that the COD was still analysed on weekly basis but with less number of samples. Besides, the COD was analysed by external laboratory on monthly basis and PP proposes to consider

conservative value between monthly external laboratory data and weekly internal laboratory data for the respective months for emission reduction calculation.
The approach was deemed appropriate as it results in conservative emission reductions.

2.1.2
Measuring frequency of depth of lagoons
It was mentioned in the registered monitoring plan, as part of the description of measurement methods, that monthly measurements and calculation of yearly average would be followed for the depth of the lagoon (D_{lng}). Nevertheless, as per the applied monitoring methodology, the parameter shall be measured daily. Therefore, PP revised the measuring frequency to be in line with the methodology. However, over the first monitoring period, the depth of the lagoon was only measured monthly. Therefore, PP proposed a temporary deviation for the first monitoring period since it was monitored as per the registered monitoring plan but not according to the monitoring methodology. For the calculation of emission reduction for the first monitoring period, PP proposed to apply the most conservative value for fraction due to depth (fd) as per Table 1 of the applied methodology, AM0013 Version 04.
The assessment team was of the opinion that this can be accepted as it results in more conservative emission reductions. The parameter would be measured daily for future monitoring periods as stated in the revised monitoring plan which is in accordance with the applied monitoring methodology.

B.2.2. Corrections

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The following corrections have been made in the revised PDD. version 10 (PRC-2148-001, approved 28/12/2014).

2.2.1 Change in PP's name from GTZ to GIZ
The name of one of the project participants has been changed i.e. the name of "Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH" has been changed to "Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH"..

2.2.2
Improvements in technology description
The project description has been improved in the section 'Technologies and/or measures'. The wastewater is first treated in Completely Stirred Tank Reactor (CSTR) followed by Up-flow Anaerobic Sludge Blanket (UASB) system. However, there was no mentioning of UASB in the technology description of the registered PDD. From the interview with the project participants, it was understood that the technology of combination of CSTR and UASB was supplied as a single package by the technology supplier which is generally called as CSTR system. Nevertheless, the description has been improved by mentioning combination of CSTR and UASB in order to make it transparent. The verification team was of the opinion that this does not have any negative impact on the project as the project technology was not altered post-registration. The technology in place i.e. combination of CSTR and UASB is the same that has been planned and the biogas generation was estimated considering the technology in place now. This is also confirmed from the original technical drawings of the project obtained from the technology supplier. Besides, the description of sludge treatment system has been improved in the revised PDD vers.10. In the registered PDD only 'sand bed filter' was mentioned for sludge treatment. However, from the onsite interviews it was assessed that there were difficulties with the original treatment system, implemented as per registered PDD. Since the sand bed filter did not deliver the expected dry sludge, to be used for land application, a belt press was proposed to be implemented. Therefore, the additional information 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. Therefore, it has been improved by stating that the treatment system would consist of sand bed filters or other technical solution such as belt press in order to produce sludge dry enough for the transportation land use.

The correction in the PDD is deemed appropriate as it describes the sludge treatment system more appropriately and it does not have any impact on the project design. The corrections in the technology description can be clearly identified in section A.3 of the revised PDD vers.10.

2.2.3
Corrections in baseline and project emissions
Some mistakes in the ex-ante estimated values of baseline and project emissions were recognised by the PP and therefore corrected in section B.6.3 and B.6.4 of the revised PDD vers.10. The following corrections have been made:

	Registered PDD (t CO_2e)	**Revised PDD (t CO_2e)**	**Changes/Rational**
Baseline Emission			
(i) Lagoon	39,175	38,531	The decrease in baseline emission from the lagoon is caused by the exclusion of refinery waste water to the new waste water treatment plant as assessed in section 3.5 of the report. This refinery waste water has a small impact on lagoon baseline emissions due to the low COD load of this discharge.
(ii) Power/Heat	905	854	The original calculation as per the registered PDD did not take into account a small amount of biogas going to the flare and therefore it resulted in slightly higher value. The calculation is now corrected by deducting the amount of biogas to flare. Further reduction is due to a correction in the registered PDD inconsistently states the amount of electricity consumed in the absence of the project activity (Egy). While the Egy was mentioned as 0 MWh/yr in B.6.2, a value of 78.2 MWh/yr was applied in the old calculations. This is now considered as zero for baseline emissions in order to be conservative.
Total	**40,080**	**39,385**	As assessed above
Project Emissions			
Lagoon	7,836.50	5,111	The applied methodology AM0013 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 now. The emission reduction calculation spreadsheet (ER sheet) submitted along with the registered PDD was checked. It was found that the COD was wrongly calculated in the ER sheet. COD available was calculated as the sum of COD at the outlet of digester and the leftover COD from the previous month. Leftover COD was calculated as $COD_{available}(1 – MCF)$. The emissions from lagoon are calculated based on COD available. Therefore, the leftover COD was accounted additionally which resulted in higher project emissions. The revised calculation is in accordance with the applied methodology.

(ii) Physical Leakage from biogas digesters	8,212.52	5,606	The calculation in the registered PDD had been based on the biogas production of 13,370 kg/day. This is not explained and is not in line with all other calculations which are based on an output of 12,700 m^3/day (refer to 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.
(ii) Stack emission from flare emissions or energy generation	182.50	125	In line with the calculation of physical leakage from the digester above, the revised value is now based on the volume of biogas. It is confirmed from the ER sheet available at UNFCCC CDM web page that it was assumed as flare would be operated 2 days in a year. Though it was mentioned quantity of biogas flared per day as 12,700 m^3/day, it was considered 13.37 tons per day in the calculation which is not correct. The revised calculation is correct
(iii) Power/Heat	315.80	324	Small deviation due to conservative rounding. It is assessed and confirmed from the revised ER sheet that the project emissions due to electricity consumption per month has been calculated as 26.32 tCO_2e. If these values are summed up for 12 months, it results in 315.8 tCO_2e. Nevertheless, for the sake of conservativeness, every month values have been rounded-up to 27 tCO_2e which account to 324 tCO_2e per annum. This is considered to be appropriate.
(iv) Emissions from land application of sludge	85.17	86	It is a small deviation due to conservative rounding of the numbers.
(v) Dewatering of sludge		0.00	The component is added in the revised PDD but is considered as zero for the ex-ante calculation. This is deemed appropriate as the dewatering would be measured only when it takes place.
Total	**16,632.49**	**11,252**	As assessed above
Emission reductions	**3,448**	**28,133**	As assessed above

3.2.4 Editorial corrections
Minor editorial revisions have been appliead to the approved revised PDD version 10, approved on 28/12/2014.

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

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n.a.

B.2.4. Inclusion of monitoring plan

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n.a.

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

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Permanent changes have been made to the registered monitoring plan with reference to the following monitoring parameters and the same have been incorporated in section B.7.1 of the revised PDD: version 10 (PRC-2148-001, approved 28/12/2014).

Parameter	Change	Details of changes
T2	Improved description against 'source of data'	Additional information how the data would be obtained is presented.
F_{Dig}	Change in flow meter type from 'Vortex Flow Meter' to 'Magnetic Flow Meter'	Magnetic flow meters are commonly used in the industry to measure wastewater quantity. The corresponding change has also been made from 'hourly' to 'continuously' with reference tomonitoring frequency.
	Data backup frequency	The data backup frequency increases from weekly to monthly
F_{Dig_out}	The parameter is mentioned separately	A common description was provided for F_{Dig} and F_{Dig_out} in the registered PDD. However, the description was mentioned separately in the revised PDD.
$COD_{c,baseline}$ $COD_{a,in}$ $COD_{a,out}$ COD_{la} COD_{c,dig_out}	Change in COD analysis method from 'Potassium Dichromate Digestion' analysis to 'Close Reflux Method'	'Potassium Dichromate Digestion' method was chosen initially and the same was mentioned in the registered PDD. The method is referred as "AWWA 5220B. P5-14,1998". In practice, the Close Reflux Method has been followed from the beginning which delivers accurate and reliable COD values. There is no change in monitoring frequency; the COD analysis is carried out weekly by collecting 4 samples per hour at different

		timings and total 12 samples per day (the samples are collected on the same day every week and at same times).
T_{lng}	No change in monitoring plan, but inclusion of additional comment for clarity	Temperature of the lagoons would be same as that of the ambient temperature. The ambient temperature data obtained from the local weather station and is use in the calculations.
D_{lng}	No change in monitoring plan, but inclusion of additional comment for clarity	
$EL_{P,y}$	Editorial correction – additional information is provided	
F_{la}	Inclusion of QA/QC procedures	It has been added in the revised PDD that the calibration of the weighbridge would be carried out once in 2 years and the accuracy of the measuring equipment would be +10 kg.
$F_{C,dw}$ $COD_{C,dw}$	Monitoring for these parameters is proposed as and when dewatering takes place	As per the registered PDD, monitoring is not applicable for these parameters because a dewatering process was not expected. However, PP proposes to modify monitoring plan for these parameters as dewatering of sludge might be needed some times due to technical difficulties. 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 actually takes place.
FR_{Bio}	Change in type of biogas monitoring equipment and its location	As per the registered PDD, it was proposed to measure biogas flow rate at outlet of digester using Coriolis Mass Flow Meter or similar with a measuring range of 100 – 500 kg/hr at 0.717 kg/m^3 and with an accuracy of the instrument <+1% at 2 – 100%. Further it was proposed to measure at

		each digester outlet. However, during the verification site visit it was observed that all the biogas flow from the digesters is combined into one pipeline and a thermal Mass Flow Meter was installed to measure total biogas flow rate from the digesters.
FR_{Bio}	Correction in ex-ante value	The ex-ante value has been corrected by deducting 15% physical leakage as mentioned in other parts of the PDD and recommended by the applied methodology. The correction is considered as editorial in nature and therefore accepted. 300 day x 12,700 m^3 = 3,810,000 m^3 3,810,000 – 15% leakage = 3,238,500 m^3
$P_{CH4,bio}$	Correction in methane content measurement	As per the registered PDD, the parameter would be measured at digester outlet (measurement at each digester line). Average of at least 5 control measurements at 1 hour frequency would be considered. However, the biogas pipelines from CSTRs and UASBs are combined into one header and the methane content is measured at common header on hourly basis using portable analyzer.
$FR_{f,inlet}$ $T_{comb,f}$ $FR_{e,inlet}$ $T_{comb,e}$	The proposed revision is same for all these parameters i.e. installed biogas flow meter is of different type compared to the one mentioned in the registered PDD.	The registered PDD states, "Two gas flow meters of standard type are currently being considered for • installation: Vortex Flow Meter, 4" meter size, Model VFM 7700 or Kobold DOG-1119L". Nevertheless, Thermal mass flow meters were installed for monitoring these parameters for the

		reasons mentioned under the assessment of FR_{Bio} above. Therefore, the monitoring plan has been revised accordingly. The accuracy of these instruments is ± 1% of reading, ± 0.2 % of full scale, which represents food practice.
$FR_{e,inlet}$	Correction in ex-ante value Applied	The ex-ante value of $FR_{e,inlet}$ has been corrected in the revised PDD based on 15% leakage assumed and 25,400 m^3 to the flare. The change is considered as editorial correction.
$FR_{e,s}$	Deviation in measurement Method	As per the registered PDD, the parameter should be measured using Coriolis mass flow meter or similar on hourly basis. As per the applied monitoring methodology also, it is required to monitor on a continuous basis. Nevertheless, PP proposes a deviation in the monitoring approach of the parameter.
$P_{CH4,e,s}$	Deviation in monitoring Frequency	As per the applied monitoring methodology, the parameter is required to monitor at least quarterly. According to the registered PDD, the parameter would be monitored quarterly using portable analyzer. Nevertheless, for the same reasons mentioned for $FR_{e,s}$, PP proposes to measure the methane content in stack gases “half-yearly” together with the flow rate of stack gases for the purpose of environmental monitoring for Department of Industry.
EGy	Correction in historical value for calculation of baseline emissions	The historical value of the parameter Egy (Amount of electricity in the year y that would be consumed at the project site in the absence of the project activity) was mentioned as 78.2 MWh in section B.7.1 while it was

		mentioned as 0 in section B.6.2 of the registered PDD vers.10
All	Due to up-gradation of the PDD form to the latest template, respective changes such as inclusion of 'monitoring frequency' and 'purpose of data' have been made in the monitoring parameter tables	

Further permanent changes have been made to the registered monitoring plan with reference to the following monitoring parameters and the same have been incorporated in section B.7.1 of the revised PDD: version 12 (PRC-2148-002, Effective approval date: 01/02/2018).

Parameter	Change	Details of changes
F_{Dig_out}	Revision for the measurement of the outflow organic wastewater	To obtain the outflow of the wastewater from the digester, the PP applies the inflow organic wastewater measured data as the outflow data for the organic wastewater from the digester. This is in accordance with the applied methodology, parameter to be monitored, project emissions - Fdig_out, Flow rate of organic wastewater into the digester. The volume of outflow organic wastewater will be same as the volume of inflow organic wastewater.

B.2.6. Changes to project design

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The below changes are applied in the approved revised PDD version 10 (PRC-2148-001, approved 28/12/2014).

3.5.1 Wastewater intake to the project system

The project activity was implemented at Chumporn Palm Oil Industry (CPI). Wastewater is produced in the factory from two sections called CPO (Crude Palm Oil) production and Refinery plant. Though it was not explicitly mentioned in the registered PDD, it was planned to treat the wastewater produced from CPO as well as Refinery in the project treatment system.

During the early stage of project operation it became clear to the operating team that the treatment of refinery waste water was difficult due to strong fluctuation in waste water composition such as quick changes in COD and pH values. Moreover, the COD load from refinery wastewater accounts to only 1.6% of the total estimated COD load. Therefore, the PP decided to bypass the wastewater of refinery section from the project treatment system and treat directly in open lagoon system i.e.

same as baseline scenario. The wastewater only from CPO is treated in the project treatment system. This is deemed appropriate as it was not explicitly mentioned in the PDD that the wastewater from both CPO and Refinery are treated in the project treatment system.

3.5.2 Utilisation of biogas

During the project design stage, it was planned to utilize the biogas produced from the project treatment system in biomass boilers at CPO section and the same was described in the registered PDD. In order to make the project activity financially more attractive it was decided post-registration, after proven reliable operation of the biogas system, to divert a part of the biogas to be utilized in two HP boilers at CPI's refinery plant although it required an additional investment to facilitate the use of biogas at refinery boilers.

Sections A.3 and B.5 of the PDD have been revised accordingly to incorporate the permanent changes in project design and the corresponding revisions in IRR calculations. The project flow diagram and the project boundary diagram have also been updated accordingly in sections A.3 and B.3 respectively of the PDD. The revised PDD describes the implemented project accurately and appropriately.

SECTION C. Description of monitoring system

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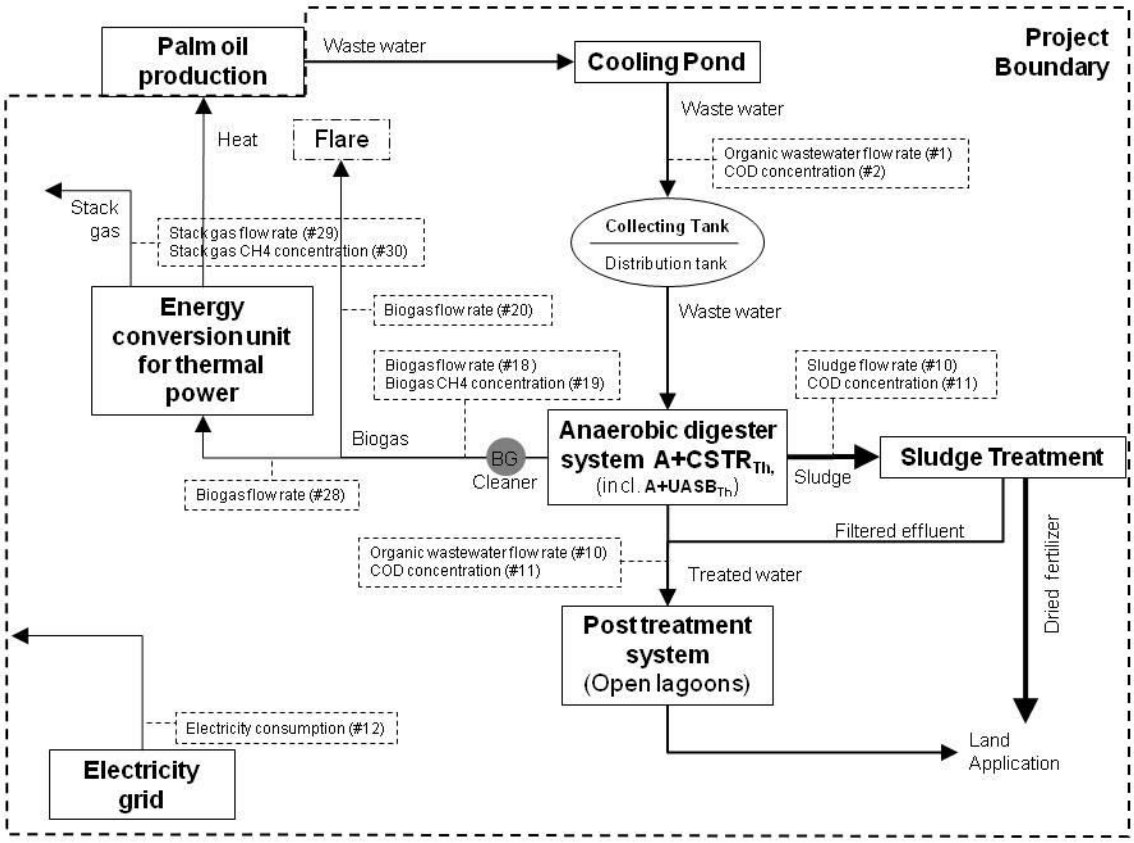
All data will be kept for at least two years following the end of the crediting period or the last issuance of CERs (whatever is the later). For all monitoring supervision, maintenance, data storage, data handling and plausibility check measures, standard operation procedures (SOP) are followed. These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



Organizational and management structures

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

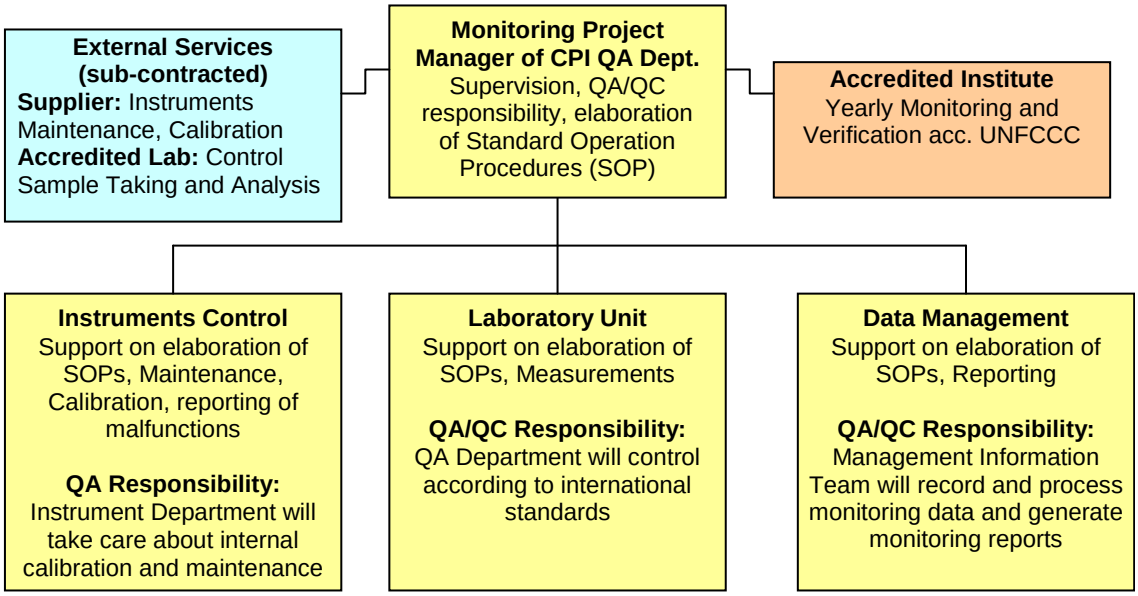
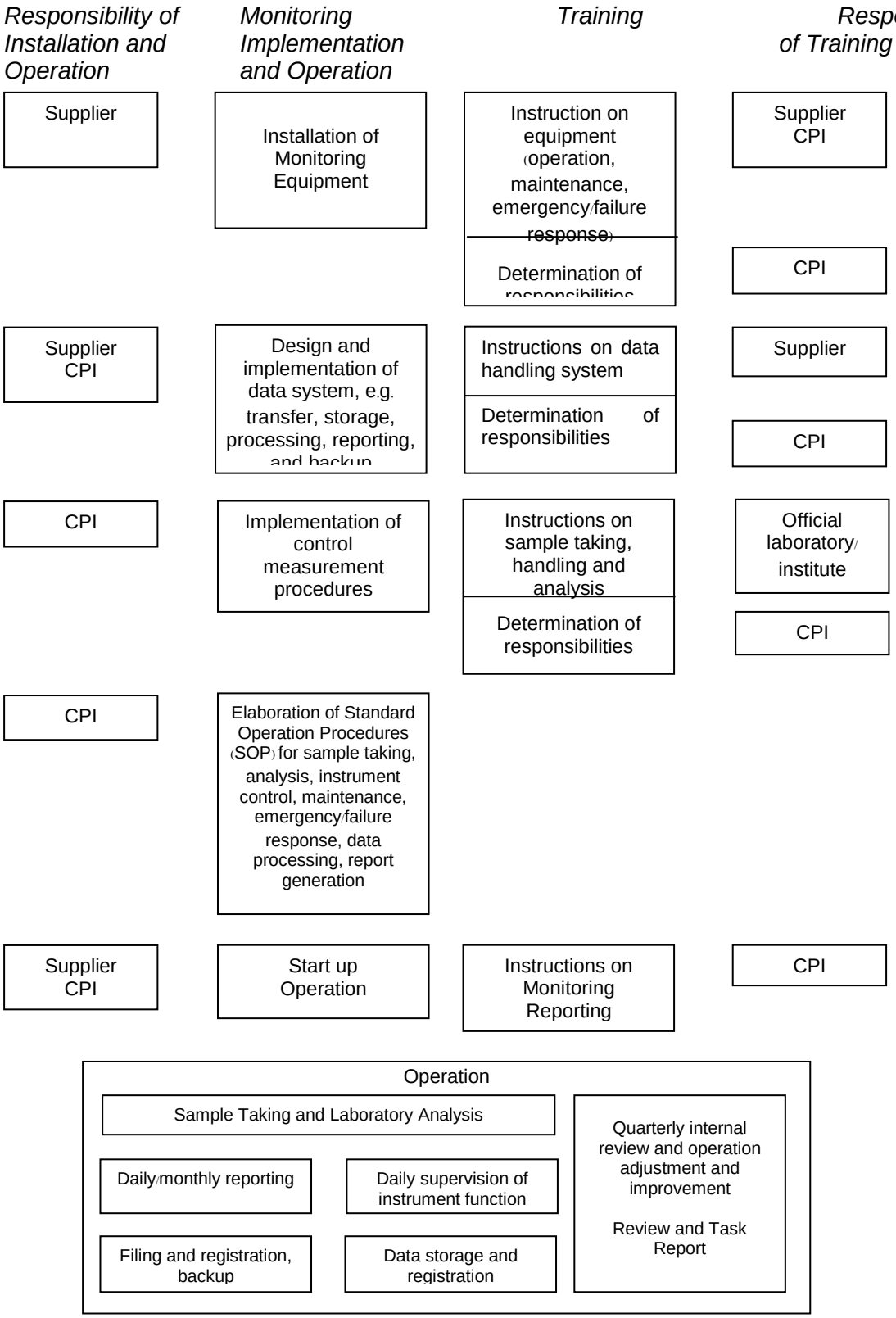


Figure 3: **Management Structure of Monitoring System**

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



Reconstruction/calculation of data in case of instrument failure

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.

Training

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

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
Choice of data or measurement methods and procedures	n.a.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	Hu_PS
Unit	MJ/kg
Description	Calorific value of palm shells
Source of data	Desk Study on Palm Oil Industry in Thailand
Value(s) applied	13.8
Choice of data or measurement methods and procedures	Value is based on detailed analysis by Thai-German Program for Enterprise Competitiveness E3AGRO-Project, Desk Study on Palm Oil Industry, Prawat Leetanakul, Bangkok, Thailand, November 2004.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

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 (40.19 MJ/t @ 0.86 t/litre)
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/Parameter	GWP_CH_4
Unit	Number
Description	Global warming potential of CH_4
Source of data	UNFCCC
Value(s) applied	21
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	$CEF_{BI, elec,y}$
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
Choice of data or measurement methods and procedures	See Appendix 4 to the approved revised PDD, page 54-55 "Baseline Information – Calculation of Thai Grid Emission Factor"
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**D_{lng}**
Unit	m
Description	Depth of lagoon
Source of data	Measurement at CPI
Value(s) applied	> 5
Choice of data or measurement methods and procedures	Standard depth meter; metering randomly selected and varying places of the lagoons.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**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%
Choice of data or measurement methods and procedures	Standard value as defined in AM0013, page 8
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**E**
Unit	Cal/mol
Description	Activation energy constant
Source of data	AM0013
Value(s) applied	15,175
Choice of data or measurement methods and procedures	Standard value as defined in AM0013., page 8.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**$COD_{a,in}$**
Unit	kg COD/yr
Description	COD that enters the lagoon
Source of data	Laboratory tests at CPI (Method AWWA 5220B.,P5-14,1998)

<table>
<tr><td>Value(s) applied</td><td>Monthly values as per table 10, Results of wastewater analysis 2006, row “COD in (CPO)+CODin (Refinery)” of the revised registered PDD
<table>
<tr><th>Month</th><th>Value</th><th>Month</th><th>Value</th></tr>
<tr><td>January</td><td>343,148</td><td>July</td><td>224,000</td></tr>
<tr><td>February</td><td>8,934</td><td>August</td><td>596,973</td></tr>
<tr><td>March</td><td>1,478,409</td><td>September</td><td>59,598</td></tr>
<tr><td>April</td><td>1,656,264</td><td>October</td><td>818,316</td></tr>
<tr><td>May</td><td>1,648,690</td><td>November</td><td>744,237</td></tr>
<tr><td>June</td><td>1,189,790</td><td>December</td><td>678,075</td></tr>
</table></td></tr>
<tr><td>Choice of data
or measurement methods
and procedures</td><td>.

- Sampling will be carried out adhering to internationally recognized procedures. Alternative 1: 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 will elaborate 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 will train O&M staff to take samples according international standard requirements. Sample and analyzing accuracy will be < ± 3 %.
- Alternative 2: Automatic continuous measurement. Method: Electrochemical oxidation. Sample Preparation: Maintenance free particle separator.

Cross-Checks: If automatic monitoring will be installed, additional quarterly sample will be taken and potassium dichromate digestion analysis carried out. The results will be stored in computer and comparison routines will check these data with quarterly average data from continuous monitoring system.
Data capture/storage: Data capture at the laboratory/IT-center resp. online transfer, if continuous monitoring system will be used. Monthly data backup on external data storage of CDM specific data will be 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 will check data reliability and data comparison automatically. Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed – two copies will be filed at factory and headquarters respectively.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Additional comments</td><td></td></tr>
</table>

Data/Parameter	**$COD_{a,out}$**
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 10 of the revised approved 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

Choice of data or measurement methods and procedures	Sample points at digester inlets. Method: APHA 5220 D **Laboratory tests at CPI laboratory** Measure COD of WasteWater Sample by using Close Reflux Method.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

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 Appendix 1 - CPI_Revised ER calculation sheet for ex-ante estimation_2014-08-09.xls

Month	Value ($COD_{available}$ in kg)	Month	Value ($COD_{available}$ in kg)
January	330,106	July	998,463
February	124,521	August	962,416
March	1,500,967	September	362,942
April	2,184,587	October	937,559
May	2,420,426	November	1,072,986
June	2,076,675	December	1,057,348

Choice of data or measurement methods and procedures	Application of AM0013, page 7
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**Uncertainty conservativeness factor**
Unit	
Description	Uncertainty conservativeness factor
Source of data	AM0013
Value(s) applied	0.89
Choice of data or measurement methods and procedures	Standard value as defined in AM0013, page 8
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**T1**
Unit	Kelvin
Description	Temperature

Source of data	AM0013
Value(s) applied	303.16
Choice of data or measurement methods and procedures	Standard value as defined in AM0013, page 8
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**R**
Unit	Cal/K mol
Description	Ideal gas constant
Source of data	AM0013
Value(s) applied	1.987
Choice of data or measurement methods and procedures	Standard value as defined in AM0013
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

Data/Parameter	**EGy**
Unit	MWh
Description	Electricity consumption of existing waste water treatment system
Source of data	CPI
Value(s) applied	0
Choice of data or measurement methods and procedures	Historical value (measurement with standard electric meter)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/Parameter	**$CEF_{BI,therm}$**
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
Choice of data or measurement methods and procedures	IPCC standard value for this fuel type
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/Parameter	**HG_{BI}**
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

Choice of data or measurement methods and procedures	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 annual biogas production (3,238,500 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).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

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
Choice of data or measurement methods and procedures	The new waste water treatment system will not lead to a consumption of thermal energy.
Purpose of data/parameter	Calculation of project emissions
Additional comments	

Data/Parameter	**$CEF_{Pr,therm,y}$**
Unit	tCO_2e/TJ
Description	CO_2 emissions intensity for thermal energy generation
Source of data	AM0013
Value(s) applied	0
Choice of data or measurement methods and procedures	Biogas is used for generating thermal energy (used at palm oil production, not for waste water treatment system itself)
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	

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
Choice of data or measurement methods and procedures	Application of AM0013
Purpose of data/parameter	Calculation of project emissions
Additional comments	

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)
Choice of data or measurement methods and procedures	Is applicable at times when sludge treatment and dewatering takes place.

Purpose of data/parameter	Calculation of project emissions
Additional comments	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:	See table below Please also see "MR CPI 2nd period_CER Calculation, 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/parameter	Calculation of baseline and project emissions
Additional comments	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.

Month	**Value (Kelvin)**	**Month**	**Value (Kelvin)**
		January-11	299.0
		February-11	300.3
		March-11	299.5
		April-11	301.3
		May-11	301.2
September-10	301.0	June-11	300.9
October-10	300.0	July-11	300.3
November-10	299.1	August-11	300.8
December-10	299.3	September-11	300.1

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

Month	Value (m^3)	Month	Value (m^3)
		January-11	2,668
		February-11	7,811
		March-11	12,858
		April-11	10,150
		May-11	12,446
September-10	16,481	June-11	15,560
October-10	14,666	July-11	14,305
November-10	13,079	August-11	13,776
December-10	3,106	September-11	15,018
Total 2010 (Sept-Dec.)	47,332	Total 2011 (Jan.-Sept.)	104,591

Please also see table "Monitoring Data" in the spread sheet "MR CPI 2nd period_CER Calculation"

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 date:
First calibration: 15/09/2008,
Following calibrations 17/09/2009; 01/10/2010; 14/04/2011
due date: 14/10/2011; (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:

Calibration due date	Actual calibration date	measured error
September 2009	17/09/2009	0.15%
17/03/2010	1/10/2010	3.9%
01/04/2011	14/04/2011	-0.41 %

Permissible error of +/- 1%.
Calibration frequency: 6 months
Each time the meter is calibrated, an On-Site-Calibration-Report is submitted to CPI.

Inspection and Maintenance: The Meter is installed such to enable easy inspection at least half-yearly and in a way installed 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/parameter

Calculation of baseline and project emissions

Additional comments

<table>
<tr><td>Data/Parameter</td><td>F_{Dig_out}</td></tr>
<tr><td>Unit</td><td>m^3 / yr</td></tr>
<tr><td>Description</td><td>Flow rate of organic wastewater out of the digester</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured.</td></tr>
<tr><td>Source of data</td><td>Measurement</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Month</th><th>Value (m^3)</th><th>Month</th><th>Value (m^3)</th></tr>
<tr><td></td><td></td><td>January-11</td><td>2,668</td></tr>
<tr><td></td><td></td><td>February-11</td><td>7,811</td></tr>
<tr><td></td><td></td><td>March-11</td><td>12,858</td></tr>
<tr><td></td><td></td><td>April-11</td><td>10,150</td></tr>
<tr><td></td><td></td><td>May-11</td><td>12,446</td></tr>
<tr><td>September-10</td><td>16,481</td><td>June-11</td><td>15,560</td></tr>
<tr><td>October-10</td><td>14,666</td><td>July-11</td><td>14,305</td></tr>
<tr><td>November-10</td><td>13,079</td><td>August-11</td><td>13,776</td></tr>
<tr><td>December-10</td><td>3,106</td><td>September-11</td><td>15,018</td></tr>
<tr><td>Total 2010 (Sept-Dec.)</td><td>47,332</td><td>Total 2011 (Jan.-Sept.)</td><td>104,591</td></tr>
</table>
Please also see table “Monitoring Data” in the spread sheet “MR CPI 2nd period_CER Calculation”
Please see momment below on calculation method</td></tr>
<tr><td>tMonitoring equipment</td><td>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.:
S5H904108 834
ID No./Tag No.: FTBG002
14/04/2011
due date: 14/10/2011; (6 month validity of calibration);
Accuracy: +/- 0.35 % of full scale</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously and recorded daily.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n.a.
The following determination of project emissions shall be used:
FDig,out = FDig</td></tr>
</table>

<table>
<tr><td>QA/QC procedures</td><td>Calibration: flow meter will be calibrated by manufacturer or approved company at the time of installation. Frequency of subsequent calibration will be appropriate to the application, but not less than half-yearly re-calibration to ensure accuracy of < ± 1% at lowest plant specific flow rate. Each time the meter is calibrated, an On-Site-Calibration-Report will be submitted to CPI.
Inspection and Maintenance: Meters will be installed such to enable easy inspection at least half-yearly and are not to be installed where they will or may be submerged. Installation will also facilitate separation valves for meter removal and repair and recalibration. For this purpose, a spare meter will be held on stock, to avoid long time loss of data record. O&M staff of the digester will be trained to maintain the meters in accordance with the manufacturer's requirements. Meters will be daily inspected by CPI staff and repaired as necessary by a service provider approved by the manufacturer. Laboratory and QA/QC staff will train 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: Counter control routine between digester inlet and outlet.
Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed and filed at factory and headquarters respectively.

<table>
<tr><th>Calibration due date</th><th>Actual calibration date</th><th>measured error</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>14-04-2011</td><td>-33.86%</td></tr>
</table>
Permissible error of +/- 1%.
Calibration frequency: 6 month
Each time the meter is calibrated, an On-Site-Calibration-Report is submitted to CPI.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td>The determination of project emissions as FDig,out = FDig as been approaved by PRC on 01 Feb 18)</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$COD_{c,baseline}$</td></tr>
<tr><td>Unit</td><td>kg COD/m^3</td></tr>
<tr><td>Description</td><td>COD - concentration of organic wastewater into the digester</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured.</td></tr>
<tr><td>Source of data</td><td>Laboratory tests at CPI (monthly) – Method: APHA 5220 D</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Month</th><th>Value (kg COD/m3)</th><th>Month</th><th>Value (kg COD/m3)</th></tr>
<tr><td></td><td></td><td>January-11</td><td>82.78</td></tr>
<tr><td></td><td></td><td>February-11</td><td>113.69</td></tr>
<tr><td></td><td></td><td>March-11</td><td>134.03</td></tr>
<tr><td></td><td></td><td>April-11</td><td>128.39</td></tr>
<tr><td></td><td></td><td>May-11</td><td>116.25</td></tr>
<tr><td>September-10</td><td>77.76</td><td>June-11</td><td>123.31</td></tr>
<tr><td>October-10</td><td>67.91</td><td>July-11</td><td>119.58</td></tr>
<tr><td>November-10</td><td>90.76</td><td>August-11</td><td>93.57</td></tr>
<tr><td>December-10</td><td>56.77</td><td>September-11</td><td>129.15</td></tr>
</table>
Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”</td></tr>
</table>

Monitoring equipment	From start of project until 04 November 2010 1) Manufacturer: HACH Model: DR/890 Serial No.: HAC070790C64568 2) Used from 05 November 2010 onwards Manufacturer: HACH LANGE Model: DR 3800 Serial No.: 1308841
Measuring/reading/recording frequency	Weekly (same day, same times) , 4 samples per hour, total 12 samples per day (weekly same day, same times)
Calculation method (if applicable)	n.a.
QA/QC procedures	- Sampling will be carried out adhering to internationally recognized procedures. *Alternative 1:* 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 will elaborate 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 will train O&M staff to take samples according international standard requirements. Sample and analyzing accuracy will be < ± 3 %. - *Alternative 2*: Automatic continuous measurement. Method: Electrochemical oxidation. Sample Preparation: Maintenance free particle separator. Calibration: Regular calibration by manufacturer or approved company (half-yearly) – calibration report to CPI. Cross-Checks: If automatic monitoring will be installed, additional quarterly sample will be taken and potassium dichromate digestion analysis carried out. The results will be stored in computer and comparison routines will check these data with quarterly average data from continuous monitoring system. Data capture/storage: Data capture at the laboratory/IT-center resp. online transfer, if continuous monitoring system will be used. Monthly data backup on external data storage of CDM specific data will be 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 will check data reliability and data comparison automatically. Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed – two copies will be filed at factory and headquarters respectively. Half-yearly control sampling and analysis by accredited laboratory. Calibration date (Instruments 1 and 2): 1) Model: DR/890: 15/07/2008, 18/05/2009, 20/10/2009, 23/03/2010, 20/10/2010 2) Model: DR 3800: 20/10/2009 (Certificate of final Inspection), 01/11/2010, 13/03/2011, 28/04/2011, 08/12/2011 (6 month validity of calibration);
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	n.a.

Data/Parameter	$COD_{a,in}$
Unit	kg COD/yr
Description	COD that enters the lagoon
Measured/calculated/ default	Measured.
Source of data	Laboratory tests at CPI, Method: APHA 5220 D
Value(s) of monitored parameter	See table below and "MR CPI 2nd period_CER Calculation", table "Monitoring Data", column CODc,dig_out - Concentration in discharged effluent from digester (CODc,dig_out = $COD_{a,in}$)
Monitoring equipment	See description at $COD_{c, baseline}$.
Measuring/reading/recording frequency	Weekly (same day, same times) , 4 samples per hour, total 12 samples per day (weekly same day, same times). Samples were taken twice a week (same day, same time). Mixed samples were collected (4 samples per hour at 3 times) for COD measurement by internal laboratory.
Calculation method (if applicable)	See description at $COD_{c, baseline}$.
QA/QC procedures	See description at $COD_{c, baseline}$.
Purpose of data/parameter	Calculation of project emissions
Additional comments	See description at $COD_{c, baseline}$.

Month	Value (kg COD/m3)	Month	Value (kg COD/m3)
		January-11	4.33
		February-11	18.83
		March-11	23.77
		April-11	22.32
		May-11	20.32
September-10	14.95	June-11	27.49
October-10	13.45	July-11	25.00
November-10	13.50	August-11	23.32
December-10	9.27	September-11	23.69

Data/Parameter	$COD_{a,out}$
Unit	kg COD/yr
Description	COD that leaves the lagoon
Measured/calculated/ default	Measured.
Source of data	Laboratory tests at CPI, Method: APHA 5220 D

Value(s) of monitored parameter	See Table 10

Month	Value (kg COD/m3)	Month	Value (kg COD/m3)
		January-11	1.436
		February-11	2.095
		March-11	1.348
		April-11	2.550
		May-11	1.090
September-10	1.489	June-11	1.636
October-10	0.970	July-11	2.000
November-10	0.887	August-11	1.200
December-10	1.469	September-11	1.118

Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”, column “COD at the lagoon”-

Monitoring equipment	See description at $COD_{c, baseline}$.
Measuring/reading/recording frequency	Weekly (same day, same times) , 4 samples per hour, total 12 samples per day (weekly same day, same times). Samples were taken twice a week (same day, same time). Mixed samples were collected (4 samples per hour at 3 times) for COD measurement by internal laboratory.
Calculation method (if applicable)	See description at $COD_{c, baseline}$.
QA/QC procedures	See description at $COD_{c, baseline}$.
Purpose of data/parameter	Calculation of project emissions
Additional comments	See description at $COD_{c, baseline}$.

Data/Parameter	T_{lng}
Unit	K
Description	Temperature of the lagoon
Measured/calculated/ default	Measured.
Source of data	Measurements by CPI. Measurement are done by submerging the thermometer into the lagoon.

Value(s) of monitored parameter

Month	Value (Kelvin)	Month	Value (Kelvin)
		January-11	301.1
		February-11	301.4
		March-11	301.1
		April-11	302.4
		May-11	303.3
September-10	296.7	June-11	301.3
October-10	296.7	July-11	302.4
November-10	299.8	August-11	301.7
December-10	300.7	September-11	296.8

(Please see also table “Data (processing)" in “MR CPI 2nd period_CER Calculation”

Monitoring equipment	Standard industrial temperature meter. O-tox Filled Laboratory Thermometer, glass tube with Kerosene filling, 405 mm. Temp. range -1 to +51 °C.. Termometer is submerged into the lagoon until a stable temperature is reached
Measuring/reading/recording frequency	Daily measurements; calculation of monthly average.
Calculation method (if applicable)	n.a.
QA/QC procedures	Internal double-check of using the correct values.
Purpose of data/parameter	Calculation of project emissions (for plausibility check against ambient temperature data.
Additional comments	That ambient temperature obtained from weather station will be used for the calculation.

Data/Parameter	**D_{Ing}**
Unit	M
Description	Depth of the lagoons
Measured/calculated/ default	Measured.
Source of data	Measurements by CPI.
Value(s) of monitored parameter:	(Please see also "MR CPI 2nd period_CER Calculation"
Monitoring equipment	Standard depth meter.
Measuring/reading/recording frequency	daily measurements; calculation of monthly average.
Calculation method (if applicable)	n.a.
QA/QC procedures	This is done by a mechanical measuring tape, which does not need recalibration. The accuracy is in the range of the scale: ± 1 cm.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Month	**Value (m)**	**Month**	**Value (m)**
		January-11	2.00
		February-11	1.96
		March-11	1.94
		April-11	1.96
		May-11	2.00
September-10	1.75	June-11	2.00
October-10	2.34	July-11	2.00
November-10	1.34	August-11	2.00
December-10	2.02	September-11	2.00

Data/Parameter	**HG_{BI}**
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 (MJ) using fossil fuel
Measured/calculated/ default	Calculation based on calorific values and quantity of biogas as well as standard calorific values of fossil fuels (heavy oil).
Source of data:	Information provided by CPI, calculation on the basis of energy content of the produced biogas.

Value(s) of monitored parameter:	<table><tr><th>Month</th><th>Value (MJ)</th><th>Month</th><th>Value (MJ)</th></tr><tr><td></td><td></td><td>January-11</td><td>155,213</td></tr><tr><td></td><td></td><td>February-11</td><td>578,315</td></tr><tr><td></td><td></td><td>March-11</td><td>1,068,609</td></tr><tr><td></td><td></td><td>April-11</td><td>806,973</td></tr><tr><td></td><td></td><td>May-11</td><td>992,037</td></tr><tr><td>September-10</td><td>1,041,449</td><td>June-11</td><td>1,112,216</td></tr><tr><td>October-10</td><td>1,318,181</td><td>July-11</td><td>1,286,879</td></tr><tr><td>November-10</td><td>1,115,103</td><td>August-11</td><td>1,220,124</td></tr><tr><td>December-10</td><td>94,573</td><td>September-11</td><td>1,512,858</td></tr></table> (Please see also “MR CPI 2nd period_CER Calculation”, table “BE heat”
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	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. HG_{BI} is calculated on the basis of biogas production, 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).
QA/QC procedures	QS/QA procedures according to ISO 9000:2000 scheme set up by CPI.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	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	<table><tr><th>Month</th><th>Value (kg COD/m3)</th><th>Month</th><th>Value (kg COD/m3)</th></tr><tr><td></td><td></td><td>January-11</td><td>4.33</td></tr><tr><td></td><td></td><td>February-11</td><td>18.83</td></tr><tr><td></td><td></td><td>March-11</td><td>23.77</td></tr><tr><td></td><td></td><td>April-11</td><td>22.32</td></tr><tr><td></td><td></td><td>May-11</td><td>20.32</td></tr><tr><td>September-10</td><td>14.95</td><td>June-11</td><td>27.49</td></tr><tr><td>October-10</td><td>13.45</td><td>July-11</td><td>25.00</td></tr><tr><td>November-10</td><td>13.50</td><td>August-11</td><td>23.32</td></tr><tr><td>December-10</td><td>9.27</td><td>September-11</td><td>23.69</td></tr></table> Please see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”

Monitoring equipment	Start of project until 04 November 2010 1) Manufacturer: HACH Model: DR/890 Serial No.: HAC070790C64568 2) Used from 05 November 2010 onwards Manufacturer: HACH LANGE Model: DR 3800 Serial No.: 1308841
Measuring/reading/recording frequency	Weekly (same day, same times) , 4 samples per hour, total 12 samples per day (weekly same day, same times)
Calculation method (if applicable)	n.a.
QA/QC procedures	- Sampling will be carried out adhering to internationally recognized procedures. *Alternative 1:* 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 will elaborate 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 will train O&M staff to take samples according international standard requirements. Sample and analyzing accuracy will be < ± 3 %. - *Alternative 2*: Automatic continuous measurement. Method: Electrochemical oxidation. Sample Preparation: Maintenance free particle separator. Calibration: Regular calibration by manufacturer or approved company (half-yearly) – calibration report to CPI. Cross-Checks: If automatic monitoring will be installed, additional quarterly sample will be taken and potassium dichromate digestion analysis carried out. The results will be stored in computer and comparison routines will check these data with quarterly average data from continuous monitoring system. Data capture/storage: Data capture at the laboratory/IT-center resp. online transfer, if continuous monitoring system will be used. Monthly data backup on external data storage of CDM specific data will be 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 will check data reliability and data comparison automatically. Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed – two copies will be filed at factory and headquarters respectively. Half-yearly control sampling and analysis by accredited laboratory. Calibration date (Instruments 1 and 2): 1) Model: DR/890: 15/07/2008, 18/05/2009, 20/10/2009, 23/03/2010, 20/10/2010 2) Model: DR 3800: 20/10/2009 (Certificate of final Inspection), 01/11/2010, 13/03/2011, 28/04/2011, 08/12/2011 (6 month validity of calibration);
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

<table>
<tr><td>Data/Parameter</td><td>$EL_{P,y}$</td></tr>
<tr><td>Unit</td><td>MWh/yr</td></tr>
<tr><td>Description</td><td>Amount of electricity in the year y that is consumed at the project site for the project activity</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Measurements at CPI</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Month</th><th>Value (kWh)</th><th>Month</th><th>Value (kWh)</th></tr>
<tr><td></td><td></td><td>January-11</td><td>10,534</td></tr>
<tr><td></td><td></td><td>February-11</td><td>13,146</td></tr>
<tr><td></td><td></td><td>March-11</td><td>14,841</td></tr>
<tr><td></td><td></td><td>April-11</td><td>11,010</td></tr>
<tr><td></td><td></td><td>May-11</td><td>12,982</td></tr>
<tr><td>September-10</td><td>18,318</td><td>June-11</td><td>17,090</td></tr>
<tr><td>October-10</td><td>19,691</td><td>July-11</td><td>27,184</td></tr>
<tr><td>November-10</td><td>17,467</td><td>August-11</td><td>27,601</td></tr>
<tr><td>December-10</td><td>10,117</td><td>September-11</td><td>27,412</td></tr>
<tr><td>Total 2010 (Sept-Dec.)</td><td>65,593</td><td>Total 2011 (Jan.-Sept.)</td><td>161,800</td></tr>
</table>
Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”
</td></tr>
<tr><td>Monitoring equipment</td><td>Standard electricity meter (separate meter for waste water plant); An officially calibrated electric meter (GENIUS power meter) is connected to the main electricity supply of the overall biogas plant. The data is recorded by the Provincial Electricity Authority (PEA). Calibration is conducted under the responsibility of PEA, data not accessible to CPI.
The data is cross checked with a separate measurement by CPI, for plausibility. The internal meter is: Schneider Electric, Power Logic PM710MG (63230-501-209A1).Serial Number: 4D6EF3F2
Calibration date: 03/02/2011
Validity of calibration: 1 year
The instrument has the measurement accuracy of ±1%.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously and recorded daily.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n.a.</td></tr>
<tr><td>QA/QC procedures</td><td>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%.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td></td></tr>
</table>

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	<table><tr><th>Month</th><th>Value (kg)</th><th>Month</th><th>Value (kg)</th></tr><tr><td></td><td></td><td>January-11</td><td>0.0</td></tr><tr><td></td><td></td><td>February-11</td><td>0.0</td></tr><tr><td></td><td></td><td>March-11</td><td>0.0</td></tr><tr><td></td><td></td><td>April-11</td><td>0.0</td></tr><tr><td></td><td></td><td>May-11</td><td>0.0</td></tr><tr><td>September-10</td><td>0.0</td><td>June-11</td><td>0.0</td></tr><tr><td>October-10</td><td>0.0</td><td>July-11</td><td>0.0</td></tr><tr><td>November-10</td><td>0.0</td><td>August-11</td><td>0.0</td></tr><tr><td>December-10</td><td>0.0</td><td>September-11</td><td>0.0</td></tr><tr><td>Total 2010 (Sept-Dec.)</td><td>0.0</td><td>Total 2011 (Jan.-Sept.)</td><td>0.0</td></tr></table> Please also see “MR CPI 2nd period_CER Calculation”, 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 Calibration dates (both scales): 19/03/2010 (Truck Scale)
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 minimum calibration frequency of the instrument is biannually (every 2 years). The accuracy is ±10 kg.
Purpose of data/parameter	Calculation of project emissions
Additional comments	

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 2nd period_CER Calculation”, table “Monitoring Data”
Monitoring equipment	Start of project until 04 November 2010 1) Manufacturer: HACH Model: DR/890 Serial No.: HAC070790C64568 2) Used from 05 November 2010 onwards Manufacturer: HACH LANGE Model: DR 3800 Serial No.: 1308841
Measuring/reading/recording frequency	Monthly (if applicable)

.Calculation method (if applicable)	n.a.
QA/QC procedures	See description at $COD_{c, baseline}$.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

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	See table below
Monitoring equipment	Flow rates are continuously recorded with Magnetic Flow Meter AXFA14C from Yokogawa .
Measuring/reading/recording frequency	Continuously.
Calculation method (if applicable)	n.a.

Month	**Value (m^3)**	**Month**	**Value (m^3)**
		January-11	0.0
		February-11	0.0
		March-11	0.0
		April-11	0.0
		May-11	0.0
September-10	0.0	June-11	0.0
October-10	0.0	July-11	0.0
November-10	0.0	August-11	0.0
December-10	0.0	September-11	
Total 2010 (Sept-Dec.)	0.0	Total 2011 (Jan.-Sept.)	0.0

Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”

<table>
<tr><td>QA/QC procedures</td><td>
Calibration: Each time the meter is calibrated; an On-Site-Calibration-Report is submitted to CPI.
FTBG0003
<table>
<tr><th>Calibration due date</th><th>Actual calibration date</th><th>measured error</th></tr>
<tr><td></td><td>15/09/2008</td><td>0.03%</td></tr>
<tr><td>15/09/2009</td><td>15/09/2009</td><td>-0.05%</td></tr>
<tr><td>15/03/2010</td><td>01/10/2010</td><td>0.14 %</td></tr>
<tr><td>01/04/2011</td><td>14/04/2011</td><td>0.03 %</td></tr>
</table>
Permissible error of +/- 1%.
Calibration frequency: 6 month
Each time the meter is calibrated, an On-Site-Calibration-Report is submitted to CPI

Inspection and Maintenance: The Meter is installed such to enable easy inspection at least half-yearly and in a way installed 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.
</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td>Is applicable at times when sludge treatment and dewatering takes place.</td></tr>
</table>

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

Month	**Value (kg COD)**	**Month**	**Value (kg COD)**
		January-11	0.0
		February-11	0.0
		March-11	0.0
		April-11	0.0
		May-11	0.0
September-10	0.0	June-11	0.0
October-10	0.0	July-11	0.0
November-10	0.0	August-11	0.0
December-10	0.0	September-11	0.0
Total 2010 (Sept-Dec.)	0.0	Total 2011 (Jan.-Sept.)	0.0

Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”

Monitoring equipment	Start of project until 04 November 2011 1) Manufacturer: HACH Model: DR/890 Serial No.: HAC070790C64568 2) Used from 05 November 2011 onwards Manufacturer: HACH LANGE Model: DR 3800 Serial No.: 1308841
Measuring/reading/recording frequency	Weekly (same day, same times) , 4 samples per hour, total 12 samples per day (weekly same day, same times)
Calculation method (if applicable)	n.a.
QA/QC procedures	- Sampling will be carried out adhering to internationally recognized procedures. *Alternative 1:* 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 will elaborate 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 will train O&M staff to take samples according international standard requirements. Sample and analyzing accuracy will be < ± 3 %. - *Alternative 2*: Automatic continuous measurement. Method: Electrochemical oxidation. Sample Preparation: Maintenance free particle separator. Calibration: Regular calibration by manufacturer or approved company (half-yearly) – calibration report to CPI. Cross-Checks: If automatic monitoring will be installed, additional quarterly sample will be taken and potassium dichromate digestion analysis carried out. The results will be stored in computer and comparison routines will check these data with quarterly average data from continuous monitoring system. Data capture/storage: Data capture at the laboratory/IT-center resp. online transfer, if continuous monitoring system will be used. Monthly data backup on external data storage of CDM specific data will be 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 will check data reliability and data comparison automatically. Aggregation to 24 hrs average, weekly, monthly and quarterly rates by routines. Monthly aggregated reports will be printed – two copies will be filed at factory and headquarters respectively. Half-yearly control sampling and analysis by accredited laboratory. Calibration date (Instruments 1 and 2): 1) Model: DR/890: 15/07/2008, 18/05/2009, 20/10/2009, 23/03/2010, 20/10/2010 2) Model: DR 3800: 20/10/2009 (Certificate of final Inspection), 01/11/2010, 13/03/2011, 28/04/2011, 08/12/2011 (6 month validity of calibration);
Purpose of data/parameter	Calculation of project emissions

Additional comments	

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

Month	**Value (m^3)**	**Month**	**Value (m^3)**
		January-11	74,692
		February-11	283,724
		March-11	527,060
		April-11	424,852
		May-11	558,660
September-10	533,898	June-11	617,358
October-10	519,538	July-11	676,476
November-10	459,890	August-11	712,648
December-10	56,876	September-11	709,328
Total 2010 (Sept-Dec.)	1,570,201	Total 2011 (Jan.-Sept.)	4,584,797

Please also see “MR CPI 2nd period_CER Calculation”, 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: first calibration 22/08/2008 :following calibrations 01/10/2010; 14/04/2011 Calibration Frequency 6 month due date: 14/10/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	n.a.

QA/QC procedures	Regular Calibration of Thermal Mass flow meter or similar by manufacturer or approved company (half-yearly) – calibration report to CPI. QC staffs 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 September to October 2010 the measured error of 4.44% was applied. QC of meter function: 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. Data recording and 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 will be printed and filed at factory
Purpose of data/parameter	Calculation of project emissions
Additional comments	

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 2nd period CER Calculation”, 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: BINDER Model: GA-m2 Serial No.: 10830 Calibration date: first calibartion 21/10/2008 Following calibrations: 21/09/2010; 15/04/2011 Due date: 15/10/2011; Calibration validity: 6 month Accuracy: ± 1% of reading, ± 0.2 % of full scale
Measuring/reading/recording frequency	Continuous measurement with at least hourly recording or periodical measurement at 95% confidence level using portable analyser.
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. Data recording/storage: Data logger reading or online transfer to computer. Monthly data backup to external data storage.

Purpose of data/parameter	Calculation of project emissions
Additional comments	

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

Month	**Value (m^3)**	**Month**	**Value (m^3)**
		January-11	2,819
		February-11	3,162
		March-11	41,084
		April-11	45,386
		May-11	135,837
September-10	42,977	June-11	156,159
October-10	21,435	July-11	132,284
November-10	576	August-11	131,436
December-10	2,271	September-11	83,056
Total 2010 (Sept-Dec.)	67,259	Total 2011 (Jan.-Sept.)	731,223

Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”

Monitoring equipment	Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 6510 ID No./Tag No.: FTBG005 Calibration date: first calibration 21/08/2008 following calibrations: 01/10/2010 and 14/04/2011 Due date: 14/10/2011; Caolibration validity: 6 month 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. For September and October 2010 the maximum calibration error of 8,97 % was applied.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	**$T_{comb,f}$**
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	<table><tr><th>Month</th><th>Value (hrs)</th><th>Month</th><th>Value (hrs)</th></tr><tr><td></td><td></td><td>January-11</td><td>0.0</td></tr><tr><td></td><td></td><td>February-11</td><td>7.6</td></tr><tr><td></td><td></td><td>March-11</td><td>102.4</td></tr><tr><td></td><td></td><td>April-11</td><td>176.1</td></tr><tr><td></td><td></td><td>May-11</td><td>369.4</td></tr><tr><td>September-10</td><td>122.8</td><td>June-11</td><td>424.3</td></tr><tr><td>October-10</td><td>357.1</td><td>July-11</td><td>481.5</td></tr><tr><td>November-10</td><td>0.0</td><td>August-11</td><td>464.0</td></tr><tr><td>December-10</td><td>8.8</td><td>September-11</td><td>294.4</td></tr><tr><td>Total 2010 (Sept-Dec.)</td><td>489</td><td>Total 2011 (Jan.-Sept.)</td><td>2,320</td></tr></table> Please also see “MR CPI 2nd period_CER Calculation”, table “Monitoring Data”.
Monitoring equipment	Measured using a run time meter connected to a flame continuous temperature controller (Thermocouple transmitter 4-20mA). Signals of the transmitter are recorded by the electronic data logging system and show run time of the flare. 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. The gas flow to the flare is monitored by a runtime meter, which is a software integrated in the PLC /SCADA to control real time fraction of time when the device is in operation. Regarding the boiler, signals are being received from the flame detector sensor, which will then record the fraction time the burner is on (real time). Tag.no. TTBG003(TEMP out flare) Calibration dates: 15/09/2008, 15/09/2009, 15/04/2011
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. The minimum re-calibration interval of the gas flow meter is 2 years.
Purpose of data/parameter	Calculation of project emissions
Additional comments	

Data/Parameter	**$PE_{flare, y}$**
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	7,045 t CO_{2e} Please see “MR CPI 2nd period_CER Calculation”, 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/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	**$FR_{e,inlet}$**
Unit	m³/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

Month	Value (m³ / yr)	Month	Value (m³ / yr)
		January-11	64,139
		February-11	238,978
		March-11	441,583
		April-11	333,467
		May-11	409,941
September-10	430,360	June-11	459,603
October-10	544,714	July-11	531,779
November-10	460,796	August-11	504,194
December-10	39,081	September-11	625,161
Total 2010 (Sept-Dec.)	1,474,950	Total 2011 (Jan.-Sept.)	3,608,845

Please also see “MR CPI 2nd period_CER Calculation”, 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 2+3 Meter: Thermal Mass Flowmeter Manufacturer: Fox Model: FT2 Serial No.: 7714 ID No./Tag No.: FTBG006 Calibration date: 25/06/2009, 01/10/2010; 14/04/2011; due date: 14/10/2011; 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: 25/06/2009, 01/10/2010; 14/04/2011; due date: 14/10/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale Start of utilization: January 2010 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, 01/10/2010; 14/04/2011; due date: 14/10/2011; Accuracy: ± 1% of reading, ± 0.2 % of full scale Start of utilization: January 2010 (with 1 test month in July 2009)
Measuring/reading/recording frequency	Continuously values are transferred online and recorded.
Calculation method (if applicable)	n.a.
QA/QC procedures	Regular Calibration of Thermal Mass flow meter or similar by manufacturer or approved company (half-yearly) – calibration report to CPI. QC staffs 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. QC of meter function: 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. Data recording and 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 will be printed and filed at factory The minimum re-calibration interval is 2 years .
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	$FR_{e,s}$
Unit	m^3/yr
Description	Flow rate of the heat generation equipment stack gases
Measured/calculated/ default	Measured/Calculated
Source of data	Measurement
Value(s) of monitored parameter:	44.69 m^3/s and 56.26 m^3/s are measured in October 2010 and May 2011, respectively. The conservative approach of using the higher value (56.26 m^3/s = 202,536 m3/hr), gives a yearly flow rate of **1,594,971,000** m^3/yr (202,536 m3/hr * 7,875 hrs gas combusted in the heat generation equipment) Please see "MR CPI 2nd period_CER Calculation", table "PE SEEG"
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 Sample dates: last before start ot this monitoring period 24/07/2009 19/10/2010; 04/05/2011 Emission rate: 44.69 and 56.26 m^3/s, respectively 160,884 and 202,536 m3/hr. (see reference to report below)
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. For conservativeness not an average, but the higher stack gas emission rate measured in the monitoring period is used for calculations (56.26 m^3/s). The flow rate of heat generation equipment is calculated by multiplying the monthly hours of gas combustion in the heat generation equipment (see $\mathbf{T_{comb,e}}$) with the emission rate of 202.536 m^3/hr (calculated from the emission rate in m3/s * 3600). This flow for the total monitoring period is divided by the number of days in the monitoring period (395) and multiplied by 365 days to determine the average flow rate per year.
QA/QC procedures	Measurements done by external certified contractor. (see Report: Environmental Monitoring for Chumporn Palm Oil Industries Public Company Ltd., prepared by Advanced Thai Testing Co., Ltd., file: "3_BL3-190102010_stack boiler3" and "4_BL3-04052011")
Purpose of data/parameter	Calculation of project emissions
Additional comments	

Data/Parameter	$P_{CH4,e,s}$
Unit	Ppm
Description	Methane content in stack gas of heat generation stack gases.
Measured/calculated/ default	Measured.
Source of data	Measurement (half yearly) – average of two measurements
Value(s) of monitored parameter	Boiler #2: 4.475 ppm Boiler #3: (1.32 ppm + 3.38 ppm/2)
Monitoring equipment	CH_4 content is determined through measurement for the environmental monitoring for Industrial department half-yearly by a certified company. Sample date: last before start ot this monitoring period 24/07/2009 19/10/2010 (boiler #2 and #3); 04/05/2011 (boilder #3)
Measuring/reading/recording frequency	Half yearly
Calculation method (if applicable)	n.a.

QA/QC procedures	CH_4 content in stack gas of heat generation equipment is determined through measurement for the environmental monitoring for Industrial department half-yearly by a certified contracted company.
Purpose of data/parameter	Calculation of project emissions Please see "MR CPI 2nd period_CER Calculation", table "PE SEEG"
Additional comments	The highest measured value (4.475 ppm) as applied to the whole monitoring period

Data/Parameter	**$T_{comb,e}$**
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	See table below
Monitoring equipment	Measured using a run time meter connected to a flame continuous temperature controller (Thermocouple transmitter 4-20mA). Signals of the transmitter are recorded by the electronic data logging system and show run time of the boiler. The valve at the biogas burner is controlled by UV detector (flame control) and/or pressure drop at gas storage.
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. A. Electronic logging data system of the heat generation equipment "boiler" will record: 1. Date and time when combustion 2. Amount of biogas to be burnt 3. Temperature at burning. B. External Lab (MIT) is coming annually to measure the above parameters by using their own equipment and compare the values of those parameters whether there is any different out of the acceptable range/accuracy or not. If in the acceptable range, then the electronic logging values of the heat generation equipment *boiler" are accepted. If not, then the recording of boiler system has to be calibrated by the external lab.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Month	**Value (hrs)**	**Month**	**Value (hrs)**
September-10	626.4	January-11	356.9
October-10	687.7	February-11	510.2
November-10	709.7	March-11	717.0
December-10	173.3	April-11	608.0
		May-11	694.9
		June-11	665.9
		July-11	722.2
		August-11	692.0
		September-11	710.7
Total 2010 (Sept-Dec.)	2,197	Total 2011 (Jan.-Sept.)	5,678

Please also see "MR CPI 2nd period_CER Calculation", table "Monitoring Data"

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	0 (zero) Please also see “MR CPI 2nd period_CER Calculation”, table “Data (processing)”
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 29/07/2008, 19/03/2010 Furthermore, no sludge applied to land, therefore not relevant for this monitoring period.
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 minimum calibration frequency of the instrument is biannually (every 2 years). The accuracy is ±10 kg.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

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	Not applicable for the monitoring period. Not measured as no sludge was used for land application. Please also see “MR CPI 2nd period_CER Calculation”, table “Data (processing)”
Monitoring equipment	Is not applicable for this monitoring period. CPI used an external lab to measure the value monthly (when applicable). The external lab calibrates the equipment by themselves.
Measuring/reading/recording frequency	When applicable. Not applicable in this monitoring period, as a result of difficulties with the original treatment system. The sand bed filter so far did not deliver the expected dry sludge, to be used for land application,
Calculation method (if applicable)	n.a.
QA/QC procedures	Is not applicable for this monitoring period. CPI used an external lab to measure the value from time to time (when applicable). The external lab calibrates the equipment by themselves.
Purpose of data/parameter	Calculation of project emissions

Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**NCV_BG**
Unit	MJ/m^3
Description	Net calorific value of biogas (dry)
Measured/calculated/ Default	Measured.
Source of data	Measurement by PTT chemical public company limited.
Value(s) of monitored parameter	18.98 MJ/m^3 and 21.39 MJ/m^3. Please also see “MR CPI 2nd period_CER Calculation” table “BE heat”
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/parameter	Calculation of project emissions
Additional comments	

Data/Parameter	**T_{FI}**
Unit	K
Description	Temperature of Flare
Measured/calculated/ Default	Measured.
Source of data	Automatic measurement
Value(s) of monitored parameter	“values available, but not able to supply in small intervals (minutes), therefore flare efficiency of zero is applied (MR_CPI 2^{nd} period CER Calculation, sheet “PE SEEG“ see cell C23)

Monitoring equipment	Measurement temperature by Thermocouple transmitter type "K", range 0 to 1200 °C. Accuracy ± 1, Temperature sensor TC "K" ID No./Tag No.: TTBG003 Calibration date: 15/09/2008, 15/09/2009 and 30/09/2010 and 15/04/2011; due date: 15/10/2011; Accuracy: ± 1% of reading
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	n.a.
QA/QC procedures	Annual calibration by certified external company.
Purpose of data/parameter	Calculation of project emissions
Additional comments	n.a.

D.3. Implementation of sampling plan

>>
No sampling plan applied.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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

Baseline emissions include:

- 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) $\underline{BE_{lagoon,y}}$

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 "$BE_{lagoon,monitored,y}$"

(i) Lagoon Baseline Emissions - theoretical

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

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 $COD_{available,m}$ x B_o x $MCF_{baseline}$

= 2,988,955 kg CH_4

Monthly calculation of CH_4 emissions from baseline lagoon are shown in the spreadsheet “MR CPI 2nd period_CER Calculation”

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 = 62,768 t CO_2-e

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

= (62,768 – 6,763) t CO_2-e

= 56,005 t CO_2-e

(ii) Lagoon Baseline Emissions - monitored

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

= ((45,087 + 7.045) – 7,045)) t CO_2-e

= 45,087 t CO_2-e

Monthly caluculation of CH_4 emissions from baseline lagoon (biogas to boiler and flare) are shown in the spreadsheet "MR CPI 2nd period_CER Calculation"

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:

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

where $HG_{BI,y}$ 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.
$CEF_{BI, therm}$ is the CO_2 emissions intensity for thermal energy generation (tCO_2 e/MJ).

BE_{heat} = 12.30 TJ * 77.37 tCO2 / TJ

BE_{heat} = 951 tCO_2-e

Emissions from baseline heat generation are shown in the spreadsheet "MR CPI 2nd period_CER Calculation".

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 3: Comparison of theoretical and monitored baseline emissions

	"$BE_{lagoon,theoretical,y}$" (t CO_2-e)	"$BE_{lagoon,monitored,y}$" (t CO_2-e)
Total	56,005	45,087

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.
($BE_{lagoon,y} = BE_{lagoon,monitored,y}$ = 45,087 tCO_2-e)

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

= 45,087 t CO_2-e + 951 t CO_2-e

$BE_{total,y}$ = 46,038 tCO_2-e

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

>>

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:

CH_4 emissions from the lagoons (kg/yr)	=	COD_{dig_out} (kg COD/yr)	X	B_o (kg CH_4/kg COD)	x	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 = 285,427 kg CH_4

Monthly calculations of CH_4 emissions from lagoon are shown in the spreadsheet “MR CPI 2nd period_CER Calculation”

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} = 5,994 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 (5,083,795 m^3) and the methane fraction of biogas (average P_{CH4} = 59.02 %).

$PE_{leakage\ digester}$ = 6,763 t CO_2-e

Monthly calculations of CH_4 emissions from biodigersters are shown in the spreadsheet “MR CPI 2nd period_CER Calculation”

(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 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

$PE_{flare, y}$ = 7,045 t CO_2-e

Monthly calculations of CH_4 emissions from flaring are shown in the spreadsheet "MR CPI 2nd period_CER Calculation"

PE_{stack} = 107.55 t CO_2-e

Monthly calculations of CH_4 emissions from stack gas are shown in the spreadsheet "MR CPI 2nd period_CER Calculation"

(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} = $EI_y * CEF_d$

= 228 MWh * 0.523 t CO_2-e/MWh

PE_{elec} = 119 tCO_2-e

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

(v) Emissions from land application of sludge

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 4: Summary of Project Emissions

Year	PE Lagoon (tCO_2)	PE Stack (tCO_2)	PE Flare (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)
Sep-10	483	9	372	0	0	0	10	874
Oct-10	387	9	188	0	0	0	10	595
Nov-10	346	10	5	0	0	0	9	370
Dec-10	56	2	21	0	0	0	5	85
Jan-11	23	5	25	0	0	0	6	58
Feb-11	289	7	27	0	0	0	7	329
Mar-11	600	10	376	0	0	0	8	993
Apr-11	444	8	401	0	0	0	6	859
May-11	496	9	1,213	0	0	0	7	1,726
Jun-11	839	9	1,357	0	0	0	9	2,214
Jul-11	702	10	1,165	0	0	0	14	1,891
Aug-11	630	9	1,160	0	0	0	14	1,814
Sep-11	698	10	735	0	0	0	14	1,457
Total	**5,994**	**108**	**7,045**	**0**	**0**	**0**	**119**	**13,265**

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 emissions

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No leakage is associated with the project activity.

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

	Baseline GHG emissions or baseline net GHG removals ($t CO_2e$)	Project GHG emissions or actual net GHG removals ($t CO_2e$)	Leakage GHG emissions ($t CO_2e$)	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	53,084	**13,265**	0	**39,819**		**39,819**

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the 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 (MP2, second monitoring period) is 395 days. Correspondingly, the total emission reduction of 30,445 tCO_2 ex ante would be estimated for this monitoring period.

Amount achieved during this monitoring period ($t CO_2e$)	Amount estimated ex ante ($t CO_2e$)
39,819	30,445

E.6. Remarks on increase in achieved emission reductions

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Compared to the registered PDD, the actual values of achieved emission reduction are increased by 31%. The main reason for increased emission reduction is an increase of available COD compared to the reference period in the registered PDD (2006), by approximately 39 %. While in the period 2006 an average of 709,347 kgCOD/month was available in the discharged wastewater from the CPO, in the monitoring period this value reached an average of 1,231,795 kgCOD/month. The average COD was measured as 102 KgCOD/m^3 compared to 74.1 KgCOD/m^3 in 2006, which is an increase by 38 %. Taking the originally stated 28,133 tonnes CO_{2e} in the revised registered PDD and calculating an 31% increase for a period of 395 days (this monitoring period), the resulting emission reductions would be 39,883 t CO_2e, which is very close to the actually determined emission reduction in this monitoring period

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Document information

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
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 GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, 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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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