Monitoring report form
(Version 03.1)

Monitoring report

Title of the project activity	Siam Quality Starch Wastewater Treatment and Energy Generation Project in Chaiyaphum Thailand
Reference number of the project activity	1993
Version number of the monitoring report	1.0
Completion date of the monitoring report	18/07/2013
Registration date of the project activity	15/04/2009
Monitoring period number and duration of this monitoring period	Monitoring period no. 2 01/12/2009 – 31/12/2012
Project participant(s)	Siam Quality Starch Co., Ltd. (Thailand) Mitsubishi UFJ Morgan Stanley Securities Co., Ltd. (Japan)
Host Party(ies)	Thailand
Sectoral scope(s) and applied methodology(ies)	AM0013 version 04/ Sectoral scope 13 AMS-I.C. version 12 / Sectoral scope 1
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	283,490 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	183,800 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Siam Quality Starch Co., Ltd. (SQS) is a Native and Modified starch manufacturer whose factory, with a production capacity of 200,000 tpy, is located in the North Eastern region of Thailand. The starch production process involves extraction and refinement of tapioca roots. This production process emits a large amount of organic content wastewater, which not only affects the local environment, but also releases methane, a potent greenhouse gas (GHG).

To alleviate GHG emission and other environmental issues, a new anaerobic digestion and methane recovery system coupled with a thermal energy generation system have been implemented to replace the previous open lagoon treatment system from which methane was freely emitted into the atmosphere.

The Project involves installation and operation of an anaerobic digestion and methane recovery system for the treatment of wastewater. The captured methane will be utilized in the thermal energy generation system as fuel for burners that produce heated air for the factory's drying process, which prior to the project activity implementation was fuelled entirely by bunker oil, a fossil fuel.

The Project reduces GHGs through two activities. The first is avoidance of methane that was previously emitted from the open lagoons, and the second is from displacement of bunker oil by utilizing captured methane generated from biogas digester as fuel.

Please also refer to Section B.1.

A.2. Location of project activity

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The project is located at 222 Moo 10, Suranarai Road, Kokroengrom, Bumnet-Narong, Chaiyaphum 36160, Thailand. The GPS coordinates are: 15°24'20"N, 101°37'35"E.

A.3. Parties and project participant(s)

Party involved **((host) indicates a host Party)**	**Private and/or public entity(ies) project participants (as applicable)**	**Indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Thailand (host)	**Siam Quality Starch Co., Ltd.**	**No**
Japan	**Mitsubishi UFJ Morgan Stanley Securities Co., Ltd. (Private entity)**	**No**

A.4. Reference of applied methodology

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The following methodologies and tools are applied:

- AM0013 "Avoided methane emissions from organic waste-water treatment" Version 4
- AMS-I.C. "Thermal energy for the user" Version 12
- "Tool to determine project emission from flaring gases containing methane" as contained in EB 28 Annex 13.
- "Tool to determine mass flow rate of greenhouse gas in gaseous stream" Version 2.0

A.5. Crediting period of project activity

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Choice of crediting period: Fixed crediting period
Start date of the crediting period: 15/04/2009 (starting date is as stated in the PDD)
The length of the crediting period corresponding to this monitoring period: 10 years

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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The project activity is illustrated by the schematic diagram below.

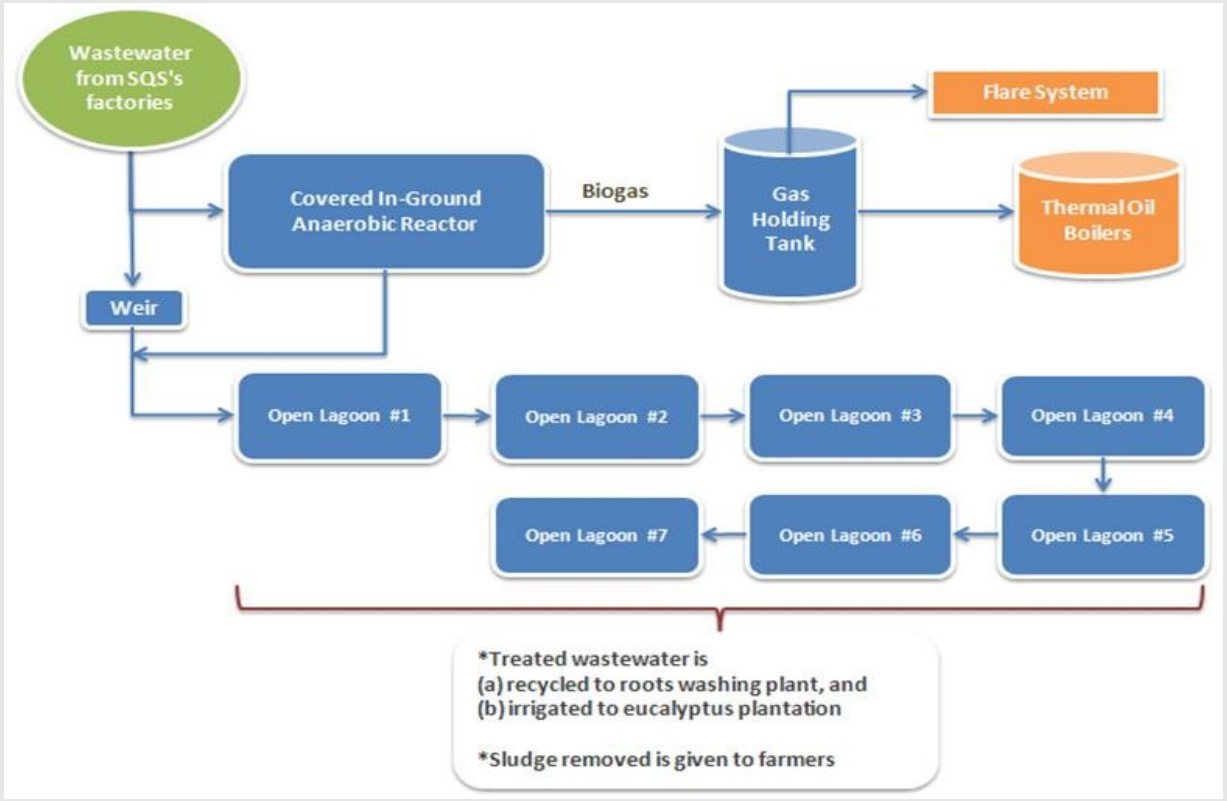

Figure 1: Schematic diagram of project boundary

The project activity involves three main technologies as follows:

- Wastewater treatment system;
- Thermal energy generation system; and
- Flare system.

To elaborate on each project component, influent fresh wastewater from the starch factory is firstly treated in a Covered In-Ground Anaerobic Reactor (CIGAR) which has a capacity of 90,000 m^3. Anaerobic bacteria activity decreases the loading of Chemical Oxygen Demand (COD) dramatically, by about 74%. The anaerobic process results in the production of methane-rich biogas, which is trapped within the digester and recovered.

In the thermal energy generation system, the recovered biogas from digester will be fed into two dual fuel burners (2 x 5,234 kW) installed at factory 1, and two others (2 x 5,234 KW) installed at factory 2. All burners can co-fire biogas and bunker oil.

Finally, any excess biogas will be combusted in the flare system, when there is overpressure in the biogas stream. It is also sometimes utilized for the purpose of checking that the flare system is properly functioning.

The wastewater exiting the CIGAR system is fed into the existing open lagoons, for secondary treatment. Final effluent is then discharged using a pump to the nearby eucalyptus plantation, within SQS's factory bounds. Sludge, when removed, is given (free of charge) to local farmers as fertilizer for application on

tapioca fields.

B.2. Post registration changes

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

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There are no temporary deviations from registered monitoring plan or applied methodology that have been applied during this monitoring period.

B.2.2. Corrections

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The change in the one of the PP name from Mitsubishi UFJ Securities Co., Ltd. to Mitsubishi UFJ Morgan Stanley Securities was accepted by the UNFCCC and was effective from 30/05/2012.

The change in the primary authorized signatory and alternate authorized signatory of Mitsubishi UFJ Morgan Stanley Securities in the MoC form was accepted by the UNFCCC and was effective from 05/09/2012

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

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There are no permanent changes from the registered monitoring plan or applied methodologies that have been approved during this monitoring period or submitted with this monitoring report.

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

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There are no changes to the project design of the project activity that have been approved during this monitoring period or submitted with this monitoring report.

B.2.5. Changes to start date of crediting period

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There are no changes to the start date of the crediting period that have been approved during this monitoring period or submitted with this monitoring report.

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

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Not applicable.

SECTION C. Description of monitoring system

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C.1. Monitoring points

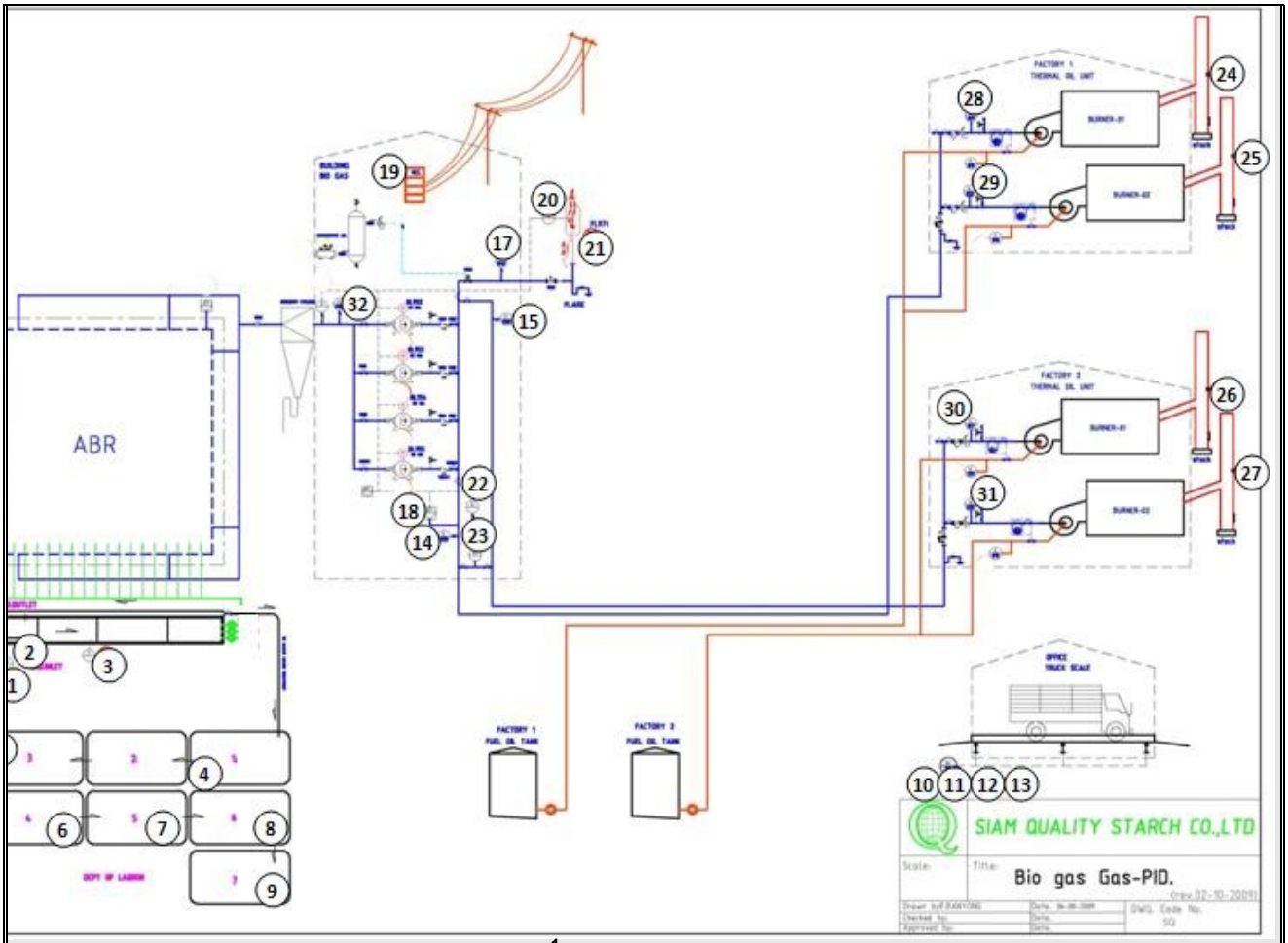

Figure 2: Location of monitoring equipment[1]

C.2. Monitoring Team and System

Consistent with the registered CDM-PDD, SQS appointed a CDM monitoring team consisting of utility staff, laboratory supervisor, project engineer, environmental & CDM project manager and managing director to fully implement data collecting, quality control and internal evaluation process. The monitoring team structure is expressed in Figure 3, which in accordance with ISO 9001.

[1] Monitoring points 14 and 15 were removed during the last monitoring period and are no longer present during this monitoring period.

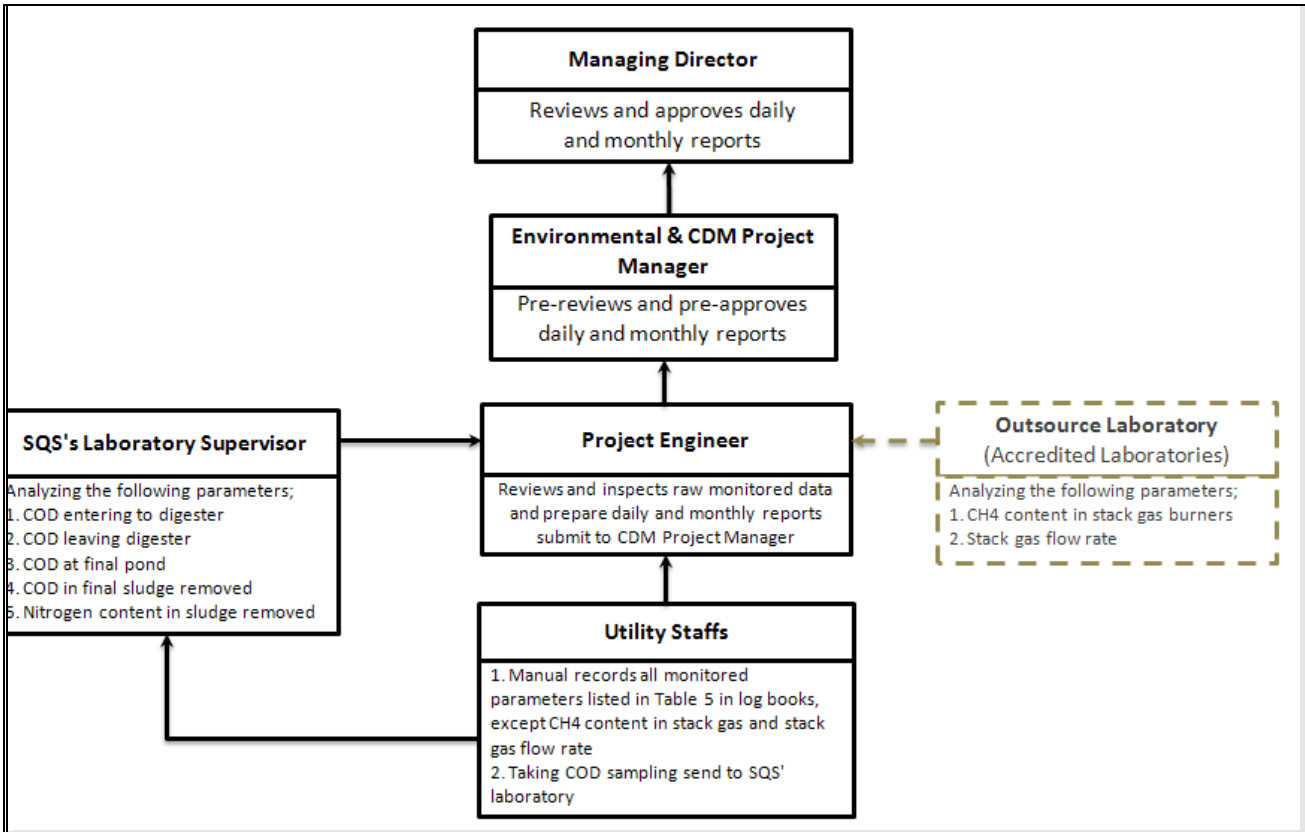

Figure 3: CDM monitoring team structure

C.3. Staff Training

Training has been carried out to make sure the relevant personnel has the necessary mechanical, electric and installation knowledge, know well the working principle and the fundamental structure of wastewater treatment and energy generation project, understand the reasons of common malfunction and the corresponding troubleshooting methods, expertly use the monitoring system and understand the importance of the monitoring system to the successful issuance of CERs. SQS also organizes professional training periodically to improve the professional skill of the operators after the project operation. Specifically, new employees have to receive training on project operation, monitoring requirements, and the importance of monitoring for the CDM. If personnel transfers happen, the worker taking over will receive the same training.

C.4. Data Collection Procedures

To ensure maximum accuracy of monitored data, data record keeping has been carried out only by members of the specifically-appointed monitoring team. The following data collection and reporting procedure is applied;

1. Utility staff manually record all parameters read from meters every 8 hours (i.e. every shift) in the data log book.
2. Those values, taken every 8 hours, will be aggregated every 24 hours to get a total/average daily value. Then, the calculation result will be submitted to project engineer.
3. The project engineer will be responsible for inspecting and calculating daily sum and average values of parameters. Then, these daily values are compiled each day in the “Biogas- CDM Daily Report”. Then, the data summarized in the “Biogas-CDM Daily Report” are compiled each month in “Biogas-CDM Monthly Report”.
4. Every month, the project engineer will submit daily and monthly operation data recorded in “Biogas-CDM Daily Report” and “Biogas-CDM Monthly Report” to Environmental & CDM Project Manager for review. After review, Environmental & CDM Project Manager will sign off the documents if there are no suspicions on the correctness of data. This document will then be submitted to Managing Director.
5. The Managing Director will review the documents signed by Environmental & CDM Project Manager and the documents will be returned to concern departments and sections.

SECTION D. Data and parameters

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

Data / Parameter:	**B_o**
Unit:	$kgCH_4/kgCOD$
Description:	Maximum methane producing capacity
Source of data:	AM0013
Value(s) applied):	0.21
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Data / Parameter:	**GWP_CH4**
Unit:	tCO2e/tCH4
Description:	Global warming potential for methane
Source of data:	AM0013
Value(s) applied):	21
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**CO_2EF_{fuel}**
Unit:	tCO_2/TJ
Description:	CO_2 emission factor for thermal energy generation using fuel oil
Source of data:	IPCC 2006 table 2.2
Value(s) applied):	75.5 (baseline emission) 77.4 (project emission)
Purpose of data:	Baseline and project emission calculations
Additional comment:	The PDD for the Project was registered using an *ex ante* fixed value of 77.4. However, for conservatism, this was changed to 75.5 for the baseline emission calculations.

Data / Parameter:	**OX_{fuel}**
Unit:	Fraction
Description:	Oxidation factor for fuel oil
Source of data:	IPCC 2006 table 1.4
Value(s) applied):	1
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**LF**
Unit:	Fraction
Description:	Rate of physical leakage from digester

Source of data:	AM0013
Value(s) applied):	0.15
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**MCF_{la}**
Unit:	Fraction
Description:	Methane correction factor of sludge in year y
Source of data:	AM0013
Value(s) applied):	0.05
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**EF_{N2O}**
Unit:	kgN_2O/kgN
Description:	Emission factor of nitrogen from sludge applied to land
Source of data:	AM0013
Value(s) applied):	0.016
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**GWP_N_2O**
Unit:	tCO_2e/tN_2O
Description:	Global warming potential for nitrous oxide
Source of data:	IPCC
Value(s) applied):	310
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$COD_{conc\_out,\ baseline,m}$**
Unit:	$kgCOD/m^3$
Description:	COD concentration of final effluent in the baseline
Source of data:	Registered CDM-PDD
Value(s) applied):	0.12
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**F_d**
Unit:	Fraction

Description:	Fraction of anaerobic degradation as a function of depth, for depth 1 – 5 m.
Source of data:	AM0013
Value(s) applied):	0.5
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	$Q_{fuel\_oil,y}$
Unit:	TJ
Description:	Maximum quantity of fuel oil consumed in year y in the absence of project activity
Source of data:	Registered CDM-PDD
Value(s) applied):	140.6
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Data / Parameter:	ρ_{CH4}
Unit:	kgCH4/Nm3CH4
Description:	Density of methane at normal condition
Source of data:	Tool to determine project emissions from flaring gases containing methane
Value(s) applied):	0.716
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	NCV_{CH4}
Unit:	TJ/Gg
Description:	Net Calorific Value of methane
Source of data:	IPCC 2006 Table 1.2
Value(s) applied):	50.4
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

D.2. Data and parameters monitored

Data / Parameter:	$F_{digester}$/ $F_{dig\_out,m}$ (F_{dig}/F_{dig_out} in AM0013)
Unit:	m^3/day
Description:	Flow rate of wastewater fed into/ discharge out of digester
Measured/ Calculated / Default:	Measured
Source of data:	Logbook

Value(s) of monitored parameter:	4,232,750 (total for monitoring period)
Monitoring equipment:	Type: SIEMENS/SITRANS F M MAGFLO MAG6000 Accuracy: +/- 2.5% Serial Number: 7ME633000817N465 Calibration frequency: 12 months Date of last calibration: 03-April-12 Validity: 02-April-13 Monitoring position: (1)/FIC-001
Measuring/ Reading/ Recording frequency:	Measured continuously, recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**OP_m**
Unit:	Days / month
Description:	Number of operation days in month
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	951 (total for monitoring period)
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Measured and recorded daily
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**$COD_{conc\_in,baseline,m}$ ($COD_{c,BL}$ in AM0013)**
Unit:	kg COD/m^3
Description:	COD concentration of effluent entering the lagoon in the baseline

Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	4.9 (average)
Monitoring equipment:	Equipment 1: Weight 1711269 Type: SATORIUS/CP224S Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 17111269 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Equipment 2: Weight 58288 Type: PRECISA/205A Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 58288 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Monitoring position: (2)/-
Measuring/ Reading/ Recording frequency:	Measured and recorded at least monthly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Data / Parameter:	**T_2 (T_{lag} in AM0013)**
Unit:	Celsius
Description:	Ambient temperature
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	28.1 (average)

Monitoring equipment:	Type: SHENGZHAN/Thermometer 0-100°C Mercury Accuracy: +/- 3 °C Serial Number: UN-02 Calibration frequency: 12 months Date of last calibration: 30-July-12 Validity: 29-July-13 Monitoring position: (3)/TIC-001
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**$D_{lagoon,project}$ (D_{lag} in AM0013)**
Unit:	M
Description:	Depth of open lagoons
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	Average values: Lagoon 1 = 4.14 Lagoon 3 = 3.96 Lagoon 4 = 4.50 Lagoon 5 = 4.57 Lagoon 6 = 4.63 Lagoon 7 = 4.79
Monitoring equipment:	Meter rods Monitoring position: (4), (5), (6), (7),(8), (9)/meter rods
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{sludge,m}$ / $Q_{sludge,y}$ (F_{la} in AM0013)**

Unit:	Tonne sludge
Description:	Amount of sludge generated/ and removed in month or year
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	3,021.8 (total for monitoring period)
Monitoring equipment:	Equipment 1: Truck scale 1 Type: METTLER TOLEDO/8142 PRO Accuracy: At 0-10,000 kg, +/- 10 kg; at >10,000-40,000kg, +/- 20kg; at >40,000-100,000kg, +/-30kg. Serial Number: 00240926 Calibration frequency: 24 months Date of last calibration: 09-February-12 Validity: 08-February-14 Equipment 2: Truck scale 2 Type: METTLER TOLEDO/8142 PRO Accuracy: At 0-10,000 kg, +/- 10 kg; at >10,000-40,000kg, +/- 20kg; at >40,000-100,000kg, +/-30kg. Serial Number: 00241276 FE Calibration frequency: 24 months Date of last calibration: -February-12 Validity: 08-February-14 Equipments 3 and 4: Truck scales 3 and 4 Type: METTLER TOLEDO/8530 COUGAR Accuracy: At 0-10,000 kg, +/- 10 kg; at >10,000-40,000kg, +/- 20kg; at >40,000-100,000kg, +/-30kg. Serial Number: 5454117-5KF, 5453962-5KF Calibration frequency: 24 months Date of last calibration: 20-April-11 Validity: 19-April-13 Monitoring position: (10),(11),(12),(13)/Truck scale 01;02;03;04
Measuring/ Reading/ Recording frequency:	When sludge is removed
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$COD_{conc\_sludge,m}$ ($COD_{c,la}$ in AM0013)**

Unit:	kg COD/ m^3
Description:	COD concentration of sludge removed in month
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	1.55 (average)
Monitoring equipment:	Equipment 1: Weight 1711269 Type: SATORIUS/CP224S Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 17111269 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Equipment 2: Weight 58288 Type: PRECISA/205A Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 58288 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13
Measuring/ Reading/ Recording frequency:	Measured and recorded at least monthly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{fuel\_oil,y}$ ($HG_{BL,y}$ in AM0013)**
Unit:	TJ/yr
Description:	Quantity of fuel oil displaced in year y
Measured/ Calculated / Default:	Calculated
Source of data:	Logbook
Value(s) of monitored parameter:	502.6 (total for monitoring period)
Monitoring equipment:	See $Q_{biogas\ burner,y}$

Measuring/ Reading/ Recording frequency:	Recorded monthly
Calculation method (if applicable):	Energy content of $Q_{biogas\_burner,y}$ considered to equal that of $Q_{fuel\_oil,y}$
QA/QC procedures:	N/A
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Data / Parameter:	**$COD_{conc\_dig\_out,m}$ (COD_{c,dig_out} in AM0013)**
Unit:	kg COD/m^3
Description:	COD out of digester to lagoons
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	4.9 (average)
Monitoring equipment:	Equipment 1: Weight 1711269 Type: SATORIUS/CP224S Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 17111269 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Equipment 2: Weight 58288 Type: PRECISA/205A Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 58288 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Monitoring position: (16)/-
Measuring/ Reading/ Recording frequency:	Measured and recorded at least monthly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{biogas\_total,y}$ (FR_{bio} in AM0013)**
Unit:	Nm^3/yr
Description:	Quantity of biogas produced and collected in the digester in year y
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	Please refer to spreadsheet due to multiple results
Monitoring equipment:	Equipments 3 – 6: GFM-003 / 0004 / 005 / 006 Type: ALIA VTX/AVF7000 Accuracy: +/- 1.0 % Serial Number: 09110106, 09110005, 09110004, 09110207 Calibration frequency: 12 months Date of last calibration: 07-May-12 Validity: 06-May-13 Equipment 7: GFM-007 Type: EPI/8240MP Accuracy: (Ref.21C) +/- (1 % of reading+(0.5%+0.02%/C of Full scale)) Serial Number: 25100705/26120501 Calibration frequency: 12 months Date of last calibration: 30-April-12 Validity: 29-April-12 Equipment 8: GFM-008 Type: FCI/ST51 Accuracy: At > 0.21 nmps +/- 2% reading+/-0.5% full scale Serial Number: 306094 Calibration frequency: 18 months Date of last calibration: 08-December-12 Validity: 07-December-12 Monitoring position / ID: (28)/GFM-003 (Burner) (29)/GFM-004 (Burner) (30)/GFM-005 (Burner) (31)/GFM-006 (Burner) (17)/GFM-007 (Flare) (32)/GFM-008 (total meter)
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	Individual streams are crosschecked against total stream
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	W_{CH4} ($P_{CH4, bio}$ in AM0013)
Unit:	m^3 CH_4/m^3 biogas (wet basis)
Description:	Fraction of methane in biogas
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	0.55 (average)
Monitoring equipment:	Type: ANRI/CAM-3L Accuracy: +/- 2% reading Serial Number: LFB-072 Calibration frequency: 12 months Date of last calibration: 20-February-12 Validity: 19-February-13 Monitoring position / ID: (18)/MTA-001
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	NC
Unit:	kg N/ kg sludge
Description:	Nitrogen content of sludge
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	0.015 (average)

Monitoring equipment:	Equipment 1: Weight 1711269 Type: SATORIUS/CP224S Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 17111269 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Equipment 2: Weight 58288 Type: PRECISA/205A Accuracy: +/- 0.0005g at standard weights 5g, 10g, 20g and 200g Serial Number: 58288 Calibration frequency: 1 month Date of last calibration: 05-December-12 Validity: 04-January-13 Monitoring position: (16)/-
Measuring/ Reading/ Recording frequency:	Measured and recorded at least monthly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{elec\_cons,y}$ ($EL_{p,y}$ in AM0013)**
Unit:	MWh
Description:	Quantity of electricity consumed due to the project activity
Measured/ Calculated / Default:	Measured / calculated
Source of data:	Logbook
Value(s) of monitored parameter:	3,493,710

Monitoring equipment:	Type: MITSUBISHI/MH96H Accuracy: +/- 2% (class 2 IEC 60521) Serial Number: 9279973 Calibration frequency: 12 months Date of last calibration: 15-May-12 Validity: 14-May-13 Type: MITSUBISHI/MH96H Accuracy: +/- 2% (class 2 IEC 60521) Serial Number: 8328033 Calibration frequency: 12 months Date of last calibration: 15-May-12 Validity: 14-May-13 Monitoring position / ID: (19)/WM-01 (electricity meters)
Measuring/ Reading/ Recording frequency:	Measured continuously, recorded every shift (8 hours)
Calculation method (if applicable):	As per revised monitoring plan
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**CO_2 EF_{elec}**
Unit:	tCO_2e/MWh
Description:	CO_2 emission factor for electricity consumed at project site
Measured/ Calculated / Default:	Calculated
Source of data:	Thailand Greenhouse Gas Management Organization
Value(s) of monitored parameter:	0.5756 (2009) 0.5113 (2010-2012)
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	As per the “Tool to calculate the emission factor for an electricity system” Version 02.2.1
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{biogas\_burner,y}$ / $Q_{biogas\_flare,\ y}$ ($FR_{e,inlet}$/$FR_{f,\ inlet}$ in AM0013)**
Unit:	Nm^3/hr
Description:	Volumetric flow rate of the biogas at normal conditions in the hour h. Same basis measurement (dry or wet) for all component in biogas
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	$Q_{biogas\_burner,y}$ = 24,915,464 (total for monitoring period) $Q_{biogas\_flare,\ y}$ = 432 (total for monitoring period)
Monitoring equipment:	Please refer to Qbiogas_total,y for details of each monitoring equipment Monitoring position / ID: (28)/GFM-003 (Burner) (29)/GFM-004 (Burner) (30)/GFM-005 (Burner) (31)/GFM-006 (Burner) (17)/GFM-007 (Flare)
Measuring/ Reading/ Recording frequency:	Measured hourly and recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	Individual streams are crosschecked against total stream
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Data / Parameter:	**T_{flare}**
Unit:	Celsius
Description:	Temperature of the exhaust gas of the flare
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	530

Monitoring equipment:	Type: JCS-33A-R/M Accuracy: +/- 2°C Serial Number: 086S01900 Calibration frequency: 12 months Date of last calibration: 08-December-12 Validity: 07-December-13 Monitoring position / ID: (20)/TIC-003
Measuring/ Reading/ Recording frequency:	Measured hourly and recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**Flare operation parameter**
Unit:	Minute/hr
Description:	Minutes that flare is detected during the hour h
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	108 (total for monitoring period)
Monitoring equipment:	Type: (Nais) Matsushita Electric Works, Ltd/ TH2385 Accuracy: +/- 3°C Serial Number: 00912 Calibration frequency: N/A Date of last calibration: N/A Validity: N/A Monitoring position / ID: (21)/Flare detector & hour counter
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded every shift (8 hours)
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**T**
Unit:	Celcius

Description:	Temperature of biogas
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	61 (average)
Monitoring equipment:	Type: RTD sensor: Rosemount/68 N11 A30C060T26 / Temperature transmitter: RosemountAccuracy: +/- 3°C Serial Number: RTD sensor: 0541593 / Temperature transmitter: 0187554 Calibration frequency: 12 months Date of last calibration: 2-January-12 Validity: 1-January-13 Monitoring position / ID: (22)/TIC-002
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded every shift (8 hours)
Calculation method (if applicable):	Measured continuously and recorded every shift (8 hours)
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**P**
Unit:	Bar (gauge)
Description:	Pressure of biogas
Measured/ Calculated / Default:	Measured
Source of data:	Logbook
Value(s) of monitored parameter:	0.411 (average)
Monitoring equipment:	Type: SIEMENS/TRANS P 7MF1563-3BA01 Accuracy: At 25 C, 0.25 % of full scale-typical (0.5% of full scale max) Serial Number: AZB/R0100522 Calibration frequency: 12 months Date of last calibration: 02-January-12 Validity: 01-January-13 Monitoring position / ID: (23)/PIC-002
Measuring/ Reading/ Recording frequency:	Measured continuously and recorded every shift (8 hours)

Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline and project emission calculations
Additional comment:	N/A

Data / Parameter:	**$Q_{burner\_stack,y}$ ($FR_{e,s}$ in AM0013)**
Unit:	Nm^3/yr
Description:	Amount of burner stack gas in year y
Measured/ Calculated / Default:	Calculated
Source of data:	Logbook, measurement campaign
Value(s) of monitored parameter:	Please refer to spreadsheet due to multiple results
Monitoring equipment:	N/A Monitoring position / ID: (24)/BU-01 (25)/BU-02 (26)/BU-330-001 (27)/BU-330-002
Measuring/ Reading/ Recording frequency:	Calculated quarterly
Calculation method (if applicable):	As per approved revision of monitoring plan
QA/QC procedures:	N/A
Purpose of data:	Project emission calculations
Additional comment:	N/A

Data / Parameter:	**W_{CH4_stack} ($P_{CH4,e,s}$ in AM0013)**
Unit:	Nm^3 CH_4/ Nm^3 stack gas
Description:	Fraction of methane in burner stack gas
Measured/ Calculated / Default:	Calculated
Source of data:	Measurement campaign
Value(s) of monitored parameter:	Please refer to spreadsheet due to multiple results
Monitoring equipment:	N/A – measurement campaign by external laboratory

Measuring/ Reading/ Recording frequency:	Quarterly
Calculation method (if applicable):	As per revised monitoring plan, the flow rate of burner stack gas in Nm^3/second is measured through a measurement campaign and used to derive a project-specific, empirically-derived Nm^3 stack gas/Nm^3 feed biogas factor.
QA/QC procedures:	Measurement campaign is carried out by an accredited external laboratory
Purpose of data:	Project emission calculations
Additional comment:	N/A

D.3. Implementation of sampling plan

>>
The monitored COD as described in section D.2 are determined by a sampling approach. The COD samples are taken from the following points:

1. $COD_{conc\ in,baseline,m}$: (Monitoring Point 2),
2. $COD_{conc\ dig\ out,m}$: (Monitoring Point 16),
3. $COD_{conc\ sludge,m}$: taken from sludge removed during the monitoring period.

The COD samplings are taken on daily basis at Points 2 and 16 and monthly for the sludge. The results are used internally for operational purposes. For CDM purpose, all samples are taken to internal laboratory where the equipments for measuring COD are calibrated every month to ensure that the COD being measured and recorded are accurate and meet the required.

The collected COD values are summarized as below:

Month	$COD_{conc\_in,baseline,m}$ COD concentration of effluent entering the lagoon in the baseline (Point 2) (kg COD/m^3)	$COD_{conc\_dig\_out,m}$ COD out of digester to lagoons (Point 16) (kg COD/m^3)	$COD_{conc\_sludge,m}$ COD of treated wastewater at the final pond (Sludge) (kg COD/kg sludge)
Dec-09	20.1	4.0	0.58
Jan-10	20.0	4.2	0.33
Feb-10	22.7	4.7	0.33
Mar-10	30.9	5.7	1.75
Apr-10	21.6	5.4	3.32
May-10	20.9	2.3	2.53
Jun-10	20.8	3.7	2.48
Jul-10	22.5	4.3	2.35
Aug-10	26.4	5.4	2.88
Sep-10	28.7	5.7	3.89
Oct-10	24.9	5.4	3.33
Nov-10	26.6	6.0	3.75
Dec-10	26.4	5.8	4.00
Jan-11	27.8	5.7	0.39
Feb-11	29.3	6.4	0.44
Mar-11	29.0	6.2	0.96
Apr-11	26.9	5.5	2.18
May-11	21.6	1.5	2.24
Jun-11	19.7	4.4	2.08
Jul-11	19.7	4.8	2.25
Aug-11	19.4	4.4	2.08
Sep-11	21.6	4.8	2.11
Oct-11	21.5	4.8	2.46

Nov-11	22.0	4.7	2.31
Dec-11	21.0	4.2	2.32
Jan-12	23.0	4.5	0.38
Feb-12	23.1	5.3	0.50
Mar-12	26.5	5.9	0.48
Apr-12	22.1	5.3	2.59
May-12	21.7	3.1	-
Jun-12	24.9	5.4	-
Jul-12	23.6	5.1	-
Aug-12	23.0	5.3	-
Sep-12	21.2	5.0	-
Oct-12	21.4	4.8	-
Nov-12	23.9	5.2	-
Dec-12	24.9	5.7	-
Average	**23.6**	**4.9**	**1.55**

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

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

>>

Baseline emissions are calculated as:

$$BE_y = BE_{lagoon,y} + BE_{fuel\_oil,y}$$

where:

BE_y = Baseline emissions (tCO_2e/yr)
$BE_{lagoon,y}$ = Baseline CH_4 emissions from the open lagoons in year *y* (tCO_2e/yr)
$BE_{fuel\ oil,y}$ = Baseline CO_2 emissions from the combustion of fuel oil in year *y* (tCO_2/yr)

$BE_{lagoon,y}$

$BE_{lagoon,y}$ is the baseline methane emission from the open lagoons. As described in AM0013, the lower figure of the two $BE_{lagoon,y}$ results computed in the following manner should be used for the calculation of emission reductions;

(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) $BE_{lagoon,theoretical,y}$

$BE_{lagoon,\ theoretical,y}$ can be estimated from the below equation. Relevant parameters and monitored data during reporting period are summarized in following table.

$$BE_{lagoon,\ theoretical,\ y} = BE_{total\ \ emission\ \ lagoon,\ y} - PE_{phys\ \ leak,y}$$

Where:

$$BE_{total\ \ emission\ \ lagoon,\ y} = \Sigma_m(COD_{available,m} \times MCF_{baseline,m}) \times B_o \times GWP\_CH_4$$

And:

$$PE_{phys\ \ leak,y} = Q_{biogas\ \ total,\ y} \times W_{CH4} \times \rho_{CH4} \times LF \times GWP\_CH_4$$

Where:

$BE_{lagoon,\ theoretical,\ y}$ = baseline methane emission less the physical leakage (tCO_2e)
$BE_{total\ \ emission\ \ lagoon,\ y}$ = baseline methane emission from open lagoons (tCO_2e)
$PE_{phys\ \ leak,y}$ = project methane emission due to physical leakage from the anaerobic digester (tCO_2e)
$COD_{available,m}$ = monthly COD available for conversion which is equal to sum of the monthly COD

entering the digester and COD carried over from the previous month (kg COD/month)
$MCF_{baseline,m}$ = monthly methane conversion factor for the open lagoons in the baseline (fraction)
B_o = maximum methane producing capacity (kg CH_4/kg COD)
GWP_CH4 = global warming potential for methane (tCO_2e/tCH_4)
$Q_{biogas\ total}$ = Quantity of biogas produced and collected in the digester (Nm^3biogas)
W_{CH4} = fraction of methane in biogas (m^3CH_4/m^3biogas)
ρ_{CH4} = Density of methane (tCH_4/Nm^3CH_4)
LF = rate of physical leakage (fraction)

The summary results for $BE_{lagoon,theoretical,y}$ is given in the table below.

Table 1: Summary results for $BE_{lagoon,theoretical,y}$

Parameters	$BE_{total\_emission\_lagoon,m}$ (tCO_2e/m)	$PE_{\_phys\_leakage,m}$ (tCO_2e/m)	$BE_{lagoon,theoretical,m}$ (tCO_2e/m)
Dec-09	8,559	1,177	7,382
Jan-10	9,848	1,219	8,629
Feb-10	14,059	1,457	12,602
Mar-10	16,235	1,138	15,097
Apr-10	10,322	249	10,073
May-10	6,197	63	6,134
Jun-10	4,957	313	4,644
Jul-10	6,448	664	5,784
Aug-10	8,893	1,336	7,557
Sep-10	12,740	1,793	10,947
Oct-10	11,874	2,021	9,853
Nov-10	12,776	1,969	10,807
Dec-10	11,405	1,161	10,244
Jan-11	9,964	942	9,022
Feb-11	15,749	1,316	14,433
Mar-11	15,367	1,263	14,104
Apr-11	14,966	345	14,621
May-11	9,062	53	9,009
Jun-11	8,590	407	8,183
Jul-11	8,909	524	8,385
Aug-11	8,691	659	8,032
Sep-11	9,342	1,178	8,164
Oct-11	10,188	877	9,311
Nov-11	10,641	842	9,799
Dec-11	8,398	943	7,455
Jan-12	11,616	722	10,894
Feb-12	15,697	928	14,769
Mar-12	18,975	866	18,109
Apr-12	13,175	224	12,951
May-12	7,145	69	7,076
Jun-12	9,059	507	8,552
Jul-12	9,925	631	9,294
Aug-12	10,979	540	10,439
Sep-12	11,884	525	11,359
Oct-12	13,052	657	12,395
Nov-12	13,715	793	12,922
Dec-12	11,739	789	10,950
Total	**411,141**	**31,160**	**379,981**

(i) $BE_{lagoon,monitored,y}$

Table 2: Summary results for $BE_{lagoon,monitored,y}$

Parameter	$BE_{biogas\_burner,m}$ (tCO_2e/m)	$BE_{biogas\_flare,m}$ (tCO_2e/m)	$BE_{lagoon,\ monitored,m}$ (tCO_2e/m)

Dec-09	7,390	0	7,390
Jan-10	7,704	0	7,704
Feb-10	9,666	0	9,666
Mar-10	7,581	0	7,581
Apr-10	1,602	0	1,602
May-10	392	0	392
Jun-10	1,294	0	1,294
Jul-10	4,206	0	4,206
Aug-10	7,922	3	7,925
Sep-10	11,711	0	11,711
Oct-10	12,667	0	12,667
Nov-10	11,398	0	11,398
Dec-10	6,591	0	6,591
Jan-11	5,675	0	5,675
Feb-11	7,974	0	7,974
Mar-11	8,318	0	8,318
Apr-11	2,243	0	2,243
May-11	349	0	349
Jun-11	2,682	0	2,682
Jul-11	3,469	0	3,469
Aug-11	3,676	0	3,676
Sep-11	6,278	0	6,278
Oct-11	5,488	0	5,488
Nov-11	5,541	0	5,541
Dec-11	5,880	0	5,880
Jan-12	4,701	0	4,701
Feb-12	6,178	0	6,178
Mar-12	5,766	0	5,766
Apr-12	1,479	0	1,479
May-12	366	0	366
Jun-12	3,377	0	3,377
Jul-12	4,204	0	4,204
Aug-12	3,586	0	3,586
Sep-12	3,468	0	3,468
Oct-12	4,362	0	4,362
Nov-12	5,209	0	5,209
Dec-12	5,076	0	5,076
Total	**195,469**	**3**	**195,472**

$BE_{lagoon,monitored,y}$ can be calculated as follows. The relevant parameters and monitored data during reporting period are summarized in the table above.

$$BE_{lagoon,\ monitored,y} = BE_{biogas\ burner,y} + BE_{biogas\ flare,y}$$
$$= \{Q_{biogas\ burner,y} + Q_{biogas\ flare}\} \times W_{CH4} \times \rho_{CH4} \times GWP\_CH_4$$

Where;

$BE_{lagoon,monitored,y}$ = baseline actual methane captured and flared/used for energy generation (tCO_2e)
$BE_{biogas\ burner,\ y}$ = baseline captured CH_4 used at burners (tCO_2e)
$BE_{biogas\ flare}$ = baseline captured CH_4 used at flare (tCO_2e)

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;

As is apparent from the above tables, for the purpose of the calculation of emission reductions, it will be appropriate to apply (ii) which is lower than (i). Therefore, actual methane captured and flare used for energy generation ($BE_{lagoon,monitored,y}$) is selected as the calculation method for the baseline methane emission from open lagoon for this Project ($BE_{lagoon,\ y} = BE_{lagoon,monitored,y}$ =**195,472** tCO_2e).

$BE_{fuel\_oil,y}$

$BE_{fuel\ oil,y}$ is baseline CO_2 emission from the combustion of fuel oil that is, displaced by biogas due to the project activity. According to the AM0013, the emission reduction claim for the displacement of fossil fuel should be capped according to the average of historical 3 years consumption which was validated as 140.6 TJ/year. This translates to a cap on the baseline CO_2 emission from the displacement of fuel oil of 10,615tCO_2e/year. Nevertheless, this cap does not affect the CER calculations for this monitoring period, and is expected to start to affect the project only in the next monitoring period. Relevant parameters and monitored data during reporting period and the result are expressed in following table.

Table 3: Summary results for $BE_{fuel\_oil,y}$

Parameter	Energy in biogas displaced (actual, TJ/m)	$BE_{Fuel\ oil}$ (actual) (tCO_2e/m)	Energy in biogas displaced (capped, TJ/yr)	$BE_{Fuel\ oil}$ (capped at 140.6TJ/yr) (tCO_2e/m)
Dec-09	17.74	1,339	17.74 TJ, capped pro-rata at 11.71TJ	884
Jan-10	18.49	1,396	198.6 TJ over 140.6 TJ So capped	10,615
Feb-10	23.20	1,751		
Mar-10	18.20	1,373		
Apr-10	3.85	290		
May-10	0.94	71		
Jun-10	3.11	234		
Jul-10	10.10	762		
Aug-10	19.02	1,435		
Sep-10	28.11	2,122		
Oct-10	30.41	2,295		
Nov-10	27.36	2,065		
Dec-10	15.82	1,194		
Jan-11	13.62	1,028	138.2 TJ Not over 140.6 TJ So no capped	1,028
Feb-11	19.14	1,445		1,445
Mar-11	19.97	1,507		1,507
Apr-11	5.38	406		406
May-11	0.84	63		63
Jun-11	6.44	486		486
Jul-11	8.33	628		628
Aug-11	8.82	666		666
Sep-11	15.07	1,137		1,137
Oct-11	13.17	994		994
Nov-11	13.30	1,004		1,004
Dec-11	14.11	1,065		1,065
Jan-12	11.29	852	114.7 TJ Not over 140.6 TJ So, no cap	871
Feb-12	14.83	1,119		1,121
Mar-12	13.84	1,045		1,045
Apr-12	3.55	268		270
May-12	0.88	66		82
Jun-12	8.11	612		612
Jul-12	10.09	761		761
Aug-12	8.61	649		652
Sep-12	8.33	628		633
Oct-12	10.47	790		793
Nov-12	12.50	944		956
Dec-12	12.18	919		952
Total	**469**	**35,409**		**30,581**

The baseline emission (BE_y) calculated in accordance with Equation 4 is summarized as follows.

Table 4: Summary of baseline emission of the project

Parameter	$BE_{lagoon,y}$ (tCO_2e/m)	$BE_{Fuel\ oil,y}$ (TJ/m)	BE_y (tCO_2e/m)
Dec-09	7,390	884	8,274
Jan-10	7,704	10,615	18,319
Feb-10	9,666	0	9,666
Mar-10	7,581	0	7,581
Apr-10	1,602	0	1,602
May-10	392	0	392
Jun-10	1,294	0	1,294
Jul-10	4,206	0	4,206
Aug-10	7,925	0	7,925
Sep-10	11,711	0	11,711
Oct-10	12,667	0	12,667
Nov-10	11,398	0	11,398
Dec-10	6,591	0	6,591
Jan-11	5,675	1,028	6,703
Feb-11	7,974	1,445	9,419
Mar-11	8,318	1,507	9,825
Apr-11	2,243	406	2,649
May-11	349	63	412
Jun-11	2,682	486	3,168
Jul-11	3,469	628	4,097
Aug-11	3,676	666	4,342
Sep-11	6,278	1,137	7,415
Oct-11	5,488	994	6,482
Nov-11	5,541	1,004	6,545
Dec-11	5,880	1,065	6,945
Jan-12	4,701	852	5,553
Feb-12	6,178	1,119	7,297
Mar-12	5,766	1,045	6,811
Apr-12	1,479	268	1,747
May-12	366	66	432
Jun-12	3,377	612	3,989
Jul-12	4,204	761	4,965
Aug-12	3,586	649	4,235
Sep-12	3,468	628	4,096
Oct-12	4,362	790	5,152
Nov-12	5,209	944	6,153
Dec-12	5,076	919	5,995
Total	**195,472**	**30,581**	**226,053**

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

>>

Project emissions are calculated as:

$$PE_y = PE_{lagoon,y} + PE_{phys\_leak,y} + PE_{sludge,y} + PE_{enegy\_cons,y} + PE_{stack,y}$$

Where:

ER_y = Emission reductions (tCO_2e/yr)

PE_y = Project emissions (tCO_2e/yr)

$PE_{lagoon,y}$ = Project CH_4 emissions from the open lagoons in year *y* (tCO_2e/yr)

$PE_{phys\ leak\ ,y}$ = Project CH_4 emissions due to the physical leakage from the anaerobic digester in year *y* (tCO_2e/yr)

$PE_{sludge,y}$ = Project CH_4 emissions from the land application of sludge in year y (tCO_2e/yr)

$PE_{energy\ cons,y}$ = Project CO_2e emissions from the consumption of energy on the account of the

project activity in year y (tCO_2e/yr)

$PE_{stack,y}$ = Project CH_4 emissions from incomplete combustion of biogas in the flare and boilers in year y (tCO_2e/yr)

It is noted that neither dewatering process nor leakage are associated with the project activity and both were excluded from the project emission calculation as indicated in the CDM-PDD.

Project emissions are summarized in the table below.

Table 5: Summary results of project emissions

Month	$PE_{stack,m}$ (tCO_2e/m)	$PE_{phys\ leakage,m}$ (tCO_2e/m)	$PE_{lagoon,m}$ (tCO_2e/m)	$PE_{sludge,m}$ (tCO_2e/m)	$PE_{energy\ cons,m}$ (tCO_2e/m)	Total PE (tCO_2e/m)
Dec-09	25	0	634	10	71	740
Jan-10	180	0	746	9	63	998
Feb-10	235	0	1,100	11	63	1,409
Mar-10	220	0	1,311	109	65	1,705
Apr-10	40	0	298	81	43	462
May-10	10	0	110	75	47	242
Jun-10	32	0	364	57	51	504
Jul-10	111	0	838	63	62	1,074
Aug-10	212	0	1,156	36	74	1,478
Sep-10	287	0	1,419	75	78	1,859
Oct-10	308	0	1,079	30	73	1,490
Nov-10	283	0	1,280	254	89	1,906
Dec-10	160	0	964	103	75	1,302
Jan-11	125	0	715	9	47	896
Feb-11	161	0	1,203	16	46	1,426
Mar-11	198	0	1,196	46	49	1,489
Apr-11	61	0	371	45	21	498
May-11	7	0	51	307	17	382
Jun-11	53	0	811	26	45	935
Jul-11	68	0	990	40	44	1,142
Aug-11	80	0	846	55	43	1,024
Sep-11	123	0	905	53	50	1,131
Oct-11	115	0	1,013	144	51	1,323
Nov-11	124	0	1,014	44	50	1,232
Dec-11	127	0	619	73	46	865
Jan-12	182	0	801	10	45	1,038
Feb-12	241	0	1,428	21	57	1,747
Mar-12	217	0	1,774	27	55	2,073
Apr-12	51	0	307	89	13	460
May-12	30	0	112	0	12	154
Jun-12	167	0	1,082	0	46	1,295
Jul-12	202	0	1,002	0	45	1,249
Aug-12	195	0	1,150	0	43	1,388
Sep-12	186	0	1,133	0	40	1,359
Oct-12	193	0	1,172	0	37	1,402
Nov-12	203	0	1,218	0	33	1,454
Dec-12	196	0	899	0	27	1,122
Total	**5,408**	**0**	**33,111**	**1,918**	**1,816**	**42,253**

Remark:

- As per AM0013, version 4.0, if lower (ii) "actual methane captured and flare/ used for energy generation ($BE_{lagoon,monitored,,y}$)" was used as baseline emission, then, emission from physical leakage from digester ($PE_{\_phys\_leak}$) is considered as zero.
- For $PE_{stack,y}$, the CE_{burner} factor of 0.997, 0.978, 0.981, 0.973 was applied to the calculation in year 2009, 2010, 2011 and 2012 respectively.
- $PE_{lagoon,y}$ is project CH_4 emissions from the in the secondary treatment open lagoons system (tCO_2e)
- $PE_{phys\_leak,y}$ is project CH_4 emission due to the physical leakage from anaerobic digester (tCO_2e)
- $PE_{sludge,y}$ is project CH_4 emission from the land application of sludge (tCO_2e)

- $PE_{energy\_cons,y}$ is project CH_4 emission from the consumption of energy on the account of the project activity (tCO_2e)
- $PE_{stack,y}$ is project CH_4 emission from the incomplete consumption of biogas in the flare and boilers (tCO_2e)

E.3. Calculation of leakage

>>
No leakage is associated with the project activity.

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

Consistent with AM0013, the emission reduction achieved during this monitoring period can be calculated from difference between baseline emission in year y (BE_y) and project emission in year y (PE_y) as:

$$ER_y = BE_y - PE_y$$

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	226,053	42,253	0	183,800

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

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	283,490[2]	183,800

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

>>
As there is no increase in CERs, this section is not applicable.

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

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	183,800	0

[2] This is calculated by dividing ex-ante estimated annual emission reductions in the PDD by number of operating days in a year estimated in the PDD and multiplied the product of these two by the number of operating days this monitoring period , (98,372 tCO_2e/330 days)*951 days = 283,490 tCO_2e.

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APPENDIX I

BASELINE INFORMATION

Calculation of the baseline emission factor ($EF_{grid,CM,y}$)

The CO_2 emissions factor for the grid system is sourced from "*The study of emission factor for electricity generation of Thailand in year 2010"*[3] (hereinafter referred to as the "Study"), published by Thailand Greenhouse Gas Management Organization (TGO) on 30 December 2011. TGO is a public organization under the Ministry of Natural Resources and Environment (MNRE) and is being the Designated National Authority for CDM (DNA-CDM) in Thailand. According to this documentation, this grid emission factor was determined based on the data given in the "*Electricity Statistic Annual Report 2008 – 2010"* and along with the procedure stipulated in latest methodological tool "*Tool to calculate the emission factor for an electricity system (version 02.2.1)"* (hereinafter referred to as the "EF Tool")

This methodological EF Tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the operating margin (OM), the build margin (BM) as well as the combined margin (CM), as follows:

Step 1: Identify the relevant electricity systems

Consistent with the requirements stipulated in the EF Tool, the delineations of the project electricity system and connected electricity systems that were published by the host country DNA, TGO, are applied. Following the Thai DNA delineation, the relevant electric power system of the project activity is Thailand's national grid. It is because the electricity transmission system of Thailand is considered as a single system since the transmission lines are networked throughout the country and owned by the Electricity Generating Authority of Thailand (EGAT). EGAT is the authority that regulates electricity generation and main transmission system, meanwhile Metropolitan Electricity Authority (MEA) is responsible for electricity distribution system in Bangkok and vicinity area, and Provincial Electricity Authority (PEA) is responsible for electricity distribution system in the rest of country.

The quantity of electricity generated and transmitted to the national grid can be obtained from the Electricity Statistic Annual Report 2008 – 2010 provided by EGAT. Data are categorized by electricity generation system, group of power producer (EGAT, Independent Power Producers (IPPs), Small Power Producers (SPPs) and type of power plant (LC/MR and Non LC/MR).

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

Project participant chosen Option I as provided in Step 2 of the EF Tool, where, only grid power plants are included in the calculation. It is because in Thailand the electricity data that generate and transmit to the national grid are available, while, the off-grid electricity data are not available.

Step 3: Select a method to determine the operating margin (OM)

The EF Tool offers four methods for the calculation of operating margin emission factor ($EF_{grid,OM,y}$), which include:
(a) Simple OM;
(b) Simple adjusted OM;
(c) Dispatch data analysis OM; or
(d) Average OM.

Out of the four methods, the simple OM method (Option a) is used, as low-cost/must-run (LC/MR) resources of the national grid was determined to be 6.32% of the total grid generation in average of the five most recent years, which constitute less than threshold limit of 50%, as shown in Table A1 below.

Table A1: The ratio of the low cost / must run (LC/MR) in the last 5 years (2006-2010)

Generation Type	Electricity Generation (GWh)	Percentage

[3] Data source: http://www.tgo.or.th/english/index.php?option=com_content&view=article&id=178:thailand-grid-emission-2010-report&catid=50:tgos-research-projects&Itemid=40

	EGAT	IPP	SPP	Total	
2010					
Total	78,517.70	67,775.98	13,897.27	160,190.96	-
- Non LC/MR	73,185.41	67,775.98	11,642.33	152,603.73	-
- LC/MR[4]	5,332.30	0.00	2,254.94	7,587.23	**4.74%**
2009					
Total	66,488.10	64,840.72	13,971.37	145,300.19	-
- Non LC/MR	59,541.66	64,840.72	11,811.42	136,193.80	-
- LC/MR	6,946.44	0.00	2,159.95	9,106.39	**6.27%**
2008					
Total	63,719.02	67,420.14	14,092.83	145,232.00	-
- Non LC/MR	56,791.19	67,420.14	11,904.81	136,116.14	-
- LC/MR	6,927.83	0	2,188.03	9,115.86	**6.28%**
2007					
Total	67,704.95	62,233.44	14,426.00	144,364.39	**-**
- Non LC/MR	59,765.33	62,233.44	11,982.99	133,981.76	**-**
- LC/MR	7,939.62	0	2,443.02	10,382.64	**7.19%**
2006					
Total	70,409.11	55,360.65	13,652.19	139,421.94	**-**
- Non LC/MR	62,480.23	55,360.65	11,619.95	129,460.82	**-**
- LC/MR	7,928.88	0	2,032.23	9,961.12	**7.14%**
Average 5 year of LC/MR					**6.32%**

Between the *Ex-ante* and *Ex-post* options of the data vintages, the *Ex-ante* option of a 3-year generation – weighted average is chosen for the project activity. The simple OM emission factor is calculated based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

Step 4: Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including LC/MR power plants/units. Option B, which is based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system, provided in Step 4 of the EF Tool was chosen with the following reasons:

(a) The necessary data for Option A is not available (Net electricity generation and a CO_2 emission factor of each power plant unit);
(b) Only nuclear and renewable power generation are considered as LC/MR power sources and quantity of electricity supplied to the grid by these sources is known; and
(c) Off-grid power plants are not included in the calculation, as per reason provided in Step 2 that off-grid data in Thailand is not available.

Therefore, the simple OM emission factor ($EF_{grid,OMsimple,y}$) is calculated based on the net electricity supplied to the grid by all power plants serving the system, excluding LC/MR power plants/units and including electricity imports, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follow:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,y}$ = Amount of fossil fuel type *i* consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)

[4] LC/MR power plants include hydropower and renewable energy (including biomass, solar and geothermal power)

EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including LC/MR power plants/units, in year *y* (MWh)

i = All fossil fuel types combusted in power sources in the project electricity system in year *y*

y = The relevant year as per the data vintage chosen in Step 3

The values of CO_2 emission from combustion of fossil fuel (per unit of fossil fuel) are shown in Table A2. Net Calorific Value (NCV) is obtained from data provided by the Department of Alternative Energy Department and Efficiency (DEDE), Ministry of Energy. The CO_2 Emission Factor of fossil fuel follows IPCC default values as specified in the *"2006 IPCC Guidelines for National Greenhouse Gas Inventories"*.

Table A2: Net Calorific Values ($NCV_{i,y}$) and CO_2 emission per unit of each type of fossil fuel

Fuel type[5]	Unit	Net Calorific Value[6]	CO_2 Emission Factor[7]	CO_2 Emission
		(MJ/Unit)	(tCO_2/TJ)	($kgCO_2$/Unit)
Natural Gas	scf.	1.02	54.30	0.055
Lignite	ton	10,470.00	90.90	951.723
Bituminous	ton	26,370.00	89.50	2,360.115
Bunker	liter	39.77	75.50	3.003
Diesel	liter	36.42	72.60	2.644

Table A3: Comparison of the name of fuel type sourced from different reports

The Study[8]	DEDE[9] (Thailand)	IPCC[10]
Natural Gas	Natural Gas (Dry)	Natural Gas
Lignite	Lignite (Mae Moh)	Lignite
Bituminous	Coal Import	Other Bituminous Coal
Bunker	Fuel Oil	Residual Fuel Oil
Diesel	Diesel	Diesel Oil

The quantity of electricity generated and delivered to the national grid can be obtained from the *"Electricity Statistic Annual Report 2008 – 2010"*, as shown in Table A4. Data are categorized by electricity generation system, group of power procedure (EGAT, IPPs, SPPs) and type of power plant and quantity of electricity generated by non LC/MR power plants. Quantity and type of fossil fuel consumed in electricity generation are also obtained from the "Electricity Statistic Annaul Report 2008 – 2010", as shown in Table A5.

Table A4: Quantity of electricity generated and delivered to the national grid[11] (excluding LC/MR power plants/units), EG_y

Generation System	Electricity Generated and Delivered to the Grid (EG_y, GWh)			
	EGAT	IPP	SPP	Total
(2010)				
Total non LC/MR	**73,185.41**	**67,775.98**	**11,642.33**	**152,603.73**
Thermal	27,289.03	15,408.42	2,162.89	44,860.34
Combined-Cycle	38,338.71	52,367.56	8,655.76	99,362.04
Gas Turbine	276.3	-	823.67	1,099.97
Diesel Engine	3.98	-	-	3.98

[5] See Table A3: Comparison of the name of fuel type sourced from different report
[6] Electric Power in Thailand 2010/Department of Alternative Energy Development and Efficiency, Ministry of Energy
[7] IPCC default values at the lower limit as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guideline for National Greenhouse Gas Inventories
[8] The Study of emission factor for an electricity system in Thailand 2010
[9] Electric Power in Thailand 2010/ Department of Alternative Energy and Efficiency, Ministry of Energy
[10] 2006 IPCC Guideline for National Greenhouse Gas Inventories
[11] Electricity Statistic Annual Report 2008 – 2010/ Electricity Generating Authority of Thailand (EGAT)

Electricity Import	7,277.39	-	-	7,277.39
(2009)				
Total non LC/MR	**59,541.66**	**64,840.72**	**11,811.42**	**136,193.80**
Thermal	23,463.69	12,388.03	2,225.63	38,077.35
Combined-Cycle	33,164.46	52,452.69	8,752.19	94,369.35
Gas Turbine	309.63	-	833.60	1,143.23
Diesel Engine	1.44	-	-	1.44
Electricity Import	2,602.43	-	-	2,602.43
(2008)				
Total non LC/MR	**56,791.19**	**67,420.14**	**11,904.81**	**136,116.14**
Thermal	26,778.89	14,398.34	1,996.83	43,174.06
Combined-Cycle	26,449.20	53,021.80	9,029.90	88,500.90
Gas Turbine	659.33	-	878.07	1,537.41
Diesel Engine	2.30	-	-	2.30
Electricity Import	2,901.47	-	-	2,901.47

Table A5: Amount of fossil fuel consumed by power plants[12] (excluding LC/MR power plants/units), $FC_{i,y}$

Fuel Type	Unit	Fuel Consumption			
		EGAT	IPP	SPP	Total
(2010)					
Natural Gas	scf.	430,662,249,446	491,131,955,423	151,290,468,150	1,073,084,673,019
Lignite	ton	16,043,174	-	-	16,043,174
Bituminous	ton	-	3,646,898	1,855,262	5,502,160
Bunker	liter	140,084,467	87,347,782	5,797,497	233,229,746
Diesel	liter	11,865,427	10,853,795	1,307,336	24,026,558
(2009)					
Natural Gas	scf.	369,146,214,392	459,228,417,361	140,550,086,056	968,924,717,809
Lignite	ton	15,818,265	-	-	15,818,265
Bituminous	ton	-	3,645,721	1,840,527	5,486,248
Bunker	liter	111,039,065	38,180,874	8,797,506	158,017,445
Diesel	liter	12,140,891	-	1,685,046	13,825,937
(2008)					
Natural Gas	scf.	340,739,529,461	490,866,999,785	145,410,364,035	977,016,893,281
Lignite	ton	16,407,465	-	-	16,407,465
Bituminous	ton	-	3,711,791	1,866,776	5,578,567
Bunker	liter	247,441,682	93,212,260	9,555,452	350,209,394
Diesel	liter	6,792,039	43,698,832	1,451,087	51,941,958

Table A6 summarizes the calculated CO_2 emissions from electricity generation in the years 2008 – 2010 categorized by fuel types. The total emissions during the 3-year period were 254,714,130 tCO2. The results in Table A6 show that the 3-year weighted average simple OM emission factor is 0.5994 tCO2/MWh.

Table A6: Determination of the simple OM emission factor, $EF_{grid,OMsimple,y}$

Fuel type	Fuel Consumption ($FC_{i,y}$)	NCV of fossil	CO_2 Emission	Electricity Generated	CO_2 Emission	OM Emission

[12] Electricity Statistic Annual Report 2008 – 2010/ Electricity Generating Authority of Thailand (EGAT)

	Unit	Volume/mass	fuels, $NCV_{i,y}$ (MJ/Unit)	Factor of Fossil Fuel, $EF_{CO2i,v}$ (tCO_2/TJ)	and Delivered to Grid, EG_y (MWh)	s (tCO_2)	Factor (tCO_2/MWh)
(2010)							
Total					**152,603,730**	**88,452,088**	
Natural Gas	scf.	1,073,084,673,019	1.02	54.3	152,603,730	59,433,868	**0.5796**
Lignite	ton	16,043,174	10,470	90.9		15,268,658	
Bituminous	ton	5,502,160	26,370	89.5		12,985,730	
Bunker	liter	233,229,746	39.8	75.5		700,304	
Diesel	liter	24,026,558	36.4	72.6		63,528	
(2009)							
Total					**136,193,800**	**82,178,673**	
Natural Gas	scf.	968,924,717,809	1.02	54.3	136,193,800	53,664,864	**0.6034**
Lignite	ton	15,818,265	10,470	90.9		15,054,607	
Bituminous	ton	5,486,248	26,370	89.5		12,948,176	
Bunker	liter	158,017,445	39.8	75.5		474,469	
Diesel	liter	13,825,937	36.4	72.6		36,557	
(2008)							
Total					**136,116,140**	**84,083,369**	
Natural Gas	scf.	977,016,893,281	1.02	54.3	136,116,140	54,113,058	**0.6177**
Lignite	ton	16,407,465	10,470	90.9		15,615,362	
Bituminous	ton	5,578,567	26,370	89.5		13,166,060	
Bunker	liter	350,209,394	39.8	75.5		1,051,551	
Diesel	liter	51,941,958	36.4	72.6		137,339	
Average simple OM Emission Factor, $EF_{grid,OMsimple,y}$, during 2008 - 2010							**0.5994**

Step 5: Calculate the build margin (BM) emission factor

The build margin is calculated as the generation-weighted average emission factor of a sample group of power plants. The sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify Tthe set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5-units) and determine their annual electricity generation (AEGSET-5-units, in MWh) that have been built most recently; or

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify Tthe set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation (AEGSET-≥20%, in MWh).

From these two options, the sample group that comprises the larger annual generation is to be chosen. In the case of the Thailand's national grid, the annual electricity generation estimated under Option (a) equals to 10,815,570 MWh (AEGSET-5-units), whereas that under Option (b) equals to 32,934,250MWh (AEGSET-

≥20%), which is equivalent to 20.56% of the total national grid generation in 2010 (AEGtotal = 160,190,960 MWh). Therefore, Option (b) is chosen.

Table A7: Annual electricity generation of the set of five power units in Option (a)

Power Unit	Commissioning Date	Grid Generation (MWh)[13]
1. North Bangkok Power Plant (Unit 01)	19-Nov-10	1,584,220
2. Bangpakong Power Plant (Unit 05)	16-Sep-09	4,643,220
3. Phu Kieaw Bio Power Project 2	15-Sep-09	79,460
4. Dan Chang Bio Power Project 2	15-Sep-09	76,750
5. South Bangkok Power Plant (Unit 03)	1-Mar-09	4,431,920
Total annual electricity generation from 5 power units that started to supply electricity to the grid most recently (AEGSET-5-units)	-	**10,815,570**

Table A8: Annual electricity generation of the set of power units in Option (b)

Power Unit	Grid Generation (MWh)[14]	Accumulated MWh	Accumulated % as of total grid generation in 2010
1. North Bangkok Power Plant (Unit 01)	1,584,220	1,584,220	0.99%
2. Bangpakong Power Plant (Unit 05)	4,643,220	6,227,440	3.89%
3. Phu Kieaw Bio Power Project 2	79,460	6,306,900	3.94%
4. Dan Chang Bio Power Project 2	76,750	6,383,650	3.99%
5. South Bangkok Power Plant (Unit 03)	4,431,920	10,815,570	6.75%
6. Chana Power Plant (Unit 01)	5,090,020	15,905,590	9.93%
7. Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	7,124,720	23,030,310	14.38%
8. Gulf Power Generation Co., Ltd. (Unit 1&2)	9,903,930	**32,934,250**	**20.56%**[15]

Between the Ex-ante and Ex-post options of the data vintages, the Ex-ante option is chosen for the project activity. For the first crediting period, the BM emission factor is calculated ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the BM emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the BM emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

The build margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year y for which electricity generation data is available. As represented in above, eight power plants listed in Table A8 comprise 20.56% of total national grid generation system in 2010, which has the larger generation than the group of power plants listed in Table A7. Therefore, the group of power plants in Option (b) of Step 5 is chosen and used for build margin emission factor calculation, shown below:

$$EF_{grid,BM,y} = \frac{\sum_m (EG_{m,y} \, x \, EF_{EL,m,y})}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO2 emission factor in year y (tCO2/MWh)

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m, in year y (MWh)

[13] Electricity Statistic Annual Report 2010/Electricity Generating Authority of Thailand

[14] Electricity Statistic Annual Report 2010/ Electricity Generating Authority of Thailand

[15] As per Step 5 of the EF Tool, "if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation", therefore, electricity generation from Gulf Power Generation Co., Ltd (Unit 1&2) was included in the calculation.

$EF_{ELm,y}$ = CO2 emission factor of power unit m in year y (tCO2/MWh)
m = Power units included in the build margin
y = Most recent historical year for which electricity generation data is available

The CO_2 emission factor of each power unit m ($EF_{EL,m,y}$) is determined as per the guidance in Option A1 of Step 4 as provided in the EF Tool as follows:

$$EF_{EL,m,y} = \frac{\sum_i (FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_{m,y}}$$

Where:
$FC_{i,m,y}$ = Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (mass or volume unit)
$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
i = All fossil fuel types combusted in power unit *m* in year *y*

Thus, the build margin CO_2 emission factor ($EF_{grid,BM,y}$) is then calculated by the following equation:

$$EF_{grid,BM,y} = \frac{\sum_i (FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_{m,y}}$$

Table A9: Build margin emission factor ($EF_{grid,BM,y}$) in 2010

Fuel type	Fuel Consumption,[16] $FC_{i,m,y}$		NCV of fossil fuels, $NCV_{i,y}$ (MJ/Unit)	CO_2 Emission Factor of Fossil Fuel, $EF_{CO2i,y}$ (tCO_2/TJ)	Electricity Generated and Delivered to Grid, $EG_{m,y}$ (MWh)	CO_2 Emissions (tCO_2)
	Unit	Volume/ mass				
Natural Gas	scf.	251,512,881,819	1.02	54.3	32,934,250	13,930,292
Lignite	ton	-	10,470	90.9		0
Bituminous	ton	-	26,370	89.5		0
Bunker	liter	-	39.8	75.5		0
Diesel	liter	1,179,772	36.4	72.6		3,119
				Total	**32,934,250**	**13,933,412**
BM Emission Factor, $EF_{grid,BM,y}$ (tCO_2/MWh)					**0.4231**	

Based on the above calculation, the resultant build margin (BM) emission factor is 0.4231 tCO_2/MWh.

Step 6: Calculate the combined margin emission factor

The combined margin emission factor ($EF_{grid,CM,y}$) is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

Where:
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
W_{OM} = Weighting of operating margin emission factor (%)
W_{BM} = Weighting of build margin emission factor (%)

[16] Fuel consumptions of the most recently built power plants as listed in Table 9 are sourced from Electricity Report 2009/ Electricity Generating Authority of Thailand.

As per the EF Tool, the weightings of OM and BM emission factors for all other projects that are not solar or wind power generation are 0.50 and 0.50 respectively for the crediting period. Table A10: demonstrates that the resultant combined margin (CM) CO_2 emission factor of Thailand's national grid is 0.5113 tCO_2/MWh, for all other project.

Table A10: Baseline emission factor of Thailand's national grid in 2010

Parameters	Solar power project
OM emission factor, $EF_{grid,OM,y}$ (tCO_2/MWh)	0.5994
Weighting of OM, W_{OM} (tCO_2/MWh)	0.50
BM emission factor, $EF_{grid,BM,y}$ (tCO_2/MWh)	0.4231
Weighting of BM, W_{BM} (tCO_2/MWh)	0.50
CM emission factor, $EF_{grid,CM,y}$ (tCO_2/MWh)	**0.5113**

Document information

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